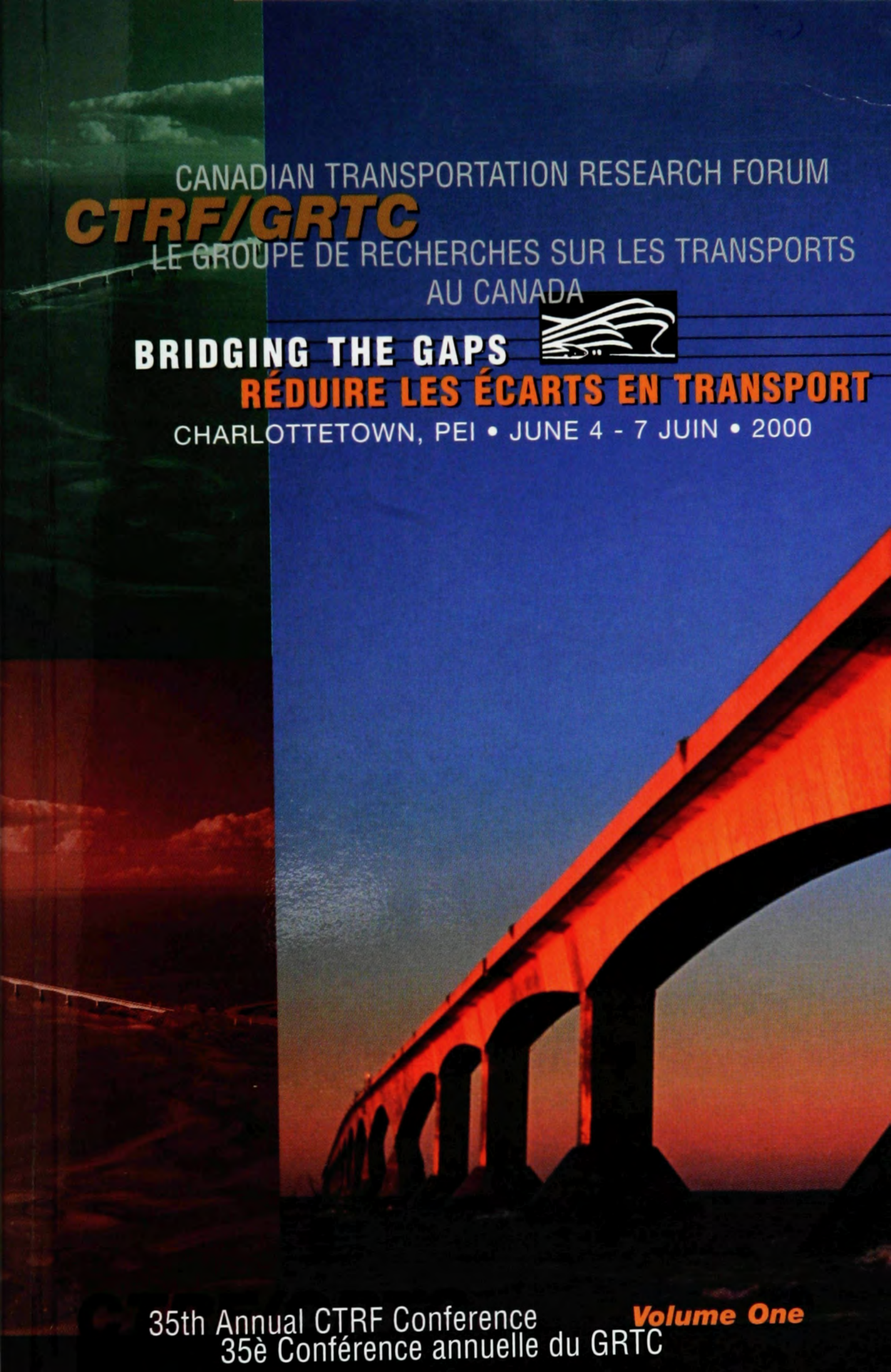


CANADIAN TRANSPORTATION RESEARCH FORUM

CTRF/GRTC

LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

BRIDGING THE GAPS

RÉDUIRE LES ÉCARTS EN TRANSPORT

CHARLOTTETOWN, PEI • JUNE 4 - 7 JUIN • 2000

35th Annual CTRF Conference
35è Conférence annuelle du GRTC

Volume One

CANADIAN TRANSPORTATION RESEARCH FORUM
LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

PROCEEDINGS
of the 35th Annual Conference

ACTES
de la 35è Conférence annuelle

BRIDGING THE GAPS
Réduire les écarts en transport

Charlottetown, Prince Edward Island
June 4-7 juin
2000

Proceedings Printed by

University of Saskatchewan
Printing Services

The Canadian Transportation Research Forum assumes no responsibility for the content of the papers published in these Proceedings, or for any errors or omissions in the printing of this volume. These papers are published by the CTRF as a means of disseminating transportation research and to encourage discussion on a broad range of issues during the CTRF Annual Conference.

President's Message

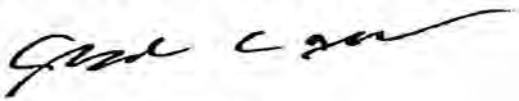
Welcome to CTRF's 35th Annual Conference. Depending how you view such matters, this year is either the last conference of the second millenium or it is the first of the third. Viewed either way, our organizers have prepared a highly relevant event that is truly geared toward Canada's changing transportation challenges and opportunities. "Bridging the Gaps" is about overcoming adversity, showing innovation and responding to needs.

These proceedings are the official record of this meeting, compiled through the efforts of our membership, presenting here, at the 3 and 1/2 days of formal sessions. These articles will be broadly distributed and read, throughout Canada, by many people who have not had the opportunity to attend in person.

The two principal organizers of this event, and their supporting teams, deserve our special thanks. Dr. Eric Hildebrand, of the Department of Civil Engineering, University of New Brunswick and Gordon Tufts, formerly of PEI Transportation and Public Works, and now with Manitoba Highways and Government Services, have assembled an intellectually stimulating forum, and a congenial social program as befits this year's historic setting -- Charlottetown.

It is a profound honor to serve this year as your president. On your behalf, I look forward to the 2000 Annual Canadian Transportation Research Forum, with thanks to the panelists, paper presenters and all of the many volunteers who have contributed to this year's success.

Yours sincerely,
CANADIAN TRANSPORTATION RESEARCH FORUM



Lloyd L. Ash, P.Eng., P.Log.
President

Message du Président

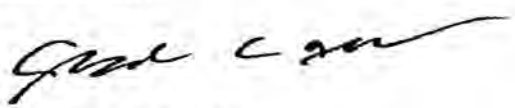
Bienvenue à la 35è Conférence annuelle du GRTC. Selon le point de vue que vous adoptez en la matière, cette année est celle de la dernière conférence du deuxième millénaire ou la première du troisième. Quelle que soit l'opinion, nos organisateurs ont préparé un événement de la plus haute pertinence, véritablement adapté aux défis et opportunités que soulèvent les changements en matière de transport au Canada. « Réduire les écarts » signifie surmonter l'adversité, faire preuve d'innovation et satisfaire des besoins.

Ces Actes constituent le relevé officiel du contenu de la présente rencontre, compilé grâce aux efforts déployés par nos membres sur place, durant les trois jours et demi de séances formelles. Ces articles seront distribués et lus à grande échelle, partout au Canada, par beaucoup de gens qui n'ont pas eu la possibilité d'assister en personne.

Les deux principaux organisateurs de cet événement et leurs équipes de soutien méritent nos chaleureux remerciements. Dr Eric Hildebrand, du Département de génie civil de l'université du Nouveau-Brunswick et Gordon Tufts, anciennement du ministère des Transports et des travaux publics de l'IPE - et actuellement au département manitobain des routes et du transport - ont mis au point un forum intellectuellement stimulant ainsi qu'un agréable programme social qui convient au cadre historique de cette année, Charlottetown.

Je suis profondément honoré d'être votre président cette année. En votre nom, j'émets le ferme espoir d'une excellente Conférence 2000 du Groupe de recherches sur les transports au Canada, et remercie les panélistes, les conférenciers et l'ensemble des nombreux volontaires qui ont contribué au succès de cette année.

Yours sincerely,



Lloyd L. Ash, P.Eng., P.Log.
Président

CONFERENCE SPONSORS
COMMANDITAIRES DE LA CONFÉRENCE

Prince Edward Island Dept. of Transportation & Public Works
Transport Canada / Transports Canada
Industry Canada / Industrie Canada
Canadian Transportation Agency / Office des transports du Canada
Statistics Canada / Statistique Canada
Canadian Pacific Railway / Canadien Pacifique
Canadian National Railways / Canadien National
GE Capital
National Steel Car Ltd.
Thrall Car Manufacturing Company
Trimac
TTX
Trinity Industries, Inc.
Reefer Sales & Service
CGTX Inc.
Thermo King of Toronto
Mi-Jack Products
Top Lift Enterprises
The Greenbrier Companies
Armour Transportation Systems
3M Company
KPMG Consulting
Bison Transport
Halifax Port Authority
Halifax-Dartmouth Port Development Commission
Saint John Port Authority
Marine Atlantic
Navigation Technologies Canada Inc.
VEMAX Management Inc.
IBI Group
Manitoba Highways and Government Services
University of New Brunswick
Confederation Bridge
PEI Tourism
Canadian Freightways Limited

DONORS TO THE CTRF SCHOLARSHIP PROGRAM
PARRAINS AU PROGRAMME DE BOURSES DU GRTC
2000-2001

Canadian Transportation Education Foundation (CTEF)
Canada Maritime Agencies Limited
Canadian National Railways
Canadian Pacific Charitable Foundation
Government of Quebec
Marine Atlantic
plus many individual donors

1999 STUDENT PAPER COMPETITION DONORS
PARRAINS DU CONCOURS DES ÉTUDIANTS EN 1999

Air Canada
CSL Group Gold Medal (CIT)
Albert Stevens Fund
Jim Davey Trust Fund

CANADIAN TRANSPORTATION RESEARCH FORUM
LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

EXECUTIVE - EXECUTIF
1999/2000

President
Lloyd Ash
Trimac Consulting Services Ltd

Executive Vice President
Ron Rice
McGill University

Secretary
Gail R. Sparks
VEMAX Management Inc.

Vice President Finance & Treasurer
Jan B. Bowland
KPMG Management Consulting

Vice President External
Paul Ouimet
Intervistas Consulting Inc.

Vice President Meetings
Gordon Tufts
Manitoba Highways and Government Services

Vice President Programs
Eric Hildebrand
University of New Brunswick

Vice President Awards
Tricia Trépanier
Statistics Canada

Immediate Past President
Janet Weiss
Canadian Pacific Railway

Vice President Organization and Development
Bill Raney
Ministry of Transportation Ontario

Vice President Sponsorship
Marcel Leduc
Canadian National Railway

Councillors:

Professeur Yves Bussière
INRS – Urbanisation

Wade Elliott
Halifax-Dartmouth Port Development

Gerry Kolaitis
VIA Rail Canada

Paul Larouche
Bombardier Transportation

Tony Nardi
Neptune Bulk Terminals Ltd.

Barry Prentice
Transport Institute, University of Manitoba

Rachid Raffa
Quebec Ministry of Transport

Barry Rempel
Canadian Airlines International Ltd.

Roger Roy
Transport Canada

Clarence Woudsma
University of Calgary

CTRF is ...
a broadly based network of transportation professionals with an interest in research and commentary on public policy issues. Membership is open to anyone interested in any aspect of transportation.

CTRF's objectives are ...
- to encourage transportation research in those disciplines which address themselves to the economic, managerial, technical, political, and social aspects of transportation
- to provide a common meeting ground to exchange ideas and research results
- to provide a forum for presenting and discussion transportation issues
- to bring together persons involved with Canada's transportation systems.

CTRF's program consists of ...
- a national conference with research papers, panel discussions, and invited speakers held annually in a different Canadian location
- published proceedings of the national conference
- a one-day semi-annual conference on a topic of national interest
- regional seminars promoted and co-sponsored with other organizations
- an annual CTRF student paper competition
- an annual CTRF scholarship competition
- a newsletter published five times a year.

Le GRTC est ....
un groupe de professionnels(les) en transport intéressés(ées) à la recherche et aux questions de politiques publiques. Etre membre du GRTC convient à quiconque s'intéresse aux transports.

Les objectifs de GRTC sont ...
- d'encourager la recherche dans les domaines suivants liés aux transports: économie, gestion, technologie, politique et aspect social
- de fournir un lieu de rencontre pour échanger idées et résultats de recherche
- de créer un forum pour présenter et discuter de questions de transport
- de réunir les personnes intéressées au système canadien de transport.

Au programme du GRTC ....
- une conférence nationale annuelle avec site variable au Canada, qui consiste en une présentation de textes, tables rondes, conférenciers invités
- la publication des textes présentés à la conférence nationale
- une conférence semi-annuelle d'une journée sur un juget d'intérêt national
- la promotion et le parrainage de colloques régionauz avec d'autres organismes
- un coucours annuel de textes d'étudiants(es)
- un fonds permettant de décerner des bourses
- un bulletin de nouvelles publié cinq fois l'an

..... ANNOUNCING .....

2001 CTRF ANNUAL CONFERENCE TO BE HELD IN VANCOUVER, BRITISH COLUMBIA

WATCH FOR CALL FOR PAPERS COMING IN SEPTEMBER 2000

For further information, contact:

Gail Sparks
(306)242-6199
e-mail: gail.sparks@ctrf.ca

CTRF website: www.ctrf.ca

CANADIAN TRANSPORTATION RESEARCH FORUM
209 - 15 Innovation Blvd.
Saskatoon, Saskatchewan
S7N 2X8
www.ctrf.ca

Telephone: (306) 242-6199
Fax: (306) 242-6199

INVOICE FOR 2000 CTRF MEMBERSHIP

CTRF Membership for Calendar Year 2000 ($60.00)	$ _____
GST at 7% ($4.20)	$ _____
Student Membership for Calendar Year 2000 ($18.00)	$ _____
GST @ 7% ($1.26)	$ _____
TOTAL	$ _____

GST Registration No. R126274562 (If GST exempt, please indicate)

Please make cheque payable to Canadian Transportation Research Forum and mail to the address noted above. **PLEASE RETURN A COPY OF THIS INVOICE WITH PAYMENT IN ORDER THAT OUR DATABASE WILL CONTAIN ACCURATE INFORMATION RELATING TO YOUR MEMBERSHIP.**
VISA and MasterCard are also acceptable.

- ❑ **VISA**
- ❑ **MasterCard**

Card Number _____
Expiry Date _____
Name on Card _____

Please complete the following to ensure accurate membership data. The information below will appear in the next published CTRF/TRF Directory.

Name: _____ Title: _____

Company: _____

Address: _____

_____

_____

Telephone: _____ Fax: _____

e.mail: _____

Please indicate your language preference: ❑ English ❑ French

Le Groupe de Recherches sur les Transports au Canada
209 - 15 Innovation Blvd.
Saskatoon, Saskatchewan
S7N 2X8
www.ctrf.ca

Téléphone: (306) 242-6199
Télécopieur: (306) 242-6199

FACTURE 2000

Membre du GRTC pour l'année 2000 (60.00 $)	$ _____
TPS (4.20$)	$ _____
Membre étudiant du GRTC pour l'année 2000 (18.00$)	$ _____
TPS (1.26$)	$ _____
TOTAL	$ _____

Numéro d'enregistrement pour la TPS R126274562. (Si vous êtes exempté de la TPS, veuillez l'indiquer.)

Veuillez libeller votre chèque au nom du Groupe de Recherches sur les Transports au Canada et poster le tout a l'adresse ci-haut. **SVP RETOURNEZ UNE COPIE DE CETTE FACTURE AVEC VOTRE PAIEMENT AFIN QUE NOTRE BASE DE DONNÉES CONTIENNE UNE INFORMATION EXACTE SUR VOUS COMME MEMBRE DE L'ASSOCIATION.**

VISA et MasterCard sont acceptes.

- ☐ **VISA**
- ☐ **MasterCard**

Numéro de Carte _____

Date d'Expiration _____

Nom Figurant sur la Carte _____

fournir les renseignements demandée ci-dessous afin de nous permettre d'avoir une information complète sur nos membres. Cette information va apparaitre dans le prochain répertoire du GRTC.

Nom: _____ Titre: _____

Compagnie:

_____

Adresse:

_____

_____

_____

Téléphone: _____ Télécopieur: _____

Courrier électronique _____

Veuillez indiquer la langue de correspondance de votre choix.

☐ anglais ☐ français

Volume I

Opening Plenary Session

Transportation Commercialization: How is it Going?
-facilitated by N.Mulder

Session 1.1 Trucking

- *The Quebec Trucking Industry's Image: Public Opinion and the Industry's Perception.* J.Roy and P. Filiatrault 1
- *The Cost of Independence: A Socio-economic Profile of Canadian Owner-Operators.* I.Bess 13
- *Challenges to Using Performance Criteria as a Basis for Vehicle Weight and Dimension Regulations.* C.Borbely, G.Gilks, J.Pearson 28

Session 1.2 Marine

- *Changes in Marine Technology Impact on Canadian Ports,* M.Ircha 43
- *Economic Issues in Marine Pilotage (1972-1997).* J. Monteiro..... 58

Session 1.3 Grain Logistics

- *Towards Optimal Rural Road Abandonment and Upgrade Strategies for Saskatchewan.* P.Christensen and G.Sparks..... 88
- *Update on Grain Transportation in a Continental Perspective.* J.Caceres and D.Richards..... 103
- *A Looming Crisis for Western Canadian Grain?* E.Vido, M.Ojah, and J.Kosior 114

Session 2.1 Governance and Management Reform

- *Governance and Commercialization: Delivering the Vision.* M.Brooks, B.Prentice, and T.Flood 129

Session 2.2 Highway Safety

- *Safety -A Critical Success Factor in Trucking.* S.Dykstra and J. Bowland..... 144
- *Crashes in Construction Areas Derived From a Case Study.* R.Raub, O.Sawaya, J.Schofer, and A.Ziliaskopoulos..... 159
- *The Rural Elderly: Driving Patterns and Accident Involvement.* E.Hildebrand, B. Myrick, and T.Creed..... 175

Session 2.3 Logistics

- *The Impact of Demand-Responsive Deliveries on the Stability of Vehicle Routing Operations.* M.Haughton 192
- *Evaluating Advanced Pickup and Delivery Systems: A Simulation Study.* L.Fu 201

Session 3.1 Infrastructure and Economic Activity

- *The Elusive Link Between Transport Infrastructure and Economic Growth: Testing for Causality Between Provincial Infrastructure Capital and Economic Activity.* W.Waters II 216
- *The Impact of the Fredericton Airport on the Knowledge Industry in Central and Western New Brunswick.* J.D.Innes, J.Brander, and M.Rajendran 231
- *Transportation Subsidies in Canada, 1987 - 1997* Wade Derkson 246

Session 3.2 Rail Panel Session

North American Railway Merger -Should the Gap be Bridged?
-led by C.Banks

Session 3.3 Urban Transportation

- *A Consumer Behaviour Approach to a Commuter Train Research Program.* P.Filiatrault, J.Roy, and P.Dorval 256
- *Factors Affecting Urban Transit Ridership.* H.Kohn 271
- *Impact of Cultural Trends on Urban Transportation.* J.Caceres and D.Richards 286
- *The Transport for Persons with Disabilities: An Economic Evaluation.* M.Boucher 301

Session 4.1 Air I

- *Aeropolitics, Global Alliances, and the Battle for Air Canada.* M.Pustay and R.Kaduck 318
- *Consumer Attitudes Towards Aviation Regulation: A Comparison of Canadian, U.S., and Mexican Air Travellers.* E.Bruning, B.Prentice, and V.Rueda 333

Session 4.2 Rail

- *Probing Railway Operating Ratios.* K.Boland 347
- *The Future of Prairie Branchlines and Short Line Railways.* R.Grant and D.Fahlman 356

Session 4.3 Transit

- *Re-inventing Public Transit in Canada: Why Jitney Buses Need a Fare Chance.* D.Prokop 371
- *Car Bus Demonstrator.* D.Petrie 387
- *Automated Rapid Transit.* R.J.Slade 400

Volume II

Session 5.1 Air 2

- *Country Loyalty Among Air Travellers: A North American Perspective.* E.Bruning, B.Prentice, V.Rueda 412

Session 5.2 Leisure Travel

- *Tourism Research in the United States.* L.Christian 428
- *Quit Yanking My Supply Chain -The Challenges Facing Travel Agencies in Canada.* G.Baldwin 443

Session 5.3 Environmental Issues

- *Overview: Railways and the Environment Workshop.* D.Duncan 455
- *Getting Back to the Basics: Transportation, the Environment, and Some Recent Reflections on Corridor Initiatives in Light of the Monumental "November Options Paper".* M.Butt 470

Session 6.1 Transport Economics and Competition

- *Enhancing Competition in the Presence of Monopoly -An Assessment of Air Policy Options Facing Canada.* J.Brander and B.Cook 487
- *The Use of Economic Analyses in Competition Cases -Analysis of a Predatory Pricing Case and an Intervention in Transportation Cases.* J.Monteiro and G.Roberts 502
- *Macroeconomic Consequences of Economies of Density in Transportation Networks.* Y.Yevdokimov 526

Session 6.2 Highway Operations and Planning

- *Multiple Objectives: Agency Cost versus Level of Service on Northern Low Volume Highways.* G.Sparks, C.Berthelot, and P.Christensen 538
- *Regional and Extra-Regional Highway Traffic in Atlantic Canada: A Review and Preliminary Model.* J.Christie 556
- *Travel Management on an Arterial Roadway.* R.Raub 570
- *Angus L. MacDonald Bridge -Third Lane Project.* M.Deveau, J.Eppell, D.O'Halloran, and S.Eisan 584

Session 6.3 Freight I

- *Open Skies for Passengers, But What About Cargo? Re-evaluating Canada-U.S. Air Cargo Regulations.* S.Shurvell and M.Crockatt 599
- *Air Cargo Leakage: Assessing Opportunities for the Local Air Cargo Market.* M.Crockatt and S.Shurvell 616
- *The Transportation of Dangerous Goods in Canada: Risky Business.* D.Prokop and J.Ogston 636

Session 7.1 Transportation Policy Reform

- *Political Influences on National Transportation Policy.* J.Caceres and D.Richards 650
- *International Regulatory Reform of Railways and Other Network Industries: Lessons for Canadian Freight Railways.* M.Cairns 664
- *Roads a Decade After the Royal Commission.* F.Nix 680

Session 7.2 Intelligent Transportation Systems (ITS) Panel Session

Session 7.3 Freight II

- *Intermodal Freight Transport -A Provincial Analysis.* F.Wilson, and R.Brander 694
- *The Potential for Modal Shift: Contestable Truck Traffic.* C.Kim and T.Ganton 710
- *North American Freight Movement: A Case Study Using Data From the North American Transportation Statistics Project.* I.Bess 723

Student Paper Winners

- *Improving Public Transit Access to Large Airports: A Case Study of Pearson Airport in Toronto.* M.Haider 724
- *A Cost Analysis of Construction Staging Options for Four Lane Highway Resurfacing Projects* Christopher M. Raymond 739
- *Transpacific Flight: The Case for a Strategic Hub* Zubin Daruwala 755

The Quebec Trucking Industry's Image: Public Opinion and Industry's Perception

1. INTRODUCTION

A decade after economic deregulation, the Quebec trucking industry has adapted its management practices and strategies to the new competitive context. However, in their effort to respond to increasing pressures from shippers and competitors, some motor carriers have adopted behaviours that are not in compliance with existing safety rules and regulations with respect to, namely, driving hours and equipment maintenance. Recently, the Quebec government has adopted a new legislation, Bill 430, that will reinforce the application of safety regulation for commercial vehicles. In this context, the Quebec Ministry of Transportation and the Quebec Trucking Association (QTA) have sponsored a study in order to better understand the perception of both the general public and the industry members with respect to the trucking industry's image.

In this paper, we present some of the major findings obtained as a result of three surveys that were conducted early in 1999. The first survey was aimed at the general public and its objective was to measure the public opinion and perceptions with respect to the trucking industry's role and economic impact, truck drivers training and behaviour on the road, the effectiveness of government control over trucking, the environmental impact of the trucking industry, the safety of dangerous goods movements, and the general public's recommendations for improving road safety. The second and third surveys were aimed at the trucking industry. One sample consisted of QTA members which represent most of the larger for-hire motor carriers and the other sample included the remaining owners of commercial vehicles. The later surveys included the same issues as for the general public survey plus some questions

regarding the carriers' implication in their community and steps taken in order to improve road safety.

The next section describes the methodology used in this research and the third section provides a synthesis of the results obtained. Finally, concluding remarks are suggested in the final section.

2. METHODOLOGY

Our research methodology consisted of personnel interviews and three surveys. Personnel interviews were conducted with industry representatives and stakeholders in order to better understand the industry's security issues and image perception. The information gathered through these interviews was instrumental in the design of the questionnaires used for the surveys.

2.1 The General Public Survey

We prepared the questionnaire and hired a survey firm, Léger & Léger, to conduct a telephone survey of 602 motorists, aged 21 and above, during the period between March 12 and April 10, 1999. The margin of error for a sample of this size is ± 4%, at a level of confidence of 95%. The statistical analyses were conducted by University of Quebec's Centre de recherche en gestion (CRG).

2.2 A Survey of QTA Members

Another questionnaire was prepared by the CRG and mailed to the 370 members of the Quebec Trucking Association during the month of March of 1999. A total of 141 completed questionnaires were returned to the CRG for a response rate of 38.1%, which is excellent for a postal survey. The margin in this case is 8.1%, 19 times out of 20.

The Quebec Trucking Association's involvement in the survey consisted of mailing the questionnaires and following up with their members. The CRG was responsible for designing the questionnaire, compiling the results and performing the relevant statistical analyses.

2.3 A Survey of Motor Carriers

A similar questionnaire was prepared by the CRG and mailed to a random sample of 3,500 motor carriers during he last three weeks of June 1999. This sample was prepared by the Quebec Ministry of Transportation and stratified according to the various types of carriers (general freight or bulk, private or for-hire) and their size (number of vehicles per carrier). A total of 996 completed questionnaires were returned to the CRG. Out of this number, 56 questionnaires were filled out by QTA members and removed from the sample when comparing results of the two industry surveys. The 940 remaining questionnaires provide a very good sample of carriers that are not members of the QTA with a maximum margin of error of plus or minus 3.3% at a 95% confidence level. Here again, the results were compiled and analysed by the CRG.

3. SURVEY RESULTS

3.1 General Public Survey Results

3.1.1 Respondents Profile

Respondents are motorists aged 21 or more; 63.3% are married and 41.2% have children, aged 18 or less. They mostly drive a 4-door sedan (42.7%), on a regular basis (85.1%) and more than half (53.7%) of them travel less than 20,000 km per year. The vast majority (79.0%) of respondents believe that they drive better than most motorists. More than half (57.2%) think that driving their car is a good way to relax. Another 53.1% consider that, in general, motorists drive carefully and 51.2% believe that they take calculated risks when driving their car. Finally, 27.8% are of the opinion that waiting in traffic causes them to be in bad humour for part of the day.

3.1.2 Major Findings

When asked what is the first thing that comes to their mind when they see a tractor-trailer assembly, most motorists (41.6%) have a passive

reaction: they have fear, they feel vulnerable or they are afraid to have an accident. Others (28.9%) have a more active reaction: they either outdistance or yield passage to the heavy vehicles. Another 15.3% of motorists have a more positive image of trucks or they have no particular image in mind.

Two surveys were also conducted previously on a similar topic and the results are compared in Table 1. We note that motorists' perceptions with respect to the trucking industry have either improved or remained relatively stable over the years.

Table 1: Motorists Perceptions Through Time With Respect to the Trucking Industry

	% Satisfied		
Truck drivers' behaviour on the road	53.3%	50.0%	62.3%
Safety of hazardous materials transportation	45.5	56.0	61.5
Respect for the environment	33.1	52.0	55.3
Drivers' training	61.9	52.0	52.8
Heavy vehicles' mechanical condition	53.9	45.0	51.1
Truck drivers' respect of speed limits	n/a	36.0	46.9
Trucking industry's contribution to the economy	90.2	83.0	92.3

(1) Léger & Léger 1992 (n=1,011); (2) SOM 1997 (n=1,000); (3) Léger & Léger 1999 (n=602).

It is also interesting to note that most motorists (59.5%) agree that truck circulation should be restricted during peak hours, but a vast majority (78.6%) is not prepared to pay a 5% additional GST (for example) to compensate for this restriction. When asked to formulate recommendations to both truck drivers and motorists, respondents suggest that they should:

Truck Drivers		Motorists	
Respect speed limits	23.6 %	Be more courteous	19.3 %
Show more courtesy	16.6	Keep their distances	16.1
Sleep more / drive less hours	12.1	Not cut in front of a truck	13.8
Be careful	11.7	Be careful	14.0
Say on the right lane	5.4	Respect speed limits	9.9
Stay off the roads during peak hours	5.4	Be more patient	6.4
Maintain their equipment properly	4.8	Yield passage to trucks	6.3
Keep their distances	4.1	Be aware of trucks' slower time of reaction	3.0

Generally speaking, we find that motorists show some empathy towards truck drivers and tend to have a positive image of the industry as a whole. However, when they have to share the road with trucks, motorists become less patient and less understanding with them. It seems like the source of irritation is the heavy vehicle, not the driver! Other results will be discussed in section 3.3.

3.2 Motor Carriers Surveys Results

3.2.1 Respondents Profile

Table 2 indicates the number of motor vehicles owned by both groups of motor carriers, that is the QTA members and the non members. As we can see, the QTA membership is composed of the larger fleets while non members are often owner operators of one or few vehicles. In the same vein, more than half of QTA members have annual revenues in excess of $ 5 million while 63.8 % of non members make less than $ 500,000.

Table 2 : Number of Motor Vehicles Owned by Motor Carriers

Number of vehicles	QTA Members	Non Members
One	n/a	43.6%
Two	n/a	18.2
3 to 10	n/a	30.9
Sub total (10 or less)	24.3%	92.7
11 to 50	45.0	5.9
51 to 100	16.4	0.5
101 and more	14.3	0.9
	(n=140)	(n=932)

Table 3 describes the markets covered by the two groups of motor carriers surveyed. We note that QTA members are exclusively for-hire carriers while 43.1 % of non members are private carriers.

Table 3: Markets Covered as a Percentage of Revenues

Market	QTA Members	Non Members
a) For hire		
◆ Truckload (TL)	49.4%	20.4%
◆ Less-than-truckload (LTL)	17.5	8.0
◆ Bulk	13.2	12.2
◆ Other	19.9	16.3
b) Private	0.0	43.1

Table 4 provides a description of the territories covered by both groups of carriers. Again, we observe a significant difference between the two groups, non members being overwhelmingly present inside the Province of Quebec.

Table 4: Territories Covered as a Percentage of Revenues

Territories	QTA Members	Non Members
Local	21.7%	67.2%
Inside Quebec	33.9	18.0
Inter-provincial	18.1	5.5
International (USA and Mexico)	26.3	9.3

3.2.2 Major Findings

Most of the results are discussed in the next section where they are compared with answers from the general public to the same questions. Table 5 deals with road safety. It provides an indication of the importance of various means to improve road safety and of the degree of effort granted to these means by the two groups of carriers.

Table 5: Importance and Degree of Effort With Respect to Various Means to Improve Road Safety

Means to improve road safety	QTA Members		Non Members	
	Importance	Degree of effort	Importance	Degree of effort
a) Hiring process	1.47	1.75	1.92	2.10
b) Drivers training	1.27	1.59	1.55	2.01
c) Safety checks by drivers	1.32	1.48	1.55	1.56
d) Personnel awareness	1.46	1.54	1.68	1.80
e) Involvement in a trade association	2.28	2.28	3.22	3.45
f) Use of technologies	2.33	2.52	2.92	3.25
g) Quality approach (ISO 9000)	3.19	3.31	3.24	3.49
h) Speed control	1.52	1.66	1.94	1.92
i) Rewards programs	2.25	2.81	2.18	2.82
j) Control over driving hours	1.54	1.63	1.82	1.94
k) Preventive maintenance	1.24	1.25	1.44	1.46
l) Renewing the fleet more often	2.15	1.94	2.59	2.70
m) Drivers fatigue programs	1.95	2.32	2.03	2.34

Note: Importance : 1 = very important; 5 = not important

3.3 Comparative Analysis

We asked the general public their opinion with respect to several statements and we asked the same questions in the two questionnaires sent to the motor carriers. We have also asked the motor carriers what they think that the general public opinion is with respect to the same statements. The results are shown in Table 6.

Table 6: Various Perceptions of the General Public Opinion (1= strongly agree; 4= strongly disagree)

Motorists think that...	Motor Carriers Perception of Motorists' Opinion		Personnel Opinion of		
	QTA Members	Non-members	QTA Members	Non Members	Public
a) The 100 km/h speed limit on highways is too low and should be increased.	2.16	2.18	2.54	2.35	2.45
b) In general, motorists drive carefully.	2.33	2.38	2.51	2.52	2.46
c) Many motorists are afraid of trucks on the road.	1.68	1.92	1.76	1.97	1.81
d) Motorists behave safely when sharing the road with trucks.	2.63	2.62	2.96	2.80	2.53
e) As a whole, heavy vehicles pollute more than cars.	2,20	2.46	3.13	2.81	2.08
f) Truck drivers never take risks that could affect other road users.	2.99	2.74	2.61	2.51	2.95
g) Truck drivers are ready to provide assistance to motorists who are in trouble on the road.	2.11	2.20	1.94	2.05	2.28
h) Truck drivers know their job very well.	2.28	2.05	1.96	1.88	1.95
i) Truck drivers are responsible to a large extent for congestion problems during peak hours.	2.09	2.33	2.83	2.61	1.94
j) Truck drivers must spend too much time on the road to earn a decent salary.	2.11	1.83	2.64	1.88	1.59
k) Truck drivers are always in a hurry.	2.00	2.01	2.50	2.27	1.68
l) Truck drivers often make dangerous manœuvres on the road.	2.33	2.67	2.96	2.91	2.32
m) Truck drivers are courteous with motorists.	2.57	2.41	2.13	2.08	2.42
n) Truck drivers are often too tired to drive.	2.26	2.35	2.68	2.50	2.28

The opinions of the general public and motor carriers have also been surveyed with respect to several other issues. Table 7 indicates that motorists and motor carriers perceptions differ when it comes to which group respects speed limits.

Table 7: Motorists and Motor Carriers Perceptions With Respect To Speed Limits

	Motor Carriers		General Public
	QTA Members	Non Members	
a) When road conditions are good, would you say that MOTORISTS respect the speed limits (usually 100 km/h on highways) ?	3.76	3.61	2.54
b) When road conditions are good, would you say that TRUCK DRIVERS respect the speed limits (usually 100 km/h on highways) ?	2.65	2.82	3.09

(1= Always; 3= half the time; 5=Never)

However, both motorists and motor carriers agree on one thing: road conditions have deteriorated during the past five years. Furthermore both motorists and motor carriers also agree that there are more trucks on the road today than there were five years ago, albeit motor carriers, and particularly QTA members, are more aware of the situation. Also, when asked what proportion of motor carriers are behaving in a responsible manner, both QTA members and non members answered that a large percentage were responsible (2.06 on a scale of 1 to 4 where 1 = a very high percentage and 4 = a very low percentage), whilst motorists consider this percentage to be relatively lower (2.78).

We asked both motorists and motor carriers what they thought was the main reason for road deterioration in the Province of Quebec. The results are reported in Table 8. It seems that the motor carriers are blaming the government for not building the roads properly in the first place while the motorists are putting some of the blame on motor carriers (heavy vehicles). Both groups agree on the impact of weather changes however.

Table 8: Perceived Main Reason for Road Deterioration

Reasons	Motor Carriers		General Public
	QTA members	Non Members	
a) Not constructed properly	50.0 %	35.0%	5.3%
b) Weather changes	17.7	23.2	39.4
c) Lack of maintenance	16.2	16.9	17.4
d) Quality of materials	5.4	7.1	6.0
e) Heavy vehicles	3.1	7.1	24.7
f) Number of vehicles on the roads	1.5	3.8	1.3
g) Use of salt	1.5	0.1	1.8
h) Other	4.6	6.8	4.1

Table 9 shows the most important causes for road accidents involving a truck according to the three groups of respondents. It is plain to see that if motor carriers (QTA members and non members) tend to agree on the major causes of accidents, motorists have a quite different point of view and place much more emphasis on truck drivers' fatigue and speed. It is interesting to note that motor carriers tend to put the blame partly on motorists behaviour.

Table 9: Perceived Most Important Causes of Accidents Involving a Truck

Causes	Motor Carriers		General Public
	QTA members	Non Members	
a) Judgement errors	32.8%	24.2%	2.3%
b) Motorists' behaviour	21.1	28.1	6.1
c) Speed	16.4	11.5	27.1
d) Truck drivers fatigue	7.8	9.7	22.9
e) Bad weather	6.3	6.2	9.6
f) Lack of drivers training	5.5	4.2	0.9
g) Dangerous driving	3.9	5.3	4.8
h) Mechanical condition of vehicle	3.1	5.3	9.7
i) Other	3.1	5.5	18.6

4. CONCLUDING REMARKS

This paper sheds some light on the Quebec trucking industry's image as perceived by both the general public and the motor carriers. In general, we found that motorists show some empathy towards truck drivers and tend to have a positive image of the industry as a whole. In particular, they acknowledge the trucking industry' contribution to the economy. However, when they have to share the road with trucks, motorists become less patient and less understanding towards them. They react in two different ways: 1) "passively" by showing fear and feeling vulnerable and 2) "actively" by moving away or staying away from heavy vehicles.

We have compared the opinions of both motorists and motor carriers on several issues and statements and found major differences between the two groups. For example, motorists feel more strongly than carriers that they behave safely when sharing the road with trucks, heavy vehicles pollute more than cars, truck drivers are responsible for congestion during peak hours, truck drivers must spend too much time on the road, are always in a hurry and are often too tired to drive. On the other hand, motor carriers feel more strongly that truck drivers never take risks and are courteous with motorists.

It is only logical to assume that the general public opinion is largely influenced by the media that cover the news related to the trucking industry like the drivers working conditions, for example, and the accidents involving trucks. Under these circumstances, it is important for the industry to make sure that the real causes of accidents are made public and that they put more emphasis on drivers training since it is considered as one of the most important measures to improve road safety along with preventive maintenance of vehicles. Motorists should also be made aware that they have their part of responsibility when sharing the roads with trucks.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the Quebec Ministry of Transportation and to the Quebec Trucking Association for their financial support and for their valuable participation in the survey process.

The Cost of Independence: A Socio-economic Profile of Canadian Owner-Operators

Irwin Bess, Statistics Canada

1.0 Introduction

Nearly 50,000 or one in five (22%) Canadian truck drivers on the road in 1998 were independent truckers or "owner-operators".[1] However, similar to other forms of self-employment, the net-earnings and socio-economic characteristics of owner-operators have often been ignored by researchers for reasons of analytical convenience or data limitations (Mathieson, 1993; Simpson and Sproule, 1998).[2] New data products recently released by Statistics Canada such as the Survey of Labour and Income Dynamics (SLID) have the potential to fill much of this gap. The 1997 SLID cross-sectional micro-data files offer a limited but meaningful insight into the work patterns of the owner-operator population, complementing and validating well-established business surveys such as the annual Small for-hire carrier and Owner-operator Survey (SFO). The purpose of this study, through a multivariate analysis of SLID and SFO survey data, was to compare the work patterns and backgrounds of owner-operators to company drivers (paid truck drivers employed by carriers). This exercise is very important not only for analysts involved in the production and use of freight transportation data, but for carriers and human resource professionals anticipating a shortage of qualified drivers and increased demand for the services independent truckers provide (CTHRC, 1998). Studies have found that initiatives that take

[1] Labour Force Survey estimates – 1998 annual average

[2] Owner-operators own or lease at least one vehicle (straight truck or road tractor), hauling freight and providing services under contract to for-hire or private carriers.

into account a driver's socio-economic realities have the potential to improve job satisfaction, the work/home environment, highway safety and carrier profitability (Corsi and Fanfara, 1988). Ultimately, understanding the work patterns, incomes, and demographic characteristics of the current generation of drivers may be fundamental to filling anticipated demand for owner-operators.

2.0 Demand and use of owner-operators

Owner-operators are essentially independent businesspeople who own or lease their trucks or road tractors and haul goods for either a private (manufacturer, wholesaler, retailer, etc.) or for-hire carrier (trucking company). As such, they may be required to invest in capital equipment, acquire debt, pay taxes, interest, and other operating expenses (maintenance, fuel, rent, insurance, etc.) as well as earn sufficient income to cover their personal expenses. Geographically, about one-third (13,500) of owner-operator businesses were based in Ontario during 1997. An additional 26% (10,300) were located in the Prairies, 18% (7,200) in Quebec and 15% in British Columbia and Territories (6,100). Owner-operators based in the Atlantic region account for about 8% (3,300) of all owner-operators (see Table 1).

For shippers and trucking companies, the hiring of owner-operators offers substantial operational flexibility. By using owner-operators, carriers and shippers can respond effectively to increases in demand for their products, without substantial permanent investments in labour and capital (McKeown and Rea, 1998). SFO survey data reveals that most owner-operators (71%) work on contract for carriers in for-hire trucking, often for long-haul shipments crossing provincial or federal boundaries. Over one half (54%) of the $5.8 billion in revenues generated by owner-operators came from movements from one province to another (extraprovincial), while (38%) was obtained from international movements. The largest category of freight hauled by owner-operators in 1997 was general freight ($1.9 billion) followed by "other commodities" ($1.4 billion), dry bulk materials materials such as mine ores and scrap ($1.0 billion), forest products

($873 million) and bulk liquids including petroleum, chemicals and milk products ($464 million). Owner-operators hauling and moving household goods and used office furniture earned $96 million in revenue during 1997. Overall, payments to owner-operators totalled $3.5 billion in 1998, accounting for about one-quarter of the total operating expenses of for-hire carriers with over $1 million in annual revenue.[3]

3.0 The Working Owner Profile

3.1 Size of business

According to the 1997 SLID, seven out of every ten owner-operators had been in business for over three years but most (68%) were also functioning as unincorporated working owners with no paid help in running their day to day trucking operation. These findings were also confirmed by data from the 1997 SFO survey which indicated that, on average, most independent truckers owned or leased only one truck or road tractor and employed only one other individual on a full or part-time basis. The estimated 40,100 owner-operators in the SFO survey represent nearly 86,900 working owners and employees, two-thirds of whom were full-time drivers. Owner-operators who employed the most full-time persons derived the majority of their revenue from the movement of bulk liquids and chemicals (average- 2.0 full-time persons) and forest products (average–1.7 full-time persons).

[3] 1998 Quarterly Motor Carriers of Freight Survey

Table 1. Owner-operator revenues and expenses by region - 1997

		Canada	Atlantic	Québec	Ontario	Prairies	British Columbia and Territories (1)
Number of Owner Operator Businesses	*No. '000*	*40.2*	*3.3*	*7.2*	*13.5*	*10.3*	*6.1*
Total Operating Revenues	**$ '000**	**5,822,897**	**516,288**	**1,095,729**	**1,656,894**	**1,652,961**	**899,027**
Transportation Revenues	"	5,791,758	509,384	1,088,171	1,655,253	1,646,464	892,487
Other Revenues	"	31,140	6,902	7,558	3,642	6,498	6,539
Total Operating Expenses	"	**5,113,198**	**501,158**	**864,797**	**1,411,318**	**1,490,049**	**845,877**
Salaries and Wages	"	963,056	95,010	222,142	188,066	292,251	165,586
Benefits	"	20,746	1,240	5,331	5,036	5,982	3,157
Fuel	"	643,450	57,571	142,694	172,220	182,068	88,868
Owner Operator Expenses	"	25,527	411	5,626	5,757	12,206	1,517
Purchased Transport	"	297,191	20,731	30,135	104,380	87,934	54,010
Maintenance	"	541,436	41,907	120,087	131,381	156,027	92,034
Depreciation	"	789,255	82,639	126,015	238,386	219,823	122,393
Insurance	"	165,868	14,888	36,551	37,302	43,373	33,754
Rent	"	108,457	5,602	12,545	20,791	46,337	23,182
Other Expenses	"	1,558,212	181,161	163,659	507,988	444,028	261,376

Note: Some totals may not add due to rounding.

1 Territories include Yukon and Northwest Territories (including Nunavut) as defined before April 1999

Source: Small For-hire Carriers and Owner-operators Survey

Table 2. Average revenues, expenses and equipment per owner-operator by industry. Canada – 1997

		Total (1)	General Freight	Household goods	Bulk liquids	Dry bulk materials	Forest products	Other commodities
Number of Owner Operator Businesses	*No. '000*	*40.2*	*14.4*	*0.6*	*3.1*	*8.8*	*4.6*	*8.8*
Operating Revenues	**$**	**144,773**	**133,117**	**160,488**	**152,418**	**119,752**	**190,672**	**161,352**
Transportation Revenues	"	143,998	132,691	157,010	151,253	118,701	190,474	160,309
Other Revenues	"	774	426	3,478	1,164	1,051	198	1,043
Operating Expenses	"	**127,128**	**112,156**	**111,987**	**144,851**	**109,418**	**174,976**	**139,364**
Salaries and Wages	"	23,944	19,664	40,969	31,553	20,941	37,142	23,240
Benefits	"	516	464	683	1,008	445	865	306
Fuel	"	15,998	15,736	4,404	19,731	11,613	25,163	15,557
Owner operator expenses	"	635	727	0	1,991	317	176	614
Purchased Transport	"	7,389	7,910	6,044	3,825	5,219	8,605	9,430
Maintenance	"	13,462	11,406	7,647	14,033	11,728	23,489	13,538
Depreciation	"	19,623	17,888	18,053	22,151	16,039	26,151	21,893
Insurance	"	4,124	3,597	4,470	5,077	3,037	6,590	4,273
Rent	"	2,697	2,697	2,813	2,654	1,850	3,034	3,379
Other Expenses	"	38,741	31,967	26,903	42,829	38,227	43,761	47,134
Equipment								
Average number of trucks/road tractors	No.	1.4	1.4	1.9	1.3	1.4	1.4	1.4
Total distance	km	146,368	172,122	83,343	128,914	94,895	160,200	159,350
Fuel consumed	'Litres	67,830	75,663	35,271	62,370	45,801	83,052	73,433

(1) Some totals may not add due to rounding.

(2) Working owners included

Source: Small For-hire Carriers and Owner-operators Survey

3.2 Operating expenses

A number of factors are known to influence the viability of an owner-operator's business, particularly variable costs such as fuel, maintenance costs, interest rates and administrative expenses. Beyond the maintenance and depreciation of their trucks and equipment which alone account for 26% of their expenses, owner-operators must budget for their insurance, rent, meals and other administrative expenses. Fuel expenses, in particular, accounted for about 13% of the total operating costs that owner-operators incurred in 1997 and it has been determined that even the smallest price increase can have an impact on a carrier's viability (Smyrlis, 1999) (see Table 1 and Table 2). Given these fixed and variable costs as well as the highly competitive nature of the trucking industry, owner-operators are known to be under substantial pressures to maintain consistent and frequent operation of their vehicles and equipment (Binkley, 1998). Independent truckers in the SFO survey averaged 146 000 kilometres of driving and consumed about 68 000 litres of fuel in 1997. Beyond driving, they may also spend a good part of each day completing a number of non-driving activities such as loading and unloading freight, clearing customs at border crossings (Johnson, 1999) and fulfilling administrative requirements (accounting, log books, permits etc.). As a result, owner-operators typically worked an average of 52.3 hours per week in 1998, longer than the average weekly hours estimated for for-hire company drivers (49.7) and other workers in the paid labour force (36.7) (Bess, 1999).

3.3 Demographic differences - owner-operators and company drivers

A simple maximum likelihood (logit) estimation model of the odds of a driver being a wage-earner or self-employed reveals that a number of demographic and household characteristics also distinguish owner-operators from company drivers (see Table 3).[4] Similar to other

[4] Logistic analysis or "logistic regression" is a form of statistical modelling that is used most often for categorical outcome variables. It describes the relationship between a categorical response (typically dichotomous) and a set of explanatory variables that are typically categorical.

studies, the model confirmed that owner-operators tend to be older and less likely to have completed post-secondary training after controlling for other factors such as their location of residence, number of dependent children at home, health and stress level (CTHRC, 1998). The odds of a trucker over the age of 40 being self-employed were six to seven times higher than drivers under age 25. Data from the monthly Labour Force Survey (LFS) indicate that two-thirds of independent truckers are over age 40 compared to one-half of for-hire company drivers and drivers employed by private carriers. However, in terms of education, the odds of a driver being self-employed were twice as high among drivers who had less than a high school education (no high school diploma) compared to those who had completed high school, college or university. The larger LFS sample estimates that only 43% of owner-operators completed high school or post-secondary training, compared to 61% of for-hire company drivers and 56% of drivers in private trucking.

Unlike company drivers, the analysis also found that self-employed drivers tend to have another major income earner to rely on in the household (Bess, 1999).[5] Drivers who were the major income earner in the household had lower odds (0.4) of being self-employed than drivers who had a household member who also made major financial contributions to the running of the household. However, the model determined that whether a driver had dependent children living at home was not a significant factor.

SLID asked individuals to assess and report the level of work-life stress they feel they experienced during 1997. The responses were coded as either "Very stressful ", "Somewhat stressful ", "Not very stressful " or "Not at all stressful". Among these four categories, almost seven out of every ten drivers (69%) reported that they felt that their work and personal lives were very to somewhat stressful. However, owner-operators were far more likely than any other type of driver to report feeling stressed given their age, health, education,

[5] About 75% of company drivers were the major income earner in their household during 1997 compared to 63% of owner-operators.

status as the household income earner and location of residence. The results showed that 80% of owner-operators felt very to somewhat stressed compared to 66% of company drivers. In this context, the odds of being self-employed among drivers feeling "very to somewhat stressed" were twice as high as drivers feeling little to no work-personal life stress (see Table 3).

3.4 Net Incomes and Earnings

The analysis also confirmed that the long hours and long distances travelled by owner-operators do not necessarily translate into incomes that are competitive with the earnings of drivers employed by carriers. Despite the long hours owner-operators were working in 1997, about 62% of owner-operators brought home total earnings under $20,000 before taxes in 1997.[6] The 1997 SLID data show that self-employed truckers earned an average of $18,300 in "total money income" which included taxable income as well as non-taxable items such as Worker's Compensation and social assistance.[7] The total money income of these drivers was also found to be substantially lower than self-employed individuals in manufacturing, trades, transport and primary industries ($22,500) and company drivers working for for-hire carriers ($33,000) and private carriers ($32,600). A similar distribution existed for the after-tax income of drivers.[8]

---

[6] Total earnings are equal to the sum of wages and salaries and net self-employment income. Wages and salaries refer to earnings from all paid worker jobs held during the year. Also included are the earnings of owners of incorporated businesses.

[7] Total money income excludes capital gains and RRSP withdrawals.

[8] After-tax income is the total money income minus taxes payable.

Table 3 – Logistic analysis of driver class of worker

Variable	Odds of driver self-employment
Current age	
Under 25	***1.0***
25 to 39	3.5+
40 to 54	5.7+
55+	7.0++
Educational Attainment	
Elementary/some high school only–not a high school grad.	1.9+
Graduated from high school, college or university	***1.0***
Household income earners	
Was major income earner in household	0.4+
Driver was not major income earner in household	***1.0***
Region of residence	
Atlantic	0.4
Quebec	0.9
Ontario	1.4
Prairies	***1.0***
British Columbia	2.0+
Size of area of residence	
Under 30,000 people or rural	1.5+
Over 30,000 people	***1.0***
Work-life stress	
Very to somewhat stressful	2.1+
Little to no stress	***1.0***
Self-rated Health	
Excellent to very good health	1.9
Good health	0.6
Fair to poor health	***1.0***

\+ Statistically significant at 0.05. ++ Statistically significant at 0.001.

Note: Reference group shown in italics. An odds ratio close to 1.0 for the comparison group means that there is little or no difference between drivers in the comparison group and the reference group, when the effects of other factors shown in the table are controlled for.

Source: Statistics Canada. 1997 Survey of Labour and Income Dynamics

Table 4. Total money-income and after-tax driver earnings by class of worker. Canada – 1997

	Self-employed		Employees	
	Other Trades Labourers	Owner Operators*	For-hire truck drivers	Drivers Private trucking
Number ('000)	*707*	*49*	*91*	*109*
Total money income (taxable/ non-taxable)				
Average	22,500	18300*	33,000	32,600
Median	18,000	18300*	32,000	31,900
Standard Deviation	27,600	14200*	12,800	17,180
After tax income				
Average	18,600	16000*	26,800	26,230
Median	16,100	17000*	26,300	26,160
Standard Deviation	18,600	12100*	9,200	12,700

*Note: Owner operator estimates have a c.v. of 22% and should be used with caution. See Data sources.
- Other Trades and Labourers include self-employed in manufacturing transport primary industries

Source: 1997 Survey of Labour and Income Dynamics

With a data quality c.v. of 15.8% at the Canada level, the SLID data estimated that about eight in ten (79%) of all independent truckers earned less than $20,000 after-tax in 1997.[9] At an average of

[9] A *coefficient of variation* is an indicator of the magnitude of sampling variability or reliability associated with an estimate. In general, the higher the CV for a given estimate, the higher the degree of sampling variability and lower level of reliability. See Appendix – Survey of Labour and Income Dynamics Design and Data Quality.

$16,000, the after-tax earnings of self-employed truck drivers was only 60% of the net earnings of for-hire drivers (see Table 4).

4.0 Conclusion

The purpose of this study was to present a socio-economic profile of owner-operators and to illustrate the potential applications of surveys such as Statistics Canada's Survey of Labour and Income Dynamics and the Small for-hire Carriers and Owner-operator Survey. By utilizing data sources such as these, researchers and policy makers can enhance their understanding of the self-employed driver population, such as their incomes, work patterns and demographic characteristics. Although many drivers may become owner-operators to gain independence, the analysis confirmed that they work longer hours to meet fixed and variable costs, in return for lower after-tax earnings and a greater likelihood of high work-life stress. The analysis also found that the odds of self-employment among truckers were highest among drivers over 40 years of age with no post-secondary training.

APPENDIX

Data Sources

The data analyzed in this study were derived from 1998 monthly Labour Force Survey estimates, the 1997 annual Small For-hire Carriers and Owner-operator Survey and the 1997 Survey of Labour and Income Dynamics. Unless otherwise noted, the occupation considered here is truck driver (code H711), defined in accordance with the 1991 Standard Occupational Classification (SOC 1991), which excludes delivery drivers, fire-fighters, snowplows, road oilers, waste and public works maintenance equipment operators. The advantage of the 1991 SOC is its representative coverage of the job characteristics of truck drivers in the trucking industry. Persons employed in this occupation are primarily concerned with operating

trucks to transport goods and materials over urban, interurban, provincial or international routes.

Quarterly Motor Carriers of Freight and Small For-hire and Owner-operators Survey

Statistics Canada's Quarterly Motor Carriers of Freight Survey sampled between 713 and 756 companies during each quarter of 1998 with $1 million or more in annual operating revenues, representing approximately 2,300 companies. Smaller companies are covered in the 1997 reference year survey of Small For-hire Carriers and Owner-operators, which collected operating and financial data from 7,745 companies with annual revenues between $30 thousand and $1 million across all provinces and territories (excluding couriers and messengers). The financial data from the survey of Small For-hire Carriers and Owner-operators was compiled from a sample of Revenue Canada's T1 records of unincorporated firms' tax files and T2 records of incorporated firms' tax files. Other types of data (such as activity, area of operation, employment, equipment, fuel and distance) were collected through a computer-assisted telephone interview (CATI).

Survey of Labour and Income Dynamics Design and Data Quality

The Survey of Labour and Income Dynamics (SLID) is a longitudinal household survey designed to detail labour market activity and income information for both self-employed and wage earning employees over time. Individuals selected for the survey are interviewed once or twice per year for six years to collect information about their labour market experiences, income and family circumstances. The target population for SLID is all persons living in Canada, excluding people in the Yukon, Nunuvut, Northwest Territories, residents of institutions, persons living on Reserves, and full-time members of the Canadian Armed Forces living in barracks. Based on a sample of 15,000 households (or 36,000 individuals aged

16 and over) drawn from the LFS, a number of SLID variables and output including hours worked are known to be consistent with the results from the LFS (Bartman and Garneau, 1998).

Although SLID is designed for longitudinal studies, it offers a broad range of labour and income variables that can be used in cross-sectional or annual studies. The data on truck drivers analyzed in this study are based upon a 1997 sample of 740 drivers, consisting of 118 self-employed truck drivers, 291 truck drivers employed in for-hire trucking (North American Industrial Classification – 484) and 331 wage earning drivers employed outside of for-hire trucking. Given that SLID is a sample survey covering many occupations, industries and themes, the *coefficient of variation* is a useful indicator of the magnitude of sampling variability or reliability associated with SLID estimates. The coefficient of variation is a ratio computed as the standard error of a sample estimate expressed as a percentage of the estimate itself. A coefficient of variation or a "CV" is largely a product of factors such as the total survey sample size, sub-population characteristics, level of non-response, sampling designs, level of geography and whether an estimate is a simple population count or percentage, difference or ratio of population sub-groups. In general, the higher the CV for a given estimate, the higher the degree of sampling variability and lower level of reliability. The 1997 SLID Micro-data Users Guide specifies two acceptable ranges or standards of coefficient of variation: 0 .0 to 16.5% and 16.6 to 25.5% (see Table 5). All estimates of for-hire and private company drivers (paid workers) detailed in this study have a CV of 16.5% or lower. However, certain estimates for the self-employed are prone to higher levels of sampling variability, up to 22.2% in the case of estimates based on the population count for owner-operators (49,000). All estimates with over 16.6% CV are footnoted in this paper.

Table 5 – Indicators of Sampling Variability, SLID 1997

Approximate coefficient of variation (%)	Restriction on use
0.0 – 16.5	Estimates can be considered for general unrestricted release.
16.6 – 25.0	Estimates can be considered for general unrestricted release but should be accompanied by a warning cautioning users of the high sampling variability associated with the estimates.
25.1 – 33.3	Estimates can be considered for general unrestricted release only when exact coefficients of variations have been calculated and are found to be acceptable. Otherwise, such estimates should not be used or released.
33.4 or greater	Estimates should not be used or released under any circumstances.

Labour Force Survey

Much of the employed/self-employed hours of work and employed driver earnings (excluding self-employed) estimates detailed in this study are based on data from Statistics Canada's Labour Force Survey (LFS). The LFS is a monthly household survey of a sample of about 53,000 households representative of the civilian, non-institutionalized population 15 years or older in the 10 provinces. Excluded are residents of the Yukon, Northwest Territories and Nunavut, as well as persons living on Indian reserves, full-time members of the Canadian Armed Forces and inmates of institutions. The estimates of the entire truck driver population are based primarily on LFS data collected from an average of 1,100 respondents during each month of 1998 representing 230,000 drivers. About 630 of these respondents were truck drivers working in NAICS industry 484 – Truck Transportation - for-hire trucking.

REFERENCES

Bartman, I. and G. Garneau. (1998) *Comparison of hours worked on the Survey of Labour and Income Dynamics and the Labour Force Survey.* Survey of Labour and Income Dynamics Research Papers Series. Catalogue No. 98-16. October 1998.

Bess, I. (1999) "Work patterns of truck drivers" *Perspectives on Labour and Income.* (Statistics Canada, Catalogue 75-001E) 2, (Winter 1999): 14-19.

Binkley, A. (1998) "How many hours truckers should be allowed to drive is shaping up to be the hottest regulatory issue of 1999" *Today's Trucking.* December 1998: 34-37.

Corsi, T. and P. Fanfara (1988) "Driver management policies and motor carrier safety", in *The Logistics and Transportation Review.* Volume 24. Issue no. 2: 153-164

CTHRC (1997) *Canadian Trucking Industry Human Resource Challenges and Opportunities – Sector Study Update.* Prepared by Trimension Group for Canadian Trucking Human Resources Council.

HRDC (1990) *Canadian Trucking Industry: Human Resource Challenges and Opportunities.* Prepared by Price Waterhouse for Human Resources Development Canada.

Johnson, J. "U.S., Canada try to uncork border." *Transport Topics* (May 31, 1999):3.

Mathieson, A. "Owner-operators in Canada: Who are these guys?", in *Proceedings of Canadian Transportation Research Forum. 1993.*

McKeown, L. and W. Rea (1996) "Wheels of Change: Employment in Canada's Trucking Industry, 1988-1994" *Trucking in Canada, 1994.* Statistics Canada. 53-222-XPB. Minister of Industry 1998.

Simpson, W. and R. Sproule (1998) *Econometric Analysis of Canadian self-employment using SLID.* Survey of Labour and Income Dynamics Research Papers Series. Catalogue No. 98-16. November 1998.

Smyrlis, L. (1999) "Diesel prices pushing higher", in *Truck News.* September 1999. Volume 19, Issue 9: 1

Statistics Canada (1997) *Survey of Labour and Income Dynamic Microdata User's Guide.* Wave 2. 1994. 75M0001GPE.

CHALLENGES TO USING PERFORMANCE CRITERIA AS A BASIS FOR VEHICLE WEIGHT AND DIMENSION REGULATIONS

1. INTRODUCTION TO PERFORMANCE BASED REGULATIONS

The rapid growth in truck transportation over the past thirty years has been accompanied by steady increases in the size and weight of trucks and truck-trailer combinations. On the whole, these increases have been accomplished without major changes in the design of highway infrastructure and without compromising the safety of the highway system.

However, as truck size has increased, the available capacity and safety margins have been reduced in a number of areas, including:

- bridges and pavements;
- turning space at intersections;
- the opportunities available for passing on two lane roads; and
- the handling characteristics of the trucks themselves.

In this context, effective regulatory policy seeks to balance the need for an efficient and productive truck transportation industry in support of the economy, with the obligations to protect the safety of the highway system and manage the extensive public investment in the infrastructure. For these reasons, the importance of sound weight and dimension regulations has grown significantly over the years.

Weight and dimension regulations were originally intended to ensure that the size and weight of trucks did not exceed the structural capacity of highways and bridges. While this objective remains true today, it is also recognized that these regulations also directly

influence the design of trucks, their stability and handling characteristics, the space required for turning and the compatibility of trucks with other vehicles on the highway.

It is also important to realize that vehicle performance is only one aspect of developing trucking regulations and policies. Public servants must recognize the delicate balance that exists between the components of good regulations and the need to respond to the political will by providing the best technical information available. These performance criteria are not a panacea for trucking regulations. Saskatchewan's experience has shown that they cannot be taken in a literal context as a form of regulation. However, vehicle performance criteria can serve as the basis for standard technical input to the development of regulations that promote safe vehicles and that optimize the use of the infrastructure.

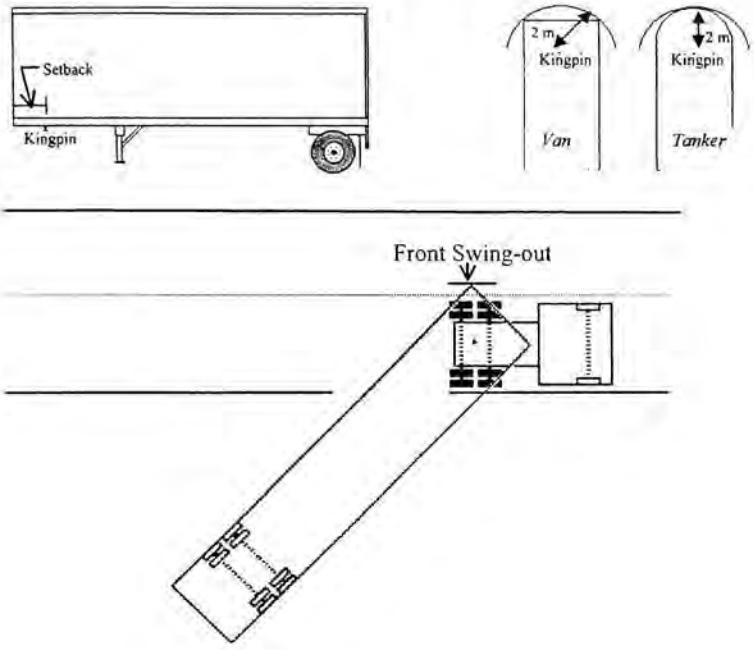
These issues were the subject of extensive research in the mid-1980's. As a result, heavy truck weight and dimension limits in Canada were modified and expanded to place limits on vehicle weights and dimensions which directly influence vehicle handling, turning, and stability and control performance.

While it may be intuitively obvious, the stability and handling characteristics of large, heavy trucks are different than for passenger cars in almost all aspects including acceleration times, braking distances, turning space requirements and resistance to rollover. In addition, there is a wide range of performance between the various types of configurations found within the commercial truck fleet.

The regulations governing truck size and weight include limits that are designed to ensure that the performance of heavy truck combinations meets or exceeds performance targets. These targets are reflected in a number of areas, including resistance to rollover in both turning and evasive manoeuvers, braking performance, space required to negotiate turns, front and rear swing-out in turning, and trailer sway.

Figure 1 provides an example of how the limits apply to control front swing-out.

Figure 1. Controlling Front Swing-out - Kingpin Setback Limit



The objective of this limit is to reduce the likelihood that the front corner of the trailer will project into the adjacent lane of traffic when a tractor-trailer combination turns onto a highway. With this control, the maximum amount of front swing-out which could occur would be no greater than about 0.8 m. The front corner of the trailer is visible to the truck driver through the turn, and extra precautions can be taken to ensure that there is no intrusion into the adjacent lane.

In recent years interest in the concept of performance based regulations has been steadily growing in many areas of public policy.

This has been spurred by broad-based efforts to eliminate unnecessary regulation, harmonize regulations between jurisdictions, and at the extreme, to deregulate where possible and practical. In this context, the appeal of performance based regulations seems to lie in the prospect of clearly articulating the expected outcome of the public policy requirement. This approach holds promise of coupling an explanation of why a requirement exists with the more traditional description of specific regulated limits or conditions.

In the vehicle weight and dimensions regime, performance based regulations are sometimes viewed as a radical alternative to conventional regulated limits on height, length, width and weight. Rather than describing how large a truck and/or its components can be, and how much it can weigh, some advocates of true performance based regulations suggest that a vehicle must be considered acceptable if it can meet all desired targets for performance. These targets can encompass as many areas as deemed necessary, including turning characteristics, stability and handling properties, horizontal and vertical clearance, impact on bridges and pavements etc.

While it may be difficult to dispute the logic of this concept, on closer examination, the implications for implementation can become quite daunting:

- Highway design standards, road and traffic conditions and geographic factors can vary widely within public road networks. Selection of performance measures suited to the entire network would, by necessity, have to address the most restrictive conditions within the system. Alternatively, portions of the road network could be grouped by standard or conditions, with different performance targets established by class or grouping of roads.
- Many aspects of truck performance cannot be determined through normal inspection procedures. Assessing offtracking, swing-out at front and rear, roll stability, pavement or bridge impact performance would require careful consideration of appropriate tests. As such tests could not likely be undertaken at normal inspection facilities, alternative means of assessing

compliance would be required. The "type certification' approach used for certifying aircraft performance may be possible in applications where the vehicle configuration and payload do not change. However, the flexibility which characterizes trucking can bring daily changes in equipment (different tractors with different trailers) and widely different types of payload, implying changes in performance which would have to be understood.

- Computer modeling can provide easily usable templates, but the models depend upon input values which can vary significantly in the field. Accurate representation of spring factors associated with tire and suspension type can lead to misplaced faith in the output values. While the models may be based upon information provided by manufacturers, the vehicles operating in the field may not be maintained at the level necessary to provide the same performance over time as the manufacturer's specifications may state. Also, programs such as central tire inflation impact on the operational characteristics of the tires. Failure to recognize the potential differences between theory and practice can lead to a false sense of security with the performance criteria.

It is important to note that every control placed on the size or weight of heavy trucks has a direct and important influence on the stability, handling or turning characteristics of the vehicle. There must be a balance between the safety of the travelling public, preservation of transportation infrastructure and support of economic activity without placing unnecessary restrictions on the trucking industry. Consequently, the impacts that changes in these limits would have on the performance of the truck combination needs to be carefully considered in the context of protecting the safety and integrity of the highway system.

Through careful consideration of the performance criteria and balancing the relevant economic and political input factors for vehicle weight and dimension regulations, public servants can develop regulations which optimize utilization of the existing road network, provide cost efficiencies to the trucking industry and improve safety.

2. SASKATCHEWAN'S EXPERIENCE

Saskatchewan Department of Highways and Transportation (DHT) recognizes that shippers and carriers do not always have vehicles and loads that fall within the current regulations for maximum allowable weights and dimensions. Saskatchewan's current permit system exists to allow these loads to be shipped, for a fee, within specified guidelines and conditions.

In Saskatchewan, dimension permits are issued for width, height, overall length, box length, trailer wheelbase, effective overhang, and kingpin setback.

DHT initiated a review of its permit system and fee structure in 1994. The purpose of the review was to develop a permit system proposal that responded to Saskatchewan's trucking industry needs. As part of the permit system review, vehicle performance criteria were used to establish guidelines for fair application of policies for the trucking industry. Good public policy must balance the concerns for safety of the general public and preservation of the highway network while facilitating economic growth by not imposing unrealistic constraints on the trucking industry. One of the recommendations of the review included, for dimension permits, a less complicated system for users of the permit system. The proposed system included implementing *General Operating Regulations (GOR)*. Over the long term, approximately 90 per cent of the dimension permits would be eliminated if the new regulation was implemented.

The proposed general operating regulations would apply to vehicles and loads that met one of the following criteria:

- Length > 23 m to 36 m;
- Width > 2.6 m to 4.4 m; or
- Height > 4.15 m.

Figure 2 provides the dimension breakdown for length and internal dimensions, width and height. Figure 3 specifies the conditions that the carriers would have to follow.

Figure 2. Proposed Regulation Conditions for Length, Width and Height

	Dimension	Conditions
Kingpin Setback	> 2 m ≤ 4 m	E, G, H
	> 3.3 m ≤ 6 m	A, B, C, E, F, H, I
	> 5.7 m	Special Case
Effective Overhang	> 35% ≤ 70%	E, G, H
	> 70% ≤ 100%	A, B, C, E, F, H, I
	> 100%	Special Case
Total Overall Length for Single Trailer	> 23 m ≤ 30 m	E, F, G, H, K
	> 30 m ≤ 36 m	A, B, D, E, F, G, H, I, K
	> 36 m	Special Case
Total Trailer Wheelbase For Unarticulated Length	> 12.5 m ≤ 15.4 m	E, G, H
	> 15.5 m ≤ 16 m	A, B, C, E, F, H. I
	> 16 m	Special Case
Total Trailer Wheelbase for Articulated Length	> 17 m	Special Case
Width	> 2.6 m ≤ 3.05 m	E, G, H
	> 3.05 m ≤ 3.3 m	A, E, G, H
	> 3.3 m ≤ 3.65 m	A, B, E, F, G, H
	>3.65 m ≤ 4.4 m	A, B, C, E, F, H, I, J
	> 4.4 m (single trip only)	A, B, C, E, F, H, I, J
Height	> 4.15 m	J

Note: Box length permits are available. Conditions, if applicable, are derived from other length parameters.

For example, a lane intrusion of one metre was the upper limit that required little evasive manoeuvres by oncoming traffic, based on a lane width of 3.7 m. For the next dimension range, the upper limit of 2.6 m for lane intrusion was chosen because the load would severely encroach into the oncoming traffic. These same principles were used for width ranges. Vehicle performance criteria provided the framework for development of the dimension ranges. Variables such as lane and shoulder width, exposure rates, low traffic volumes, and passing requirements were factored into the calculations for establishing range limits. Since many of Saskatchewan's highways have less than 500 vehicles per day, the risk in allowing overdimension loads is reduced without compromising the criteria.

Figure 3. Conditions for Length, Width and Height

Condition	Restriction	Particulars of Restriction
A	Travel is not permitted	• on Sundays or public holidays • when visibility is 1000 m or less • when the highway is slippery • on December 24, 26, 27, 31 and January 2 when Christmas and New Year's Day fall on a Sunday
B	Travel is not permitted from 3:00 p.m. to midnight	• on any day prior to a public holiday • on any Friday during the summer from Friday prior to Canada Day until Labour Day • on any Friday when the following Monday is a public holiday
C	Travel is not permitted	• from sunset to sunrise of the following day
D	Travel is not permitted	• from sunset to sunrise of the following day on any two-lane highway
E	During day light hours	• flags will mark the portions of the load that extends beyond the extremities of the vehicle.
F	Lights	• two amber rotating lights are required.
G	Night travel	• amber lights shall be located 30 cm above the headlights on the front corners of the load • amber lights shall be spaced not more than 8.0m apart on both sides of the load • red lights visible from the side and the rear shall be located on the rear corners of the load • red clearance lights shall mark the end of any load extending beyond the vehicle • the trailer shall be equipped with extendible clearance lights
H	Signs	• A "D" sign is required at the rear of the load on a multi-lane highway and at the front and rear of the load on a two-lane highway
I	Escort Vehicle	• required at the rear on a multi-lane highway and at the front and rear on a two-lane highway
J	Route	• Travel on any given route is subject to approval dependent on structural clearances from SaskTel, SaskPower, CN/CP Telecommunications and Saskatchewan Highways and Transportation
K	Vehicle Speed	• restricted to a maximum of 90 kph if total overall length exceeds 25 m

These restrictions were derived from existing permit conditions. They were streamlined to ensure consistency of application. The operating regulations strictly addressed the operating characteristics of vehicles and established an acceptable threshold limit. Using this reasoning appeared to move application of performance criteria closer to regulation.

Even though sound engineering principles were used to develop the new regulatory framework, implementation of the principles into functional and enforceable regulations proved to be difficult. This is a perfect example where theory and practice do not always complement each other.

3. DIFFICULTIES ENCOUNTERED

The most significant problem associated with using strict interpretations of performance criteria for regulations was the nature of the criteria itself. Since the criteria are based upon input values (such as center of gravity, suspension width and stiffness, etc.), true performance based regulations should also address those input factors. However, field enforcement personnel are generally not in a position to evaluate many of these input factors. They are limited to evaluating weights and dimensions that can be easily measured during a quick evaluation of a vehicle at a scale location or at a roadside inspection.

Enforceable regulations must address weights and dimensions, which are once removed from the primary inputs affecting vehicle stability characteristics. For example, roll stability is highly dependent upon the center of gravity height, suspension width and suspension type, but these are not easily measured in the field, so the regulations must be based upon measurables such as track width and axle loading.

While the tabular format for the regulations was relatively simple to develop and provided an easy-to-follow summary, the tables could not be adopted into law. The legal regulations had to have a text format in order to be enforceable by field staff. Field staff indicated

that they required specifically numbered sections of the regulations for reference when filing a charge. The judiciary concurred that the charges, which do not refer to very specific violations, would probably not be upheld in court. The tables had to be placed into linear text with each section appropriately numbered for easy and unquestionable reference. Placing the tables into text was not so difficult, but the resulting draft regulations proved to be very long. This was clearly contrary to the original intent of simplifying the regulations.

The complexity of the engineering principles did not lend itself to simple regulations. When combinations of input factors are considered, the enforceability became practically impossible. For example, the maximum hitch offset is required to ensure that the vehicle is not configured such that the "tail wags the dog". However, as the weight of the trailing unit decreases relative to the towing unit, the hitch offset can increase without reducing the safety performance of the vehicle. Transport Compliance staff felt they could not effectively enforce regulations that required them to obtain measurements then interpret the legality of a vehicle from a chart on the basis of the measurements. This would be impractical and probably would lead to many violations going undetected.

According to strict interpretation of the performance criteria, compliance with some thresholds can depend upon a combination of dimension and weight. In these instances regulatory compliance cannot be associated with the vehicle, but only with the vehicle under certain loading conditions. Ideally, an owner should be able to look at a trailer in the yard and determine whether it is legal. For example, current regulations set the minimum track width for a semi-trailer at 2.5 m; this is necessary to accommodate the maximum legal height of 4.15 m. However, a vehicle with a narrower track width can still comply with the performance criteria as long as the maximum height is reduced. The owner should not be placed in a situation where a trailer is legal only under limitations. Perhaps more commonly, the owner should not be required to "marry" vehicles in the fleet such that certain trailers can be towed only by certain power units because

the wheelbases must balance to comply with the offtracking requirements. The complexity took on a new level when vehicle speed was factored into the equation for criteria such as load transfer ratio. This is another instance where simplicity could not be achieved by strictly maintaining the integrity of the performance criteria.

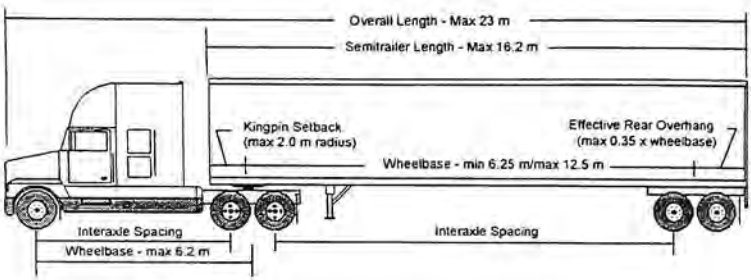
As the draft regulations continued to evolve, it became clear that the key to practical regulations would be simplicity and enforceability. It was essential to keep the regulations simple, not only for the truckers who must live and work with the regulations on a daily basis, but also for the compliance staff who must interpret the regulations and defend them in court, if necessary. From an engineering perspective, the intent of the performance criteria was evident, but the theoretical thresholds could not be practically and strictly interpreted to produce operational vehicle weight and dimension regulations. Compromises had to be made.

The Department also tried pictorial regulations as a means of showing the intent. Figures 4 and 5 illustrate how the conditions that apply to a vehicle's dimension and weight limits could be easily illustrated in a pictorial format. Despite the simplicity of presentation, the judiciary indicated that violations would not be upheld in court unless the violations could be specifically referenced. The pictorial format was not enforceable.

The difficulties encountered were all a result of stakeholder input. They were good reminders that engineering principles provide good tools for regulatory development, but cannot be taken at face value as the regulations themselves. Although, the final regulations followed a more conventional framework, they respected the performance criteria while giving due regard for the practical concerns of the stakeholders.

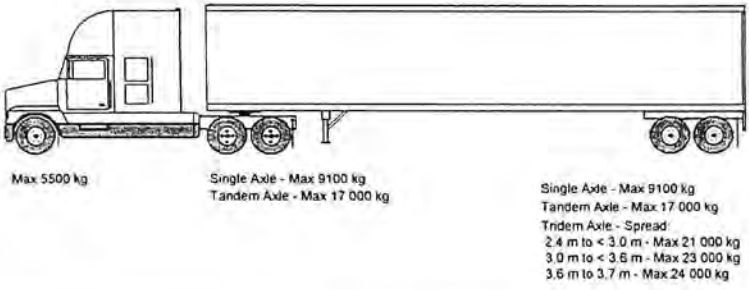
Figure 4. Pictorial Format for Dimension Limits

Category 1: Tractor Semitrailer



DIMENSION	LIMIT
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Tandem Axle Spread	Minimum 1.2 m/Maximum 1.85 m
Tridem Axle Spread	Minimum 2.4 m/Maximum 3.7 m
Track Width	Minimum 2.5 m/Maximum 2.6 m
Interaxle Spacings	
Single Axle to Single, Tandem or Tridem Axle	Minimum 3.0 m
Tandem Axle to Tandem Axle	Minimum 5.0 m
Tandem Axle to Tridem Axle	Minimum 5.5 m

Figure 5. Pictorial Format for Weight Limits



WEIGHT	LIMIT
Tridem Axle:	
Axle Spread 2.4 m - less than 3.0 m	Maximum 21 000 kg
Axle Spread 3.0 m - less than 3.6 m	Maximum 23 000 kg
Axle Spread 3.6 m - 3.7 m	Maximum 24 000 kg
Gross Vehicle Weight Limits	
Three Axles	Maximum 23 700 kg
Four Axles	Maximum 31 600 kg
Five Axles	Maximum 39 500 kg
Six Axles - with 2.4 to < 3.0 m spread tridem	Maximum 43 500 kg
with 3.0 m to < 3.6 m spread tridem	Maximum 45 500 kg
With 3.6 to 3.7 m spread tridem	Maximum 46 500 kg

4. APPROACHES TO THE DIFFICULTIES

Despite the difficulties encountered, DHT remained committed to the principles of the vehicle performance criteria. Ultimately, the thresholds could be respected through permit programs because the permit conditions would specify the conditions that apply to a given vehicle. While this would allow the Department to optimize the thresholds to allow any vehicles, which comply, all vehicles would have to operate according to a permit. This is not only impractical, but also undesirable.

For the vehicle weight and dimension regulations, the performance criteria serve as a guide for addressing the safety of the vehicles. Since the regulations could not easily address every scenario, the worst case scenario was chosen. For example, a conventional 16.2 m semi-trailer with a maximum wheelbase of 12.5 m can comply with the offtracking thresholds if the maximum wheelbase of the power unit is limited to 6.2 m. These figures have been included in the regulations. If the power unit is towing a 14.6 m or a 13.7 m trailer, the vehicle performance will be well within the maximum threshold value. Thus the regulations reflect the "worst case scenario".

If the example noted above involves a power unit with a longer wheelbase but it never hauls a trailer longer than 13.7 m, it can be allowed to operate on the highway system without violating the performance thresholds. Situations such as this are addressed within the permit system. By requiring that the vehicle operate with a permit, the operator is aware that the power unit is restricted. It does not comply with the regulations, so it is not "legal". It cannot go into a shipper's yard and connect with any trailer in the fleet. This restriction unto itself is a disincentive for anyone to want to operate such a vehicle in Saskatchewan. However, since it can comply with the performance threshold, the Department will consider allowing it to operate under a "single trip permit". In this example, the permit would limit the trailer length to correspond with the power unit wheelbase. Field staff who recognize that the power unit wheelbase exceeds that allowed in the regulations would then have to ask to see the permit to confirm the operating conditions.

Permit options can be applied in several ways, but for them to be effective they should address the exception rather than the norm. Saskatchewan's permit policies strike a compromise which recognize that some situations will arise where a vehicle can comply with the performance criteria and may not be able to comply with the regulations in a cost effective manner. Under these circumstances, permits are available as a means of supporting economic activity, which might otherwise not occur or occur with less efficiency.

5. FUTURE OPPORTUNITIES

Saskatchewan's vehicle weight and dimension regulations reflect the performance criteria governing the movement of vehicles and loads by the trucking industry. Permits are required for vehicles and loads that exceed the regulations. In Saskatchewan, the criteria are also used as a basis for issuing permits. Without a permit process, these vehicles would not be allowed to operate on the highway system, which would have a detrimental effect on the province.

As managers of the road transportation system, DHT must ensure the long term sustainability of the network for future generations while balancing its role of supporting economic and social well being. Further work needs to be done to support the development of new vehicles. Practical permit policies founded on the vehicle performance criteria will enable Saskatchewan to consider new configurations that are not addressed in the regulations. Through this process, industry will understand the issues that must be considered before a new configuration is allowed to operate on the highway system.

The most significant initiative, which we feel we can undertake in Saskatchewan, is education. By promoting awareness of the concerns about performance criteria and the need to balance between the economic and technical issues, the industry and public will have a greater appreciation for the vehicles using the highway system. Industry will realize that vehicles cannot simply be made bigger to carry more weight as a means of increasing efficiency. Also, by helping the industry to understand the basis for the regulations, we can assist them in appreciating the implications of violating the regulations. Through a public education program, the Department can minimize the impact of negative feelings toward big trucks. If the public is made aware of the factors affecting truck safety they may better understand that we, as regulators are minimizing their risks and not simply conceding to the wishes of industry. As public awareness of performance criteria increases, there will be less reluctance by the legal system to recognize tabular or pictorial based regulations that more accurately reflect the performance thresholds.

Changes in Marine Technology Impact on Canadian Ports

Michael C. Ircha
The Transportation Group
University of New Brunswick

Introduction

Contemporary Canadian port reform sought to increase the autonomy of major commercial ports to enable them to be more responsive to competitive pressures. Port reform legislation, the *Canada Marine Act*, was adopted by Parliament in June 1998 for implementation beginning in January 1999. Most major commercial ports have now been re-established as business-oriented, not-for-profit corporations as Canada Port Authorities (CPA) within a National Port System.

During the past decade, ports faced significant challenges as marine technology and logistical systems evolved. Two major technology thrusts that impacted ports were increased specialization in ship design (such as the continued development of cellular container vessels), and growth in ship size. In each case, ports had to expand their facilities and modify their cargo-handling technology and operations to meet new demands. Specialized vessels often led to the development and installation of new, automated land-side cargo-handling equipment. In the case of the container trade, specialization meant ports had to invest extensive capital to acquire new ship-to-shore quayside gantry cranes, expand container storage yards, improve container handling equipment, and develop on-dock rail transfer systems. The current trend of deploying ever-larger container ships continues to force ports

to again replace existing systems with greater out-reach post-Panamax gantry cranes and other cargo-handling equipment and at even greater cost, deepening access channels and draft at berths. These two thrusts of ship specialization and increasing size are not diminishing. A third related thrust impacting ports is the growth of integrated logistics, reflected by the development of improved inter-modal links and rationalization of the whole logistics chain. In the shipping world, this thrust has been demonstrated in the development of several major alliances and mergers of shipping lines. On the land-side, similar trends can be seen in the acquisitions and mergers of major railroad companies.

The objective of this paper is to evaluate the position of East Coast Canadian ports with respect to these three major thrusts. Each has had an effect on the development of the container trade and the growth of continental competition. The present trend in the container trades is the development of major hub container ports served by post-Panamax vessels (larger than the Panama Canal locks) that currently reach 7,060 TEU (twenty-foot equivalent containers on board) in size. Forecasters suggest that this is not the optimum size and that future container ships may reach 16,000 TEU capacity. Such large vessels will likely serve only main hub ports with further distribution to and from feeder ports and inland container depots by coastal shipping and intermodal systems (rail and road). The major Canadian container ports of Vancouver, Montreal and Halifax have developed capability to handle today's trade. How will these ports deal with the changing dynamics of ever larger ships and an evolving network of designated hub ports?

Containership Evolution

Major commercial ports worldwide have been dealing with the containerization revolution for many years. As pointed out by Cullinane and others (1999), containerization has gone through two phases. The first phase to the mid-1980s found ports dealing with four distinct generations of ship size until the Panamax limit of 13 containers

across a 32.2 m wide deck was reached. Since the mid-1980s, the second phase involved an organizational and logistical reorientation towards a totally integrated distribution system coupled with rapid growth in ship size beyond the Panamax limit.

By 1993, other major shipping lines followed APL's earlier lead and began introducing larger and wider post-Panamax vessels. As pointed out by Baird (1999), "almost three-quarters of the current port-Panamax fleet (i.e. generally vessels of 4000 TEU and above) were built in the 1993-99 period." In 1996, Maersk introduced its "K" class of container ships of 6000+ TEU with 17 containers across the deck. These ship sizes are by no means the limit on future growth. Various authorities (Baird 1999, Cushing 1999, Germanischer Lloyd 1998, and de Monie 1996) argue the next generation of mega-size container ships in five to ten years will be 12000 to 16000 TEU capacity with 24 containers across a 60 m wide deck.

Larger ships provide economies of scale (increased capacity with higher speeds at lower costs per TEU), greater ship stability, better flexibility in handling containers, and improved reliability (Cushing 1999). However, as ships become larger, the economies of scale reduce (the effect of diminishing returns), but still remain significant. One study of such mega-ships found that the economies of scale justify the deployment of 15,000 TEU vessels on the round-the-world pendulum route (de Monie, 2000A). A Delft Technical University analysis suggested the maximum size for container ships will be 18,000 TEU given draft restrictions in the Malacca Strait between Indonesia and Malaysia - the major shipping route between Europe and Asia (de Monie, 2000B).

The container trade will likely not be faced with the maximum size vessel in the near future. It is expected that over the next five years, shipping lines will consolidate their long haul fleet with vessels ranging from 5,500 to 9,000 TEU. The next generation of ships, required beyond five to ten years will see a bigger leap to 14,000 to 15,000 TEU capacity to achieve value from diminishing returns in

economies of scale (de Monie, 2000A). Such ships will likely be twin screwed adding considerably to their cost (Crook, 2000).

Trade Growth

The use of containers to handle higher value general cargo continues to grow. A recent forecast projects world port container throughput growth to 491 million TEU in 2012 (i.e. 2.6 times 1998 throughput of 188 million TEU). The forecast for North America is for a port throughput of 58 million TEU by 2012 (up from 27 million in 1998) (Ocean Shipping Consultants 1999). As the container trade grows, ships become larger. Larger ships require container consolidation at designated hub ports. De Monie (1996) suggested that tomorrow's "mega-ships" will likely be used on the main east-west global pendulum routes (ending on either coast of North America) calling only at a limited number of off-shore, deep-water ports (rather than the present on-shore facilities). All containers at these off-shore terminals would be transhipped to other ports. Terrassier and Uguen (1999) report that some of de Monie's suggestions are coming to fruition as container throughput is rising in Mediterranean ports located on the main east-west shipping lanes. This is in contrast to relative declines in container throughput in other European ports that require significant deviation from the main east-west shipping routes.

Implications for Ports

The challenge for Canadian container ports is to capture the opportunity offered by this shift to increasingly larger ships. Seeking to serve this trade presents several problems for ports including: ensuring adequate deep water (an environmental concern relating to dredging needs), wider channels, deeper berths, suitable cargo-handling equipment (including post-Panamax sized, quay-side gantry cranes), a highly productive and reasonably priced labour supply, and good road and rail intermodal connections to inland destinations. Although larger out-

reach post-Panamax cranes are being built and delivered to various ports (including Halifax and Vancouver), there may be limitations to the marginal wharf capacity and pile bearings leading to additional expensive renovations. Alternative finger pier systems with more traditional Panamax-sized cranes serving both sides of the mega-ship simultaneously have been proposed. The first example of this alternative form of container terminal is currently being developed in Amsterdam (Port News 1999).

Canadian deep-water ports at Halifax, the Strait of Canso, and Vancouver are key contenders for on-shore container terminals for mega-ships as opposed to the off-shore facilities proposed by de Monie. These harbours have deep water, sufficient manoeuvring space, and good intermodal services to the North American continent. There are other contenders in the North American port system to consider, particularly now that the U.S. government has approved major dredging operations in various key hub ports (New York/New Jersey, Oakland) (MARAD, 1999). On the West Coast, Long Beach and Seattle also have deep water, but they lack suitable waterfront land to serve the storage needs of mega-carriers (Mottley, 1998).

The East Coast Canadian Case

Two of Canada's major container ports, Vancouver and Halifax, can be considered as potential hub ports for the next generation of mega-sized container ships. Montreal will continue to serve a specific niche providing a short water route from Central Canada and the U.S. Mid-West to Europe. However, draft restrictions in the St. Lawrence River will continue to limit Montreal's accessibility for mega-sized ships. A further contender as a potential hub port is the Strait of Canso - a deep-water port with sufficient land-side storage space to develop a new, state-of-the-art container terminal. The following sections outline the case for Halifax and Canso to serve eastern North America. Space limitations in this paper prevent a similar analysis of Vancouver on the West Coast.

The East Coast provides a terminus for pendulum trade from Asia travelling through the Suez Canal and the Mediterranean. Currently, post-Panamax ships serve this route to New York (with a stop in Halifax) (Gillis, 1998). Both Halifax and Canso lie relatively close to the main shipping lanes from Europe to New York. Serving these ports represents a minor deviation of about one hours sailing time.

Halifax

Halifax has recently been in a major competition with New York and Baltimore to secure a contract with Maersk/Sea-Land to provide a large container terminal serving their post-Panamax fleet. In the end, Maersk/Sea-Land chose to remain in New York. However, Halifax's bid raised the port's profile within the shipping community as a major container facility. As pointed out in their 1998 *Port Rating Outlook*, "Moody's expects Halifax to emerge as one of the container load centres on the East Coast, based on a combination of a deep harbour, improved rail connections, an established market position and a good carrier mix" (Halifax-Dartmouth, 1999).

Halifax has ice-free, deep-water berths (14 m) that can be dredged deeper, and a main channel of 18 m. Canadian National Railway (CN) provides trunk line service to the port, serving two competing container terminals (Halterm and Fairview). CN provides intermodal rail links to Central Canada, the U.S. Mid-West, Central, and Gulf states through its purchase of Illinois Central and marketing agreement with Kansas City Southern Railways. CN's recent proposed merger with Burlington Northern Santa Fe Railway has the potential of expanding Halifax's hinterland to almost all of the North American continent. Most of Halifax' container throughput is shipped by rail. Both container terminals provide on-dock rail transfer systems linking them to CN's intermodal service.

Despite these advantages in serving the container trade, the Halifax Port Authority (HPA) has several drawbacks in comparison to its major U.S. competitor, New York/New Jersey. These drawbacks include the lack of a significant local market - more than 80 percent of

Halifax' container throughput is received from or destined to inland centres. Despite CN's use of efficient double-stack container trains, shipping to and from inland points by rail adds considerable transportation costs for shippers. Currently, the two container terminals in the HPA are operating at about 60 percent of their full container handling capacity (Bellefontaine, 2000). As this surplus capacity is filled over time, the HPA has time to plan the development of a future container terminal to handle ever larger container ships. Halterm has two post-Panamax gantry cranes on order to serve this growing trade. Despite Halifax' surplus capacity, there are times when one terminal becomes congested while the second stands relatively idle. A situation that has led some critics to argue that Halifax does not need two competing terminals, but rather should have one integrated facility. Plans for a third competing terminal will compound this concern. On the other hand, competition among terminals within the port serves to reduce costs to the shipping lines.

The Maersk/Sea-Land proposal call enabled the HPA (and its many stakeholders) to participate in planning a new terminal. Many potential sites were evaluated during the planning process. The optimal site selected by the HPA to meet the bid requirements was an infill project along the present CN mainline in the Bedford Basin. This project entailed extending the foreshore at Rockingham into the Bedford Basin by 300 m and along the shore from the present Fairview terminal by 1000 m to 1300 m. This site allows CN to readily provide spur lines to facilitate on-dock transfer. To meet the bid requirements, this new container terminal would have to handle 750,000 TEU per year by providing 1800 m of contiguous berth face (accomplished by merging with Fairview Terminal), up to 16 post-Panamax gantry cranes, container storage for 24,000 TEU, on-dock rail service, and 15 m of water depth (Salzano, 1999A).

Supplying a new container terminal to meet the needs of Maersk/Sea-Land or other carriers in the future requires a considerable capital outlay. Under its CPA status, the HPA must acquire its capital funds from the private lending agencies based on its current and

projected cash flow. The federal government is prevented by the *Canada Marine Act* from providing direct financial support to ports. The HPA cannot borrow funds by using the federal government's assets (land, in particular) as collateral. Based on its current cash flow position, the HPA is limited to borrowing a maximum of $25 million (Bellefontaine, 2000). This is a far cry from the $250 to $450 million needed to construct a new container terminal. The HPA's financial limitations under the *Canada Marine Act* relegates it to a minor participant in the development of new container handling facilities in Halifax. Most of the financial support will have to come from other sources - the shipping lines (who are reluctant to invest, arguing for government support), terminal operators, CN, municipal and provincial governments, and others. HPA and other ports may have to lobby the federal government to change Canada's tax regime to allow ports to issue tax-exempt revenue bonds (as is done by their U.S. competitors).

Knowledgeable observers have suggested many reasons for HPA's failure to acquire the Maersk/Sea-Land contract. Some of the main concerns relate to the lack of direct, double-stack intermodal links from Halifax to the U.S. North-East (Boston and New York), apparent labour inflexibility (a major post-Panamax facility must operate 24 hours per day, 7 days per week to ensure optimal utilization of expensive ships), and too many competing interests on the waterfront (such as, Halifax Port Authority, Port Development Commission, two private container terminals, three Waterfront Development Commissions, Greater Halifax Partnership, CN, and so forth). In some cases, these competing interests submitted their own bids to Maersk/Sea -Land call for proposals.

Relationships between HPA and one of its two container terminals have become contentious during the current round of negotiations for the renewal of Halterm's operating lease. Halterm has claimed it cannot afford to operate under the market-based lease that the HPA is proposing. Halterm's position is that the significant increase HPA is requesting is unfair. As a result of this dispute, the HPA is seeking expressions of interest from other parties that may be willing to

operate the container terminal at the end of Halterm's lease in 2001 (Peters, 1999).

Strait of Canso

The Strait of Canso provides a unique alternative to the established container facilities in Halifax. It provides a deep-water, ice free harbour capable of handling the largest container ships. The main harbour is capable of handling Ultra-Large crude oil tankers (500,000 tonnes). The Strait Superport is 20 km long, 1.5 km wide and has a limiting depth of 27 m. The area has more than 6,800 hectares of industrial lands available for port development. The Strait Superport is served by the Cape Breton & Central Nova Scotia Railway - a short line service connecting to the CN mainline at Truro, Nova Scotia. A relatively short spur line would be needed to connect to a potential container terminal. In addition, it is expected that the current trackage to Truro would have to be upgraded to handle double stack container trains.

The advantages of using Canso for a future on-shore container terminal for mega-ships are considerable: deep water, manoeuvring room, ample land-side storage areas, a labour force that has not historically been involved in waterfront unions and thus may be more flexible in their work practices, and good intermodal connections.

The main drawback is that Canso is not an established container handling facility. This means development is on a "green-field" site with all the inevitable start-up problems of a new major operation. These problems are particularly acute with respect to labour. Operating a modern container terminal requires highly skilled port technicians, hence considerable investment will be required for attracting sufficient suitably qualified individuals to the Canso area and providing appropriate training to enable them to operate a very large container terminal with significant daily throughout. Canso is fortunate in having the Province's Nautical Institute close by. This member of the Nova Scotia Community College system should be able to provide the necessary start-up and ongoing training to support the development of a major container terminal.

Obtaining capital for container terminal development would be problematic in Canso. However, given the area's status as an economically depressed region, such a major project with its employment opportunities should have a good probability of attracting regional development funds from provincial and federal sources.

Developing new major container handling facilities in green-field sites is not unheard of in the shipping business. The new container facility at Neva Sheva in India was built as a major container handling terminal outside the boundaries of the port of Bombay. This enabled the new terminal to operate with new work practices more suitable to the needs of the container trade; something that could not be attained within the rigid labour regime within Bombay.

Canso could emerge as a major international hub port serving Eastern North America. Funding could be provided by an international consortium of major shipping lines or alliances and terminal operators with suitable backing from Canadian and U.S. governments.

Comparisons

Serving the container trade has some risks. Shipping lines are relatively mobile and can decide to move their operations to another competing port, leaving a port's major capital investment under-used. The loss of the Far-East shipping lines in Saint John in 1987 reduced the port's container throughput to a mere shadow of its former traffic levels. As pointed out by J. White, President of the North Atlantic Ports Association, the region faces an unsettled market. "Its getting difficult to tell from year to year, month to month, day to day, who's on what ship and what their calls are" (Salzano, 1999B). In this dynamic and uncertain environment, care must then be taken to ensure that any facility being developed meets the needs of the shipping lines - its primary customers. The key factors used by shipping lines to select among competing container terminals and ports include: handling costs, gantry crane performance (number of lifts per hour), ship turn-around time (reducing the idle time in port to a minimum), berthing windows

(ensuring a dedicated berth upon ship arrival), port deviation times, and linkages to an effective intermodal network (Brooks, 1998).

A new container terminal in either Halifax or Canso would have to satisfy most, if not all, of these key factors. Container handling costs in Halifax would likely be higher than in Canso given the higher wage scales of port labour in the established terminals. In the Canso situation, new labour practices should result in lower charges and higher productivity. For example, the unionized labour in the port of Bayside, New Brunswick provide cargo-handling on a per tonne basis rather than the higher cost hourly process used by ILA workers in the competing port of Saint John.

Crane performance in Halifax, at 25 lifts per hour, is equivalent to most of its East Coast competitors (Brooks, 1998). It is expected that during the start-up phase of a Canso terminal handling rates would be lower, but given new, well trained labour working on modern gantry cranes, these rates should increase beyond those in the Halifax terminals. Increased productivity, including having a dedicated work force willing to work 7/24, means rapid ship turn-around. This is a major consideration for shipping lines using vessels that cost more that US$100 million to build. Again, improved labour practices and increased productivity with new work rules at Canso should ensure more rapid turn-around than in Halifax. Provision of dedicated berthing times can be handled in both ports given the development of new container terminals. Similarly, both ports have a minimum deviation time from the North Atlantic Great Circle Route and both are linked to an efficient intermodal rail system.

Serving Tomorrow's Mega-Ships

As outlined, both Halifax and Canso appear to be suitable contenders for an on-shore container handling facility to meet the demands of tomorrow's 8,000 - 15,000 TEU container ships. Both locations provide sufficient deep water, manoeuvring room, ice free berths and access to a continental intermodal rail service. To truly be competitive with other

East Coast ports in achieving hub port status, a direct double-stack rail line is needed to serve the U.S. North-East market. This means that CN must enter into suitable operating agreements with other railways in Canada and the U.S. to achieve this goal. In addition, it is likely that capital investment will be required to upgrade track and related infrastructure to handle a higher volume of double-stack container trains to the major markets of Boston and New York.

In the Halifax case, the large number of competing interests within the port community initially hampered the HPA's ability to submit a cohesive proposal. For example, CN submitted its own bid to Maersk/Sea-Land. Ultimately a strong contingent came together to support the HPA bid. In today's era of transportation system consolidation, alliances and mergers, a port must not appear to be fragmented. In a recent report to Congress, the U.S. Maritime Administration listed the need for coordination as the first of seven strategic issues facing marine transportation (MARAD, 1999). In this report, stakeholders expressed concerns about the lack of a national vision, fragmented government responsibilities, inadequate information, unclear responsibilities, and overlapping jurisdictions. These same concerns could be voiced about the Canadian marine transportation system at both national and regional levels. There is a growing need to address these issues to rationalize Canada's ports and their supporting intermodal systems.

For either Halifax or Canso to become tomorrow's hub port for the Canada and the Eastern U.S., major steps are required. In both cases, there must be a clear determination of who will lead the process of container terminal development - there must be a united and well coordinated approach to secure necessary funding and the support of major shipping alliances. The establishment of a major container terminal for tomorrow's mega-ships goes well beyond the confines of the port authority, the municipality, the province, and indeed, the nation. This is a project of international scope and should be tackled in this manner. Hence, despite the federal government's reticence to be involved in port matters (given the nature of the *Canada Marine Act*)

there is a need for federal participation and leadership to ensure this major opportunity for Canadian ports is realized.

Conclusion

There is a significant opportunity for either of Eastern Canada's two deep-water ports to develop into major hub terminals for the coming generation of mega-size container ships (12,000 to 16,000 TEU). Seizing this opportunity requires effective and skilful coordination of all the major elements within the marine logistics chain. There is a need to provide a highly productive container terminal capable of rapidly handling and turning around these mega-size ships, and a dedicated, high-speed intermodal double-stack rail connection to the U.S. North-east markets of Boston and New York (complementing the current intermodal linkages to the rest of the continent). But even more important is the need for clear leadership to provide direction to achieve this opportunity. A dedicated task force should be established comprised of the federal, provincial, and municipal governments and the transportation industry (port, shipping lines, rail and road, and other port users). This task force should be mandated to provide coordination to ensure a united goal and direction for all participants for this opportunity to become a reality for the benefit of the Canadian transportation industry.

Acknowledgements

I wish to thank David Bellefontaine, Halifax Port Authority and Gary Crook, UNCTAD, for their helpful comments on an initial draft of this paper.

References

Baird, A.J. 1999, "Container Vessels in the New Millennium: Implications for Seaports", *Liner Shipping: What's Next?, Proceedings,*

Halifax Conference of the International Association of Maritime Economists, September, pp. 141-173.

Bellefontaine, D. 2000, President and CEO, Halifax Port Authority, personal communication, January 25.

Brooks, M.R. 1998, "Halterm", case study, Centre for International Business Studies, Dalhousie University, Halifax.

Crook, G. 2000, Ports Section, UNCTAD, electronic communication, February 8.

Cullinane, K, Khanna, M. and Song, D.W. 1999, "How Big is Beautiful: Economies of Scale and the Optimal Size of Containership", *Liner Shipping: What's Next?, Proceedings*, Halifax Conference of the International Association of Maritime Economists, September, pp. 108-140.

Cushing, C.R. 1999, "Containerization - the Next Thirty Years", Halifax Port Days, September.

de Monie, G. 1996, "Container Shipping: Trends and Threats", 23rd ICHCA International Biennial Conference, Jerusalem, Israel.

de Monie, G. 2000A, Project Director, Policy Research Corporation N.V., Antwerp, Belgium, personal electronic communication, January 19.

de Monie, G. 2000B, Project Director, Policy Research Corporation N.V., Antwerp, Belgium, personal electronic communication, February 4.

Germanischer Lloyd 1998, ""Vision of 15,000 TEU ships by 2010", *Containerisation International*, December, p. 13.

Gillis, C. and Damas, P. 1998, "Intermodal or all-water?", *American Shipper*, 40:10, October, pp. 66-70.

Halifax-Dartmouth Port Development Commission, 1999, *1998/1999 Annual Report*, Halifax.

MARAD, 1999, *An Assessment of the U.S. Marine Transportation System*: A Report to Congress, Maritime Administration, Washington, D.C.

Mottley, R. and Gillis, C., 1998, "Ports face 6,000 TEU question", *American Shipper*, 40:7, July, pp. 73-75.

Ocean Shipping Consultants 1999, *World Container Port Markets to 2012*, summarized in "World container port boom set to accelerate", *Canadian Sailings*, September 6, pp. 5-12.

Peters, T. 1999, "Halterm/Port of Halifax dispute escalates", *Canadian Sailings*, December 20, p. 15.

Port News 1999, "Amsterdam", *AAPA Advisory*, June 7, p. 3.

Salzano, C.J. 1999A, "Maersk,Sea-Land Select Northeast Port", *World Wide Shipping*, 62:4, June, pp. 6-7.

Salzano, C.J. 1999B, "Managers Face Seemingly Insurmountable Challenges", *World Wide Shipping*, 62:4, June, p. 38.

Terrassier, N. and Uguen, M. 1999, "Impact of Liner Shipping on Port Traffic", presented to the Halifax Conference of the International Association of Maritime Economists, September.

Economic Issues in Canadian Marine Pilotage (1972-1997)

Joseph Monteiro*

Introduction

Transportation by ocean ships involves numerous related services, one of which is marine pilotage, a service not usually known to most individuals. Perhaps, there are a few occasions when our attention is drawn to these services for example when we hear of disasters such as the Exxon Valdez Oil spill. Marine pilotage is the conduct of ships through unique bodies of water by qualified officers who have acquired specialized knowledge of these local waters. It is governed in Canada by the *Pilotage Act*, whose origins can be traced to the Royal Commission chaired by Yves Bernier in the 1970s.

This *Act* of 1972 provides for the establishment of four pilotage authorities in Canada, the Great Lakes Pilotage Authority (GLPA), the Laurentian Pilotage Authority (LPA), the Atlantic Pilotage Authority (APA) and the Pacific Pilotage Authority (PPA). These Crown corporations have the responsibility of establishing, operating and administering efficient pilotage services in their respective regions in Canada in the interests of safety. To assist in this task, they are empowered to make regulations relating to pilotage. In effect, pilotage is a regulated monopoly or a group of monopolies. This group of four geographically defined monopolies generated revenue of approximately $100 million in 1997. Of the first thirteen years of their operation since 1972 only one was profitable resulting in large losses which were covered by appropriations of money from the federal government.

As a result, by the mid 1980s excessive pilotage costs and creeping inefficiencies in the pilotage system were so noticeable that they became a matter of grave concern to the Canadian Transport Commission (i.e., CTC). These concerns were also reiterated in several investigations into proposed tariff increases by the Pilotage Authorities. In addition, correspondence by the Treasury Board and the Minister of Transport requested the Authorities to move towards full cost recovery, as these Authorities are required to operate on a self-sustaining financial basis.

---

* The views expressed are those of the author and not necessarily those of the Competition Bureau, Industry Canada

The basic purpose of this paper is to review the major economic issues in the provision of pilotage services. Accordingly, section one briefly describes marine pilotage services in Canada. Section two examines the major economic issues and section three reviews the proposed reforms. Finally, a few concluding remarks are provided.

A Brief Description of Marine Pilotage Service in Canada

The following description of marine pilotage services in Canada is reviewed under a description of the service; the structure of the industry (i.e., pilotage regions, the demand for pilotage services, the supply of pilotage services); and pilotage regulations in Canada.

A) Pilotage Service

The profession of pilotage services developed because ports and bodies of water are different, each with unique hazards. To circumvent these hazards, a pilot is used to guide the vessels throughout these waters. This practice of using pilots is not unique to Canadian waters, maritime vessels throughout the world are required to use local pilots to enter and leave ports or navigate other restricted waters. A 'river pilot' is a term used for pilots in designated waters (i.e., river channels and approaches to ports). 'Lake pilots' are used in undesignated waters (i.e., open waters and ports in undesignated waters). Pilotage service not only consists of the provision of pilots, but also related services, for instance provision of pilot boats, dispatching and communication services and other support services.

B) The Structure of Marine Pilotage Services

i) Pilotage Regions: There are four pilotage regions in Canada - the Great Lakes Pilotage Region, the Laurentian Pilotage Region, the Atlantic Pilotage Region and the Pacific Pilotage Region - each of these geographic regions fall under the jurisdiction of their respective authorities noted earlier and will be briefly described.

GLPA: The boundaries of the region of the Great Lakes Pilotage Authority, a subsidiary of the St. Lawrence Seaway Authority, is defined in the schedule of the *Pilotage Act* as "all Canadian waters in the province of Québec south of the northern entrance to St. Lambert Lock and all Canadian waters in and around the Province of Ontario and Manitoba." The region is divided into

the following districts: 1. The Canadian sector consisting of a) The Cornwall District, b) The Welland Canal [part of the International District 2], and c) The Port of Churchill. 2. The International sector consisting of a) International District 1 [ID1] including Lake Ontario, which contains two divisions, b) International District 2 [ID2] including Lake Erie, containing three divisions, and c) International District 3 [ID3] including Lakes Huron, Michigan and Superior. All the waters in ID1, ID2 and ID3 are designated waters.

LPA: The Laurentian Pilotage Authority is a public body established pursuant to section 3 of the *Pilotage Act*. The Laurentian Pilotage region is defined in the scheduled of the *Pilotage Act* as "all Canadian waters in and around the Province of Québec, north of the northern entrance to St. Lambert Lock except the waters of Chaleur Bay south of Cap d'Espoir in latitude 48 degrees 25 minutes 08 seconds N., longitude 64 degrees 19 minutes 06 seconds W." By regulations made pursuant to the provisions of section 14 of the *Pilotage Act*, the LPA has divided the region under its jurisdiction into four districts: 1. District 1-1: including all waters of the port of Montreal; 2. District 1: including all waters between Montreal and Québec; 3. District 2: including all waters between Québec and Les Escoumins; and 4. District 3: including all other waters in the Authority's territory. Pilotage is compulsory in the first three districts but is not compulsory in the fourth.

APA: The Atlantic Pilotage Authority is a federal crown corporation established pursuant to section 3 of the *Pilotage Act*. The APA region defined in the schedule of the Act is "all Canadian waters in and around the Provinces of Nova Scotia, Prince Edward Island, Newfoundland and New Brunswick including the waters of Chaleur Bay in the Province of Québec, south of Cap d'Espoir in latitude 48 degrees 25 minutes 08 seconds N., longitude 64 degree 19 minutes 06 seconds W." The APA has established 17 compulsory areas under section 3 of the APA regulations. The areas in each of the Provinces are: 1. New Brunswick: Miramichi, Restigauche, and Saint John; 2. Newfoundland: Bay of Exploits, Stephenville, Humber Arm, St. John's, Holyrood, Clarenville and Placentia Bay (Come by Chance); 3. Nova Scotia: Sydney, Bras d'Or Lakes, Canso, Halifax and Pugwash; and 4. Prince Edward Island: Charlottetown and Confederation Bridge. The APA also provides ice and coastal pilotage as well as pilotage services in non-compulsory areas. Some of the non-compulsory areas in each of the Provinces are: 1. New Brunswick:

Bathurst, Butouche, Caraquet and Shediac; 2. Nova Scotia: Pictou; 3. Quebec: Chandler; 4. Prince Edward Island: Georgetown, Souris and Summerside; and 5. Newfoundland: Port aux Basques.

PPA:The PPA region defined in the schedule of the Act is "all Canadian waters in and around the Province of British Columbia."

ii) The Demand for Pilotage Services:

GLPA: Demand for pilots originates from four basic sources on the Great Lakes: Canadian lakers, US lakers, Canadian ships engaged in foreign trade to ports inside or outside the system, and US or foreign ships to ports inside or outside the system. The demand for pilotage services can be measured by the number of pilotage assignments or pilot hours or volume of cargo transported by ship. In terms of revenue, the GLPA accounted for $7.2 million in 1997 seventy percent of which was generated from the Canadian sector and the remainder from the International sector. Statistics on the number of pilot assignments in the GLPA (domestic and international) is shown in

TABLE 1-PILOTAGE ASSIGNMENTS IN THE GLPA 1978-1997

YEAR	1978	1982	1987	1992	1997	% Δ 1978-1997
NO. OF ASSIGNMENTS	14.495	10.173	7.032	5.091	7.192	-50.4

Table 1. Over the period 1978-1997, the demand for pilotage services as measured by the number of assignments declined by 50.4 percent.

LPA: In the Laurentian region, the demand for pilotage services originates mainly from two sources -- Canadian vessels engaged in Foreign trade out of the region and Foreign vessels or US vessels to ports inside or outside the system. The demand for pilot services is shown in Table 2 and revenue derived from these services in 1997 was $38.2 million. Districts 1-1, 1 and 2 generated approximately eight, fifty-five and thirty-seven percent of the revenue earned in this pilotage region. Over the period 1979-1997 the number of pilotage assignments declined by 32.4 percent.

TABLE 2-PILOTAGE ASSIGNMENTS IN THE LPA 1979-1997

YEAR	1979	1982	1987	1992	1997	% Δ 1979-1997
NO. OF ASSIGNMENTS	30.979	28.778	24.784	20.339	20.941	-32.4

APA: In the Atlantic region, the demand for pilotage services originates from the same two sources noted in the LPA region. The demand for pilotage in the APA region as measured by pilotage assignments is shown in Table 3 hereafter. In terms of revenue, the APA earned $9.6 million in 1997. The pilotage areas in the provinces of Nova Scotia, New Brunswick, Newfoundland & Labrador, and Prince Edward Island accounted for forty-eight percent, twenty percent, twenty-three and two percent of the revenue

TABLE 3-PILOTAGE ASSIGNMENTS IN THE APA 1978-1997

YEAR	1978	1982	1987	1992	1997	% Δ 1978-1997
NO. OF ASSIGNMENTS	12,997	11,617	10,413	9,008	9,760	-24.9

earned. Over the period 1978-1997, the demand for pilotage services as measured by the number of assignments declined by 24.9 percent.

PPA: In the Pacific region, the demand for pilotage services originates also from the two basic sources. The demand for these services basically originates from British Columbia coastal waters and from the Fraser River. Table 4 hereafter indicates the number of assignments or demand for pilotage services in these areas. In terms of revenue, the PPA earned $39.8 million in 1997 of which ninety-three percent was earned from pilotage operations in the BC costal waters and the rest from pilotage operations in the Fraser River.

TABLE 4-PILOTAGE ASSIGNMENTS IN THE PPA 1981-1997

YEAR	1981	1982	1987	1992	1997	% Δ 1981-1997
NO. OF ASSIGNMENTS	12,061	11,575	15,142	13,814	14,212	17.8

Over the period 1981-1997 for which data were published, the number of pilotage services assignments increased by 17.8 percent. This resulted in the PPA being the only pilotage region which recorded an increase in demand for pilotage services over this period. However, this increase was insufficient to offset the total decline in demand for these services (23.2 percent) for all the pilotage regions for the period 1981-1997. The decline in pilotage services in Eastern Canada is linked to the lack of strong growth in the waterborne trade - domestic and international; and the strong tendency towards increasing ship size, which has resulted in fewer assignments.

iii) The Supply of Pilotage Services:

The supply of pilotage services consists of the provision of pilots,

pilot boat services, dispatching and communication services, support and other administrative services.

GLPA: In the Canadian sector of the Great Lakes, pilotage services are supplied by the Great Lakes Pilotage Authority. Pilot services in the international sector are supplied by the GLPA and the United States Coast Guard (USCG). The pilots of the Great Lakes Pilotage region in Canada are employees of the GLPA. The USCG operates with voluntary associations using pilots who are self employed, i.e., private entrepreneurs.

In the above sector, pilots are members of the Corporation of St. Lawrence and Seaway pilots in the Cornwall District. Dispatching service are provided by the GLPA from its headquarters at Cornwall at its dispatch office at Port Weller. In the Port of Churchill, few pilotage services are rendered as the Port is accessible for only three months of the year.

In the International Sector in ID1, Canadian pilots are members of the Corporation of Upper St. Lawrence Pilots, and in ID2 and ID3 are members of the Corporation of Professional Great Lakes Pilots. United States pilots are members of the St. Lawrence Seaway Pilots Association in ID1, and members of the Lakes Pilot Association, Inc., and the Upper Great Lakes Pilots in ID2 and ID3, respectively. Pilot boat services in the ID's are provided by the GLPA either with its own pilots boats or pilot boats under contract and by the US pilot organizations. Dispatching services are provided by the GLPA, the Lakes Pilot Association, Inc., and the Upper Great Lakes Pilots, Inc.

The USCG plays a minor role in the provision of pilot services, leaving the day to day operation and administration to pilot associations or pools in each ID. In each ID only one pool has been authorized, though there is nothing in the US Great Lakes Pilotage Act or Regulations that requires only one pilot pool in each district of the Great Lakes. Thus it may appear that there are two suppliers of pilot services in the IDs, however, in effect there is only one supplier because of the division of the ID's into territories and the division of assignments.

LPA: The LPA is responsible for the provision of pilots, pilot boat services and other administrative services. In District 1-1, pilots are employees

of the LPA. In Districts 1 and 2, pilots are members of professional associations which negotiates service contracts for their members. Pilots belong to one of the three corporations or professional associations, Corporations des pilotes du port de Montreal in District 1-1 (represented by the Canadian Merchant Service Guild), Pilotes du Saint-Laurent Central Inc. in District 1, and Corporation of Lower St. Lawrence Pilots in District 2.

Pilot boat services are provided by LPA boats at Les Escoumins, and boats of independent contractors, for instance Les Remorquers de Trois Riviéres Inc., Sam Vezina Inc., etc., at the boarding stations at Québec, Trois-Riviéres, Sorel, Lanoraie and Montreal. There are two dispatching centres, one in Montreal and the other in Québec. The first is responsible for assigning pilots in District 1-1 and 1, the second assigns pilots in District 2. The boarding of pilots is provided for by the LPA at the Les Escoumins boarding station, and by private companies at the other boarding stations mentioned above.

APA: The APA is responsible for the provision of pilotage services in the Canadian Atlantic waters. The majority of pilots here are employees of the APA. The APA also contracts with entrepreneur pilots to provide services in compulsory and non-compulsory areas, they represent roughly twenty-two percent of all pilots. The pilot employees of the Authority are members of the Canadian Merchant Service Guild, the pilots bargaining agent. Pilot boat services are supplied by the APA, private contractors and private boat operators and companies.

PPA: The PPA is responsible for the provision of pilotage services in the waters in and around British Columbia. The majority of the pilots who provide these services are members of a company, the British Columbia Coast Pilots Ltd., which has a contract with the PPA. A few pilots are employees of the PPA. Pilot boat services or helicopter services needed for the boarding of ships by pilots are provided from various stations. The former from Victoria, Prince Rupert, Steveston, and Cape Beale (Port Alberni) and the latter from the Prince Rupert area and the West Coast of Vancouver Island. These pilot boat services are provided under contract with companies such as Riley ' s Boat Service Ltd., Tymac Launch Service Ltd., the Nanaimo Harbour Commission, etc.

---

7 Joseph Monteiro

C) Pilotage Regulations in Canada

Pilotage services in Canada are basically regulated pursuant to the *Pilotage Act*, and the pilotage regulations including the *Memorandum of Arrangements*. Other relevant laws are the *Canada Transportation Act* (i.e., CTA) and the *Canada Marine Act*.

The major aspects of economic regulation are: 1) the creation of pilotage Authorities and geographic pilotage areas; 2) the economic objects that pilotage Authorities are to pursue and the arrangements for the provision of pilotage service, 3) conditions governing the entry of personnel into the pilot profession, and 4) prescription of pilotage tariffs. These are briefly described.

The creation of pilotage Authorities and geographic pilotage areas are provided for in sections 3 and 4 and the Schedule of the *Pilotage Act*. The boundaries of any pilotage region may be extended with the approval of the Governor-in-Council pursuant to subsections 4(4)(a) and (d). Though the pilotage regions are specified in the Schedule, the *Act* is silent on the criteria the Authority should follow in establishing compulsory pilotage areas. Further, regulations may also be made regarding the establishment of compulsory pilotage areas and prescribing circumstances for the waiver of compulsory pilotage with the approval of the Governor-in-Council.

The objects that an Authority shall pursue according to section 18 of the *Pilotage Act* are to establish, operate, maintain and administer in the interests of safety an efficient pilotage service. The terms 'interests of safety' in this section are considered to include directly, the safety of lives, ships and property and indirectly, preservation of the environment, the smooth flow of maritime commerce and the avoidance of marine casualty resulting in prohibitive costs. The word 'efficient' in this section has taken an economic connotation. To provide pilotage services, the Authority may employ such officers and employees as are necessary. Further, the Authority may enter into a contract with a corporate body for the provision of services of licenced pilots. If this occurs, the Authority is prevented from employing pilots. This has been considered a serious impediment to lowering costs of pilotage.

Entry into the pilotage profession is controlled through the issuance of licences and certificates. Conditions governing the issuance of licences and

certificates are specified in sections 2, 22, 25 and 44 of the *Pilotage Act*. There are restrictions on these licences and certificates such as age, nationality, and current employment status. The Authority is also empowered to make regulations which affect entry, the most pertinent relate to prescribing classes of licences and classes of pilotage certificates that may be issued, prescribing the qualifications required for licences and certificates, limiting the number of licences that may be issued for any compulsory area, prescribing the manner of issuing licences and pilotage certificates which are contained in subsections 14(1)(e), (f), (j) and (k).

The prescription of tariffs of pilotage charges to be paid to that Authority for pilotage, including tariffs of pilotage charges (eg. pilot boats, use of telecommunications equipment, etc.), shall be made by the Authority with the approval of Governor-in-Council. Further, pursuant to section 33(3) of the *Pilotage Act*, the tariffs of pilotage charges prescribed by the Authority shall be fair and reasonable and consistent with providing a revenue together with any revenue from other sources, sufficient to permit the Authority to operate on a self-sustaining financial basis. When an Authority proposes to prescribe a tariff of pilotage charges, any interested person may object on grounds that it is prejudicial to the public interest (as defined in section 5 of the CTA). Where a notice of objection is filed, sections 34(4) and 35 of the *Pilotage Act* requires the Agency to: (a) make an investigation of the proposed charge; (b) make a recommendation thereon to the Authority; and (c) file a copy of the recommendation with the Minister of Transport forthwith. The Authority is obligated under section 35 of the *Pilotage Act* to abide by the recommendation.

Related to the above economic factors, a few amendments to the Act which came into effect on October 1, 1998 pertain to faster setting of tariffs, an end to appropriations by Parliament to cover losses except in emergencies, provision for borrowing of money fixed by the Governor-in-Council and a review of pilotage issues by the Minister of Transport within one year of coming into force of the Act.

Besides the above Act, there are eleven regulations applicable to pilotage. From the economic perspective, the most relevant sections in the regulations cover designation of compulsory pilotage areas within the region, vessels requiring compulsory pilotage, the waiving of compulsory pilotage and

qualifications required for an applicant, classes of licences, scope of licences and holders of licences, pilotage certificates and tariff of pilotage charges.

Finally, in addition to the above regulations, the Memorandum of Arrangements (MOA) with the U.S. plays a major regulatory role in the International districts of the Great Lakes. From the economic perspective, the relevant sections of the MOA are concerned with: 1. Definition of geographic areas in the districts and co-ordination of pilotage services by Canada and the US, 2. Allocation of dispatching and pilot boats by Canadian and US pilotage authorities, 3. Participation by the authorities in the two countries in the provision of pilotage services, 4. Reimbursement of cost, and 5. Regulations regarding imposing identical rates, charges and other conditions.

Analysis of the Major Economic Issues

In examining the issues related to pilotage, three issues will be examined: A) Costs, B) Economic efficiency/productivity, and C) Monopoly power.

A) Costs: The Federal Government's policy on the operations of the Pilotage Authorities commits them "to operate on a self-sustaining financial basis" under subsection 33(3) of the *Pilotage Act*. This intent was reiterated in correspondence from the Associate Secretary of the Treasury Board and the Minister of Transport in 1984-85.

For the entire period 1972-1997, the four authorities incurred a total loss of $66.58 million being profitable for only two of the twenty-six years. This loss was basically incurred by the three Eastern pilotage authorities as shown in Table 5 and offset by appropriations received from the federal government shown in Table A17. The LPA was responsible for the major share of the loss accounting for $44.2 million, followed by the APA which accounted for $13.68 million and the GLPA which accounted for $10.23 million. The first two accounted for 87 percent of the total loss. The only Authority that operated at a profit was the PPA. The GLPA was profitable for nine of these twenty-six years, the LPA for four, the APA for six and the PPA for fourteen.

TABLE 5 - PROFIT (LOSS) OF THE PILOTAGE AUTHORITIES 1972-1997 ('000)

YEAR	GLPA	LPA	APA	PPA	ALL PILOTAGE AUTHORITIES
1972	(288)	(977)	(948)	(602)	(2, 815)
1973	(853)	(717)	(1, 449)	(471)	(3, 490)
1974	(2, 083)	(2, 061)	(1, 267)	(254)	(5, 665)
1975	(1, 366)	(576)	(1, 945)	(363)	(4, 250)
1976	(1, 075)	99	(1, 973)	82	(2, 867)
1977	(836)	238	(1, 097)	501	(1, 194)
1978	(409)	448	(987)	448	(500)
1979	(88)	(391)	(125)	(109)	(713)
1980	40	(89)	(157)	(313)	(519)
1981	(918)	248	(31)	(76)	(777)
1982	42	(108)	(530)	773	177
1983	(489)	(872)	4	704	(653)
1984	(569)	(1, 386)	(109)	95	(1, 969)
1985	(3, 213)	(2, 078)	(565)	209	(5, 647)
1986	774	(1, 414)	(239)	(220)	(1, 099)
1987	(945)	(1, 691)	(130)	10	(2, 756)
1988	28	(1, 773)	55	136	(1, 554)
1989	(299)	(1, 836)	35	(481)	(2, 581)
1990	(1, 593)	(2, 232)	(333)	(433)	(4, 591)
1991	(1, 900)	(5, 118)	(518)	1, 288	(6, 248)
1992	(1, 139)	(4, 936)	(1, 466)	1, 717	(5, 824)
1993	40	(5, 965)	(808)	67	(6, 666)
1994	3, 336	(3, 175)	(732)	(1, 603)	(2, 174)
1995	1, 342	(4, 177)	58	(1, 142)	(3, 919)
1996	1, 016	(2, 828)	636	180	(996)
1997	1, 210	(834)	1, 043	1, 283	**2, 702**
1972-1997	**(10, 235)**	**(44, 201)**	**(13, 578)**	**1, 426**	**(66, 588)**

SOURCE: ANNUAL REPORTS OF THE PILOTAGE AUTHORITIES. NUMBERS ARE ROUNDED.

These statistics indicate that the three Eastern Pilotage Authorities have incurred 'excessive costs' (in the sense of incurring losses consistently), thus failing to meet the requirement of operating on a self-sustaining financial basis. This has also been noted in other reports for example "The conclusion drawn is that ... the objective of financial self-sufficiency is not being achieved." Even if one reviews the period after the Ministerial statements in 1984-85, the statistics do not indicate a substantial improvement, perhaps, the only noticeable improvement is in the statistics of the GLPA and the APA after 1993.

Before concluding, the components of revenue and costs of the pilotage authorities will be briefly noted. The basic sources of revenue for the Authorities are from pilotage charges, with minor contributions from pilot boat rentals, and interests and other revenue. In the GLPA, LPA, APA, and PPA -- 97%, 89%, 99% and 99% of revenue is obtained through pilotage charges, only in the LPA do pilot boats provide any reasonable revenues. These statistics are shown in Tables A9, A11, A13 and A15.

The basic sources of costs for the Authorities are from: pilot salaries and benefits, pilot boats, staff salaries and benefits, and transportation and travel. The proportion of these components differ for different pilotage authorities and some are more significant in some of the authorities. In addition, there are other costs such as, accommodation, communication, administration, etc. In the GLPA, these four components account for 74%, 4%, 9% and 6%. In the LPA, the first two components account for 80%, and 9% with administration costs accounting for another 11%. In the APA, the first two components account for 49%, 30%, with the latter two accounting for 6 and 4 percent respectively. In the PPA, these four components account for 72%, 11%, 5% and 8%, respectively. These components of costs have tended to remain remarkably stable over the entire period 1972-1997. These statistics are shown in Tables A10, A12, A14 and A16.

B) Economic efficiency/productivity: The object of operating and maintaining an efficient pilotage service is specifically mentioned in section 18 of the *Pilotage Act*. Efficiency is usually measured using various measures of productivity and cost-efficiency. In the provision of these pilotage services, measures of productivity are generally unavailable, nevertheless some indication of efficiency can be obtained for each of the authorities by examining indicators such as 1) changes in the number of pilots with changes in assignments per pilot, 2) cross-sectional comparison of hours on board per season per pilot, and 3) a comparison of pilotage cost indices and other price indices.

1) Changes in the number of pilots with changes in assignments per pilot: The change in the number of assignments per pilot is shown in Table 6 for the period 1978/79-1997 and for the period 1985-1997. Table A2, A4, A6

and A8 indicates the number of pilots, the number of assignments and the

Table 6 - Assignments per pilot for the Authorities

Year	GLPA	LPA	APA	PPA*
1978/79	117.8	130.7	294	131.10
1997	114.2	119.7	195	121.47
% Δ 1978/9-97	-3.06	-8.4	-34.0	-7.3
1985	66.0	100.5	222	124.11
1997	114.2	119.7	195	121.47
% Δ 1985-97	73.0	19.1	-12.2	-2.1

* The data for the PPA are from 1981

assignments per pilot for the entire period 1972-1997. The statistics indicate that over the entire period, the number of assignments per pilot have been declining in each of the authorities. This decline is most pronounced for the APA. If the period is restricted to 1985-1997, assignments per pilot have declined both in the APA and the PPA. The reason for the increase in assignments per pilot for the GLPA and the LPA despite the overall decrease in assignments is because the number of pilots have decreased even more. For the APA, the number of pilots has not decreased substantially which has resulted in decreases of assignments per pilot in light of the decrease in number of assignments. In the case of the PPA, the decrease has resulted even though the number of pilot assignments have increased because the number of pilots have also increased.

2) Cross-sectional comparison of hours on board per season per pilot: Statistical data on hours of work per pilot are limited. The available data indicates that for the GLPA in general, hours on board per person per pilot decreased over the period 1981-1986 and continued to decline probably until 1992. In addition, the hours worked by GLPA pilots in the GLPA International districts was less than the number of hours worked by US pilots in the same districts for the period 1981-86. Further, the number of hours worked in various ID's and the Canadian sector of the GLPA varied widely. For the LPA, the number of hours of work per pilot has also steadily declined over the

period 1979-1986. For the APA, statistics on hours on the bridge (i.e., bridge time) spent by APA pilots over the period 1981-86 increased. Given the absence of the most recent data, it is not possible to provide any general statements on productivity from this measure.

3) A comparison of pilotage cost indices and other price indices: An indication of overall measure of cost effectiveness can be obtained by considering the changes in average pilot cost per assignment and the consumer price index. The indices of average pilot cost per assignment for the four authorities for selected years are shown in the Table 7 and in the Tables A2, A4, A6 and A8 for the entire period.

The indices indicate that the average pilot cost per assignment increased significantly more that the consumer price index for the LPA , APA and the PPA. For the GLPA, the increase in the index was greater than the

Table 7 - Indices of Average Pilot Cost per Assignment for the Authorities and the CPI

Year	GLPA	LPA	APA	PPA*	CPI
1980	100	100	100	100	100
1985	200	175	161	149	143
1990	215	221	203	181	178
1997	210	314	263	230	205
% Δ 1980-97	110	214	163	130	105

* For the PPA the initial year is 1981. A CPI with a base of 1981 indicates that the CPI increased by 82 percent, so that when the PPA index and the CPI are compared the difference is more than 50 percent.

CPI but the increase was not very significant. This is because the GLPA has been more successful in reducing its cost after 1990, due to a reduction in the number of pilots, the Authorities attempt to reduce costs, and an increase in the number of assignments.

The various indicators of productivity or cost efficiency indicate that efficiency has declined from 1978 or 1979. This has led to numerous statements in the past such as "excessive pilotage costs and creeping inefficiencies in the pilotage system have been a matter of grave concern to the Committee since the Pilotage Act came into force in 1972..." A major factor for this decline may be attributed to the fact that the number of assignments have declined significantly for the eastern pilotage authorities and adjustment

in the number of pilots employed has not kept pace with this decline. However, it should be noted that the Authorities have been making an effort to deal with the matter as evidenced in the profits or decline in losses of the eastern pilotage authorities in the last five years.

C) Monopoly Power: In a 1988 Department of Justice study on pilotage services in the US, several abuses of monopoly power were noted. Though none of these have been documented in the Canadian context, two indications of monopoly power that have been noted are: 1) Cross-subsidization, and 2) the increase in tariffs.

1) Cross-subsidization: To determine if there has been cross-subsidization, one can compare the increases in pilotage charges in each sector of an Authority with the profit or loss incurred in that sector of the Authority. Since the data on the matter normally are provided only when there is an investigation into a proposed hearing, the data provided is for only two selected years 1981 and 1992. Table 8 provides the data of tariff increases by sector and Table 9 provides the data on profit/loss as a proportion of revenue or assignment for each sector.

Thus the same increases in pilotage tariffs for the two years for districts and ports under each Authority and varying profit or loss as a proportion or revenue or assignment incurred by the pilotage authority

Table 8 - % Increase in Tariffs of the Pilotage Authorities by Sector for 1981 and 1992

Year	G	LP (B)	A	G	L P (C)	A	L	P	A	A P	A
	ID1	ID2	ID3	Cornwall	Welland	Churchill	D1-1	D1	D2	Halifax	All Oth
1981	10	16	10	12	12	15.0	17.9	17.9	17.9	9.0	9.0
1992	5.4	5.4	5.4	5.4	5.4	5.4	7.10	7.10	7.10	2.5	2.5

Table 9 -Profit (Loss) as a Proportion of Revenue or Assignment for the Pilotage Authorities by Sector for 1981 and 1992

Year	G	LP (B)	A	G	L P (C)	A	L	P	A	A P	A
	ID1	ID2	ID3	Cornwall	Welland	Churchill	D1-1	D1	D2	Halifax	All Others
1981	(.144)	.049	(.282)	(.202)	(.588)	(.733)	(64)	(2)	32	1	11
1992	(.524)	(.19	.095	(.169)	(.131)	(.96)	(56)	(88)	(207)	(327)	(1139)

For the GLPA the profit/loss data is for Proportion of Revenue. For LPA the profit/loss is per assignment and for the APA it is total profit/loss.

indicates the presence of cross-subsidization within the pilotage district or ports of an Authority. Cross-subsidization also exists for other reasons for example ability of larger ships to pay rather than actual cost incurred.

Cross-subsidization among ports under the jurisdiction of an Authority is not specifically dealt with under the present *Pilotage Act*. The *Act* requires an Authority to operate on a self-sustaining financial basis, further the tariffs should be fair and reasonable and be consistent with providing a revenue, together with any revenue from other sources. As a result, cross-subsidization is not prohibited. Further, since the *Act* does not define what is fair and reasonable, cross-subsidization has not been disallowed.

Cross-subsidization has always been a contentious issue from the social, economic and political perspective. Before deregulation was in vogue, cross-subsidization was used as a justification for the need for regulation. Modern economic thought does not view cross-subsidization favourably, especially if it is used for anti-competitive purposes or to distort competition. As a result, the practice of cross-subsidization has been denounced in a number of reports of inquiry officers into proposed tariff increases. Further, cross-subsidization among ports has also been a source of objections at interventions by supporters of the larger more efficient ports. In addition, it not only affects the competitiveness of the most efficient ports vis-a-vis neighbouring ports but also against US ports. To circumvent this problem, some writers have suggested the payment of direct subsidies to small ports which would otherwise not be able to survive.

2) Increases in Tariffs: The percentage changes in tariffs of the Pilotage Authorities and the consumer price index over the 1976-1997 are shown in table 10. The tariff increases in the GLPA international sector does not include the currency equalization factor. If this added, it is clearly evident that the rate of tariff increase for the GLPA (international) and GLPA domestic sectors is greater than the CPI over the 1976-1997 period. This increase was incurred not withstanding the fact that the pilotage tariffs were subject to a maximum increase provided by the wage and price guidelines beginning in 1983 and the freeze on tariff increase in 1986-1987. For the APA too, the tariff

Table 10 - Percentage Increases in Tariffs by the Pilotage Authorities and the Consumer Price Index

Year	GLPA	LPA	APA	PPA	CPI
1976	25.00	11.32	26.00	16.80	7.55
1977	18.00	2.44	0.00	6.00	8.01
1978	13.00	7.09	24.80	2.00	8.95
1979	14.20	8.99	25.00	4.00	9.13
1980	7.50	9.76	10.00	13.10	10.16
1981	11.50	17.90	9.50	13.50	12.43
1982	12.20	11.00	11.50	17.00	10.80
1983	6.00	0.00	6.00	3.75	5.86
1984	5.00	5.00	5.00	4.50	4.30
1985	4.20	0.00	3.40	1.50	3.96
1986	3.00	0.00	13.60	0.00	4.18
1987	0.00	9.20	0.00	2.00	4.34
1988	0.00	0.00	0.00	3.00	4.05
1989	4.40	4.75	0.00	0.00	4.99
1990	6.00	3.70	0.00	11.20	4.76
1991	5.90	0.00	3.00	4.50	5.62
1992	5.40	7.10	2.50	3.00	1.49
1993	-2.00	0.00	0.00	0.00	1.86
1994	4.00	8.90	5.70	0.00	0.16
1995	0.00	0.00	0.00	5.50	2.17
1996	0.00	5.00	8.20	1.50	1.58
1997	0.00	5.90	0.00	3.25	1.62
1976-97	143.3*	118.0	154.2	116.1	117.97

SOURCE: TRANSPORT CANADA. STATISTICS PROVIDED BY MCDONALD GERARD.

*Currency Equalization Factor not included. It represents an increase when the Canadian dollar is lower than the U.S. dollar. This increase is considerable for purposes of comparison when first introduced in April 1986 it represented a 40 percent increase in tariff, a 12% increase in December 1991 and about a 29% increase in December 1992.

increases over the period 1976-1979 are also considerably greater than the CPI for that period. For the LPA and the PPA, the percentage tariff increases are nearly equal to the increase in the CPI for the above period. The greater increase in pilotage tariffs can be attributed to the monopoly power of the pilots. Had the Agency not denied the proposed tariff increases on numerous occasions, as a result of objections filed under section 34(4) of the *Pilotage Act*, the exercise of monopoly power would be striking.

Thus the two indicators of monopoly power examined, cross-subsidization and tariff increase, not surprisingly suggest the exercise of monopoly power by the pilotage authorities.

Summarily, an analysis of major economic factors indicates that the Pilotage Authorities have incurred excessive costs in the sense that only in two of the twenty-six years they have been profitable and the losses for the twenty-three years had to be offset by government appropriations. Further, various indicators of productivity or cost efficiency indicate that productivity or efficiency has declined since 1978 or 1979, though the Authorities have been making an effort to deal with the matter in the last few years. Finally, indicators such as increase in tariffs and cross subsidization indicate the exercise of monopoly power.

Attempts to Bring About Reform

The issues facing marine pilotage in Canada were examined by a number of studies - The Acres Report, The Blouin Report, the Canadian Transport Committee Study, The Transport Canada Study, The Gauthier Report, The Standing Committee on Transport Report - before attempts were made to introduce reforms into the *Pilotage Act* in 1998. A number of these studies were extremely critical of the issues identified in this paper and made several recommendations. The last report mentioned above called for a repeal of the *Pilotage Act* and a dissolution of the Pilotage Authorities which would be replaced by a Pilotage Desk/Secretariat which would regulate pilotage in Canada. In addition, it recommended commercialization of pilotage services, a review of compulsory pilotage areas and criteria for exemption, and a mechanism for settlement of disputes.

Despite these views, the revised *Act* which came into effect on October 1, 1998 only contained a few amendments. These pertain to: faster setting of tariffs; an end to appropriations by Parliament to cover losses except in emergencies, provision for borrowing of money; and a review of pilotage issues by the Minister of Transport within a year of the Act being force.

The issue now is will the financial problems of the authorities be resolved or will they continue? It is hard to believe that in the absence of competition the issues raised in the past will disappear, except perhaps that the government will not have to cover the losses of the pilotage authorities. As noted elsewhere "in seeking to be financially self-sustaining the Authorities have tended to follow a policy of increasing tariffs rather than reducing costs. Such an attitude has been documented in a number of earlier CTC

investigations and confirmed by the responses of the Authorities during recent investigations in 1985. The results of such a policy are tariff levels that reflect the expenses of the Authority rather than an efficient level of costs."

It is true that in the last few years the pilotage authorities have made a real effort to deal with the problem of inefficiency but in the absence of competition it is difficult to determine the efficient level of costs. If not for the constant objection to proposed tariff increases of the authorities by users of the waterway which the CTC was in agreement with, the tariffs would have further raised the cost of these services which could have affected the competitiveness of the St. Lawrence Seaway vs. alternative routes or Canadian vs US ports.

Further, the provision of pilotage services in Canada do not display any of the typical characteristics such as economies of scale or natural monopoly, missing markets, etc. that are used to justify the provision of such services through a regulated monopoly. Consequently, it is suggested that consideration be given to introducing alternative ways in which such services can be provided so that competition can be developed and encouraged. As noted by the US Department of Justice "Because economic regulation in the form of entry restrictions, monopoly pools and regulated fees is unnecessary, the current regulated monopoly system of providing pilotage should be replaced, to the maximum extent possible, with free and open competition that prevails in most of the United States economy."

As a general rule advocates of competition do not believe that direct government economic regulation of specific services is superior in capturing public policy objectives. In normal situations, the production of goods and services is best achieved under a competitive regime. Competition is an alternative to direct economic regulation. While there may be circumstances where the later may be the most appropriate public response, it is hard to accept that this is the case in the provision of pilotage services for the above reasons.

By advocating competition it is not suggested that all regulations be removed. Safety and environmental protection will continue to require pilotage services. Even here, it is suggested that areas that require compulsory pilotage be periodically reviewed and several reforms in this regard have recently been suggested in the *Ministerial Review of Outstanding Pilotage Issues.*

---

19 Joseph Monteiro

Concluding Remarks

Despite the concerns and views expressed by the federal government in 1984, regarding the excessive costs incurred by the Pilotage Authorities, their advise went unheaded and the Authorities incurred even great losses after that period. It is not that the Authorities made no effort to improve their efficiency, the market conditions were simply not favourable and their effort was not sufficient. To deal with the pilotage problems the government introduced a few reforms which they believed were adequate. These reforms would ensure that the government would not cover losses of the Authorities, provide for faster setting of tariffs, etc.

Notwithstanding the amendments and the recent recommendations, it is difficult to visualize how the economic ills faced by the Pilotage Authorities will disappear, if the decline in demand for pilotage services continues. Hopefully this will not occur! With an increase in demand, perhaps the overall picture will look better as financial self-sufficiency will be achieved. But whether tariff levels will be just and reasonable will not be known. The current tariffs reflect the low level of demand and not when demand is at a much higher level. There is no mechanism in the Act which requires the Authorities to file for lower rates. And should they do, how could lower rates be prejudicial to the public interest? It has been pointed out in many tariff reviews that the Authorities lack an appropriate rate setting methodology.

In the absence of competition, the efficient level of costs will never be known and whether the St. Lawrence Seaway will become competitive with alternative routes or ports is not known. Recently, the *Ministerial Review of Outstanding Pilotage Issues* offered recommendations to deal with these concerns but none dealt with competition as it was not within the terms of reference.

BIBLIOGRAPHY

1. *Pilotage Act*, Chapter P-14.

2. *Report of the Inquiry Officer, An Inquiry into the Proposed 1985 Amendment to the Atlantic Pilotage Tariff Regulations*, W.T.C., C.T.C., Ottawa, Canada, December 1985.

3. *Report and Recommendation of the Canadian Transport Commission in the Matter of the Proposed Tariff of Pilotage Charges Published by the Laurentian Pilotage Authority on January 29, 1985*, W.T.C., C.T.C., Ottawa, Canada, April 4, 1986.

4. *Marine Pilotage in Eastern Canada, A Synthesis of Economic Issues Arising Out of Recent CAC Investigations*, W.T.C., C.T.C., June 1986.

5. Saarty, David, *Report of the Inquiry Officer on the Great lakes Pilotage Authority's Proposed Tariff of International Pilotage Charges*, W.T.C., C.T.C., Ottawa, Canada, May 1987.

6. *Report and Recommendations on Marine Pilotage Policy*, Transport Canada, TP8931E, January 1988.

7. *Great Lakes Pilotage Study, Draft Report for Public Comment, US* Department of Transportation, Washington, DC 20590, March 14, 1988.

8. *Comments of the Department of Justice, Regarding Great Lakes Pilotage Review, Before the United States Coast Guard*, Department of Transportation, Docket No. 87-034, May 12, 1988.

9. Brooks, Mary, "Marine Cost Recovery", Part 1 and Part 2, *Seaports and the Shipping World*, May 1988, pp. 38-39/66 and June 1988, pp. 40-41.

10. Brooks, M., "Pilotage - Time for Review", *Seaports and the Shipping World*, Dec. 1988, pp. 45/60.

11. *Staff Investigation of the Atlantic Pilotage Authority's Tariff Proposal of December 23, 1989*, Dispute Resolution Branch, National Transportation Agency, July, 1990.

12. *Staff Investigation Report of the Atlantic Pilotage Authority's Proposed Tariff Amendment of February 27, 1993*, Marine, Trucking and Regional Offices Branch, N. T. A., April 1993.

13. *Staff Investigation Report of the Laurentian Pilotage Authority's Tariff Proposal of July 4, 1992*, Marine, Trucking and Regional Offices Branch, N. T. A., April 1993.

14. Saarty, David, *An Economic Analysis of the Great Lakes Pilotage Authority's Proposed Tariff Amendment of December 12, 1992*, Ottawa, Canada, May 1993.

15. Keys, Stan, *A National Marine Strategy*, Standing Committee on Transport, House of Commons, May 1995, pp. 22-27.

16. *Canada Marine Act*, Transport Canada, December 1997, pp. 15-16.

17. *Pilotage Issues Discussion Paper*, Ministerial Pilotage Review, CTA., 1998.

18. *Pilotage Reform*, Views of the St. Lawrence Seaway Management Corporation on Pilotage Issues, Submitted to the Pilotage Review Panel, October 1998.

Table A1-Revenue, Expense, Profit (Loss) of the GLPA 1972-1997 ('000)

Year	Revenue	Expense	Profit (loss)
1972	4. 454	4. 742	(288)
1973	4. 046	4. 899	(853)
1974	2. 587	4. 670	(2. 083)
1975	3. 663	5. 029	(1. 366)
1976	4. 941	6. 016	(1. 075)
1977	6. 413	7. 249	(836)
1978	8. 026	8. 435	(409)
1979	9. 272	9. 360	(88)
1980	9. 536	9. 496	40
1981	8. 907	9. 825	(918)
1982	10. 346	10. 304	42
1983	10. 035	10. 524	(489)
1984	10. 852	11. 421	(569)
1985	8. 583	11. 796	(3. 213)
1986	11. 384	10. 610	774
1987	9. 850	10. 795	(945)
1988	9. 747	9. 719	28
1989	9. 365	9. 664	(299)
1990	8. 374	9. 967	(1. 593)
1991	8. 044	9. 944	(1. 900)
1992	8. 292	9. 431	(1. 139)
1993	9. 428	9. 388	40
1994	13. 954	10. 618	3. 336
1995	11. 318	9. 976	1. 342
1996	12. 659	11. 643	1. 016
1997	13. 119	11. 909	1. 210

Table A2-GLPA No. of Pilots, Ass., Ass per Pilot, Cost and Rev. per Ass. and Indices (1972-97)

Year	Pilots	Assignments	Ass. per Pilot	Pilot Cost per Ass. ($)	Index of Pilot Cost	Rev. per Ass. ($)	Ind. of Pil Rev.
1978	123	14. 495	117.8	418	73	540	72
1979	125	13. 394	107.1	504	88	669	89
1980	125	12. 187	97.1	574	100	754	100
1981	124	10. 129	81.4	731	127	841	112
1982	121	10. 238	84.3	746	130	970	129
1983	119	9. 199	77.3	846	147	1. 057	140
1984	113/0	9. 377	82.6	905	158	1. 118	148
1985	113/0	7. 465	66.1	1. 149	200	1. 109	147
1986	102/5	8. 222	78.9	974	170	1. 348	179
1987	97/5	7. 195	72.5	1. 085	189	1. 321	175
1988	81/9	7. 106	83.6	961	167	1. 318	175
1989	77/9	6. 535	80.7	1. 045	182	1. 365	181
1990	74/4	5. 781	76.3	1. 232	215	1. 381	183
1991	70/2	5. 346	75.4	1. 307	228	1. 448	192
1992	65/2	5. 091	77.3	1. 307	228	1. 592	211
1993	48/12	5. 481	102.9	1. 184	206	1. 697	225
1994	52/9	7. 787	139.2	1. 006	175	1. 770	235
1995	55/7	6. 091	104.9	1. 159	202	1. 790	237
1996	57	6. 903	121.1	1. 258	219	1. 786	237
1997	63	7. 192	114.2	1. 206	210	1. 762	234

Table A3- Revenue, Expense, Profit (Loss) of the LPA 1972-1997 ('000)

Year	Revenue	Expense	Profit (loss)
1972	6. 827	7. 804*	(977)
1973	8. 565	9. 282	(717)
1974	7. 468	9. 530	(2. 061)
1975	10. 430	11. 006	(576)
1976	12. 899	12. 800	99
1977	14. 974	14. 736	238
1978	16. 890	16. 443	448
1979	17. 303	17. 694	(391)
1980	20. 346	20. 435	(89)
1981	22. 775	22. 526	248
1982	23. 124	23. 233	(108)
1983	23. 951	24. 823	(872)
1984	25. 669	27. 055	(1. 386)
1985	24. 839	26. 917	(2. 078)
1986	27. 039	28. 453	(1. 414)
1987	27. 221	28. 912	(1. 691)
1988	26. 950	28. 723	(1. 773)
1989	28. 004	29. 840	(1. 836)
1990	28. 589	30. 821	(2. 232)
1991	28. 966	34. 084	(5. 118)
1992	27. 508	32. 444	(4. 936)
1993	26. 966	32. 931	(5. 965)
1994	33. 354	36. 529	(3. 175)
1995	34. 367	38. 544	(4. 177)
1996	36. 019	38. 847	(2. 828)
1997	38. 185	39. 019	(834)

* Includes $127. 935 payable to Canada

Table A4-LPA No. of Pilots, Ass., Ass per Pilot, Cost and Rev. per Assignment and Indices (1979-97)

Year	Pilots	Assign	Ass. per Pilot	Pilot Cost per Ass ($)	Index of Pilot Cost	Pilot Rev per Ass ($)	Index of Pilot Rev.
1979	237	30. 979	130.7	451	93	553	104
1980	241	33. 611	139.5	485	100	534	100
1981	246	31. 722	128.9	575	119	634	119
1982	242	28. 778	118.9	635	131	708	133
1983	250	27. 107	108.4	733	151	784	147
1984	16/229	27. 103	110.6	793	163	842	158
1985	16/229	24. 515	100.5	848	175	900	169
1986	14/228	25. 632	105.5	868	179	936	175
1987	13/229	24. 784	102.4	934	193	975	183
1988	13/224	24. 069	101.6	966	199	992	186
1989	13/216	23. 223	101.4	1. 029	212	1. 079	202
1990	12/207	22. 922	104.7	1. 073	221	1. 114	209
1991	12/194	22. 723	110.3	1. 223	252	1. 145	214
1992	12/194	20. 339	94.2	1. 339	276	1. 249	234
1993	10/186	19. 216	98.0	1. 402	289	1. 265	237
1994	10/175	22. 550	121.9	1. 331	274	1. 311	245
1995	9/166	21. 973	125.6	1. 450	299	1. 383	259
1996	8/165	21. 342	123.4	1. 497	309	1. 480	277
1997	8/167	20. 941	119.7	1. 525	314	1. 607	301

Statistics with a / employee pilots/Entrepreneur pilots

Table A5- Revenue, Expense, Profit (Loss) of the APA 1972-1997 ('000)

Year	Revenue	Expense	Profit (loss)
1972	1, 382	2, 330	(948)
1973	1, 732	3, 181	(1, 449)
1974	2, 025	3, 292	(1, 267)
1975	1, 757	3, 703	(1, 945)
1976	2, 030	4, 003	(1, 973)
1977	2, 780	3, 877	(1, 097)
1978	3, 203	4, 189	(987)
1979	4, 313	4, 437	(125)
1980	4, 781	4, 938	(157)
1981	5, 225	5, 256	(31)
1982	4, 948	5, 478	(530)
1983	5, 480	5, 477	4
1984	5, 859	5, 968	(109)
1985	5, 549	6, 114	(565)
1986	5, 834	6, 074	(239)
1987	6, 373	6, 503	(130)
1988	7, 104	7, 048	55
1989	7, 287	7, 252	35
1990	7, 259	7, 592	(333)
1991	7, 490	8, 008	(518)
1992	6, 494	7, 960	(1, 466)
1993	6, 906	7, 714	(808)
1994	6, 903	7, 635	(732)
1995	7, 642	7, 584	58
1996	8, 174	7, 538	636
1997	9, 638	8, 595	1, 043

Table A6-APA No. of Pilots, Ass., Ass per Pilot, Cost and Rev. per Assignment and Indices (1979-97)

Year	Pilots	Assignments	Ass. per Pilot	Pilot Cost per Ass. ($)	Index of Pilot Cost	Pilot Rev. per Ass.($)	Index of Pilot Rev.
1979	48	14, 107	294	154	91	304	92
1980	46	14, 428	314	169	100	330	100
1981	46	13, 932	303	184	109	366	111
1982	45	11, 617	258	240	142	415	126
1983	41	11, 993	292	226	134	448	136
1984	40/13	12, 325	233	241	143	461	140
1985	40/10	11, 082	222	272	161	485	147
1986	37/9	10, 242	223	290	171	524	159
1987	37/10	10, 413	222	302	179	608	184
1988	38/11	11, 000	224	303	179	642	194
1989	38/11	10, 971	224	315	186	660	200
1990	37/12	10, 643	217	343	203	678	205
1991	37/11	10, 792	225	368	218	690	209
1992	35/13	9, 008	188	424	251	717	217
1993	36/14	8, 867	177	444	263	775	235
1994	32/14	8, 655	188	456	270	793	240
1995	32/16	8, 668	181	441	261	877	266
1996	33/18	8, 576	168	436	258	931	282
1997	34/16	9, 760	195	445	263	979	297

Statistics with a / indicates: : employee pilots/contract pilots

Table A7-Revenue, Expense, Profit (Loss) of the PPA 1972-1997 ('000)

Year	Revenue	Expense	Profit (loss)
1972	2, 668	3, 270	(602)
1973	3, 825	4, 295	(471)
1974	4, 601	4, 856	(254)
1975	4, 973	5, 336	(363)
1976	6, 851	6, 769	82
1977	8, 292	7, 790	501
1978	9, 450	9, 002	448
1979	10, 029	10, 137	(109)
1980	12, 223	12, 536	(313)
1981	14, 261	14, 338	(76)
1982	16, 316	15, 544	773
1983	18, 954	18, 250	704
1984	20, 121	20, 026	95
1985	21, 949	21, 740	209
1986	23, 321	23, 541	(220)
1987	26, 281	26, 271	10
1988	27, 233	27, 097	136
1989	25, 339	25, 820	(481)
1990	29, 328	29, 761	(433)
1991	33, 779	32, 491	1, 288
1992	32, 789	31, 072	1, 717
1993	31, 012	30, 945	67
1994	33, 674	35, 277	(1, 603)
1995	34, 221	35, 363	(1, 142)
1996	36, 039	35, 859	180
1997	39, 802	38, 519	1, 283

Table A8-PPA No. of Pilots, Ass., Ass per Pilot, Cost and Rev. per Assignment and Indices (1979-97)

Year	Pilots	Assignments	Ass. per Pilot	Pilot Cost per Ass. ($)	Index of Pilot Cost.	Pilot Rev. per Ass. ($)	Index of Pilot Rev.
1979	90						
1980	91						
1981	92	12, 061	131.1	837	100	1, 179	100
1982	94	11, 575	123.14	956	114	1, 400	119
1983	93	12, 094	130.04	1, 077	129	1, 559	132
1984	99	12, 199	123.22	1, 178	141	1, 641	139
1985	101	12, 535	124.11	1, 251	149	1, 744	148
1986	111	13, 479	121.43	1, 262	151	1, 720	146
1987	111	15, 142	136.4	1, 278	153	1, 728	147
1988	115	14, 986	130.31	1, 308	156	1, 808	153
1989	115	13, 433	116.81	1, 356	162	1, 874	159
1990	115	14, 215	123.61	1, 517	181	2, 056	174
1991	115	14, 992	130.36	1, 570	188	2, 243	190
1992	115	13, 814	120.12	1, 607	192	2, 359	200
1993	113	12, 871	113.9	1, 696	203	2, 394	203
1994	110	14, 053	127.75	1, 808	216	2, 385	202
1995	115	13, 199	114.77	1, 910	228	2, 578	219
1996	119	13, 403	112.63	1, 930	230	2, 684	228
1997	117	14, 212	121.47	1, 927	230	2, 794	237

Table A9 - GLPA Sources of Income (1972-1997) ('000)

Year	Pilotage Charges	/ %	Misc Disp Income	/ %	Int. & Other Income	/ %	Total Revenues
1972	4 461	99.4			26	.6	4, 487*
1973	4 037	99.3			29	.7	4, 066**
1974	2, 563	99.1			24	.9	2, 587
1975	3, 538	96.6	95	2.6	30	.8	3, 663
1976	4, 751	96.1	113	2.3	75	1.5	4, 941
1977	6, 239	97.3	127	2.0	46	.7	6, 413
1978	7, 792	97.1	155	1.9	78	1.0	8, 026
1979	8, 960	96.6	161	1.7	158	1.6	9, 272
1980	9, 188	96.3	159	1.7	189	2.0	9, 536
1981	8, 515	95.6	174	1.9	218	2.4	8, 907
1982	9, 930	96.0	187	1.8	229	2.2	10, 346
1983	9, 722	96.9	177	1.8	135	1.3	10, 034
1984	10, 487	96.6	204	1.9	160	1.5	10, 851
1985	8, 276	96.4	208	2.4	99	1.1	8, 583
1986	11, 082	97.3	198	1.7	104	.9	11, 384
1987	9, 508	96.5	176	1.8	166	1.7	9, 850
1988	9, 163	96.1	195	2.0	189	1.9	9, 747
1989	8, 919	95.2	182	1.9	264	2.8	9, 365
1990	7, 986	95.4	174	2.1	214	2.5	8, 374
1991	7, 739	96.2	166	2.1	139	1.7	8, 044
1992	8, 105	97.7	126	1.5	61	.7	8, 292
1993	9, 290	99.1	81	.9	48	.5	9, 387
1994	13, 783	98.8	79	.6	92	.7	13, 955
1995	10, 901	96.3	93	.8	324	2.9	11, 318
1996	12, 330	97.4	0	0	329	2.6	12, 659
1997	12, 670	98.6	149	1.1	301	2.3	13, 120

* $32, 000 payable to Canada was not deducted from the total revenues. ** $20, 000 payable to Canada was not deducted from the total revenues.

Table A10-GLPA Operating Expenses (1972-1997) ('000)

Year	Pilot Salaries & Benefits	/%	Staff Salaries & Benefits	/%	Transportation & Trave	/%	Pilot Boats	/%	Accounting & Admin.	/%	Total Expenses
1972	4, 115	86.8	238	5.0	135	2.8	166	3.5	88	1.9	4, 742
1973	4 145	84.6	327	6.7	135	2.8	185	3.8	107	2.2	4, 899
1974	3, 841	82.3	352	7.5	179	3.8	179	3.8	116	2.5	4, 670
1975	3, 849	76.5	451	9.0	217	4.3	211	4.2	711	14.1	5, 059
1976	4, 442	73.8	534	8.9	350	5.8	248	4.1	442	7.3	6, 016
1977	5, 433	74.9	626	8.6	489	6.7	288	4.0	413	5.7	7, 249
1978	6, 030	74.5	681	8.1	589	7.0	334	4.0	801	9.5	8, 435
1979	6, 754	72.2	780	8.3	643	6.9	356	3.8	827	8.8	9, 360
1980	6, 925	72.9	876	9.2	689	7.2	381	4.0	625	6.6	9, 496
1981	7, 258	73.9	949	9.7	619	6.3	416	4.2	583	5.9	9, 825
1982	7, 546	73.2	963	9.3	662	6.4	433	4.2	699	6.8	10, 304
1983	7, 782	73.9	1, 023	9.7	670	6.4	448	4.0	651	6.0	10, 524
1984	8, 488	74.3	1, 050	9.2	708	6.2	478	4.2	697	6.1	11, 421
1985	8, 574	72.7	1, 142	9.7	637	5.6	488	4.1	935	7.9	11, 796
1986	7, 956	75.0	1, 009	9.5	724	6.8	491	4.6	427	4.0	10, 610
1987	7, 628	70.7	1, 036	9.6	707	6.5	486	4.5	938	8.7	10, 795
1988	6, 831	70.5	1, 015	10.4	715	7.3	501	5.1	657	6.7	9, 719
1989	6, 827	70.6	1, 063	11.0	651	6.7	484	5.0	639	6.6	9, 664
1990	7, 123	71.5	1, 047	10.5	689	6.9	495	5.0	613	6.1	9, 967
1991	6, 988	70.3	1, 041	10.5	636	6.4	494	5.0	785	7.9	9, 933
1992	6, 655	70.6	1, 031	10.9	610	6.5	476	5.0	659	7.0	9, 431
1993	6, 491	69.1	1, 066	11.3	658	7.0	289	3.1	884	9.4	9, 388
1994	7, 834	75.7	983	9.5	936	8.8	325	3.1	543	5.1	10, 618
1995	7, 059	70.7	1040	10.4	817	8.2	428	4.3	632	6.3	9, 976
1996	8, 682	74.6	923	7.9	916	8.1	382	3.3	711	6.1	11, 641
1997	8, 670	72.8	967	8.1	978	8.2	407	3.4	888	7.5	11, 910

#=Administration staff salaries and benefits

Table A11-LPA Pilot Revenue, Pilot Boat Revenue, Interest and Other Revenue (1972-1997) ('000)

Year	Pilotage Revenue	/ %	Pilot Boat Revenue	/ %	Interest and Other Rev.	/ %	Total Revenues
1972	6, 812	99.8			15	.2	6, 827
1973	8. 538	99.7			28	.3	8. 565
1974	7. 451	99.5			38	.5	7. 468
1975	10. 386	99.6			44	.4	10. 430
1976	12. 736	98.7			163	1.3	12. 899
1977	14. 867	99.3			107	.7	14. 974
1978	16. 764	99.2			126	.7	16. 890
1979	17. 119	98.9			184	1.1	17. 303
1980	17. 958	88.3	2. 238	11.0	154	.8	20. 346
1981	20. 116	88.3	2. 521	11.1	137	.6	22. 775
1982	20. 361	88.0	2. 586	11.2	177	.8	23. 124
1983	21. 253	88.7	2. 543	10.6	155	.6	23. 951
1984	22. 812	88.9	2. 712	10.6	100	.4	25. 669
1985	22. 078	88.9	2. 593	10.4	167	.7	24. 839
1986	23. 990	88.7	2. 967	11.0	82	.3	27. 039
1987	24. 160	88.7	3. 022	11.1	39	.1	27. 221
1988	23. 872	88.6	2. 943	10.9	135	.5	26. 950
1989	25. 047	89.4	2. 910	10.4	47	.2	28. 004
1990	25. 546	89.3	2. 941	10.3	105	.4	28. 589
1991	26. 021	89.8	2. 881	9.9	64	.2	28. 966
1992	25. 394	92.3	2. 023	7.3	91	.3	27. 508
1993	24. 301	90.1	2. 634	9.8	31	.1	26. 966
1994	29. 556	88.6	3. 740	11.2	58	.2	33. 354
1995	30. 397	88.4	3. 909	11.4	61	.2	34. 367
1996	31. 586	87.7	4. 356	12.1	77	.2	36. 019
1997	33. 654	88.1	4. 142	11.6	89	.2	38. 185

Table A12-LPA Pilot Cost, Pilot Boat Costs, Interest and Administration Costs (1972-1997) ('000)

Year	Pilot Cost	/ %	Pilot Boat Cost	/ %	Administration Costs	/ %	Expense
1972	6. 540	83.8	182	2.3	1. 082	13.9	7. 804*
1973	7. 327	79.5	670	7.2	1. 235	13.3	9. 282
1974	7. 077	74.3	743	7.8	1. 710	17.9	9. 530
1975	8. 646	78.6	961	8.7	1. 399	12.7	11. 006
1976	10. 133	79.2	1. 210	9.4	1. 457	11.4	12. 800
1977	11. 777	79.9	1. 425	9.7	1. 534	10.4	14. 736
1978	13. 152	80.0	1. 595	9.7	1. 696	10.3	16. 443
1979	13. 971	79.0	1. 832	10.3	1. 891	10.7	17. 694
1980	16. 286	79.7	1. 996	9.8	2. 152	10.5	20. 435
1981	18. 247	81.0	2. 230	9.9	2. 226	8.9	22. 526
1982	18. 282	78.7	2. 417	10.4	2. 533	10.9	23. 233
1983	19. 882	80.1	2. 398	9.7	2. 543	10.2	24. 823
1984	21. 529	79.6	2. 744	10.1	2. 782	10.3	27. 055
1985	20. 781	77.2	3. 049	11.3	3. 087	11.5	26. 917
1986	22. 254	78.2	2. 814	9.9	3. 385	11.9	28. 453
1987	23. 158	80.1	2. 672	9.2	3. 082	10.7	28. 912
1988	23. 242	80.9	2. 644	9.2	2. 837	9.9	28. 723
1989	23. 908	80.1	2. 858	9.6	3. 074	10.3	29. 840
1990	24. 597	79.8	3. 071	10.0	3. 153	10.2	30. 821
1991	27. 786	81.5	2. 910	8.5	3. 388	9.9	34. 084
1992	27. 232	83.9	1. 920	5.9	3. 292	10.1	32. 444
1993	26. 945	81.8	2. 751	8.3	3. 235	9.8	32. 931
1994	30. 024	82.3	3. 485	9.5	3. 030	8.3	36. 529
1995	31. 869	82.7	3. 753	9.7	2. 922	7.6	38. 544
1996	31. 958	82.3	4. 031	10.4	2. 855	7.3	38. 847
1997	31. 946	81.9	4. 081	10.5	2. 992	7.7	39. 019

Table A13-APA Pilot Revenue, Pilot Boat Revenue, and Travel Revenue (1972-1997) ('000)

Year	Pilotage Revenue / *1		Pilot Boat Revenue / *1		Travel Revenue / *1		Total Revenues
1972	1. 369	99.1	13	9			
1973	1. 723	99.5	8	0.5			1. 732
1974	2. 009	99.2	16	0.8			2. 025
1975	1. 726	98.2	31	1.8			1. 757
1976	2. 003	98.7	27	1.3			2. 030
1977	2. 727	98.1	53	1.9			2. 780
1978	3. 187	99.5	16	.5			3. 203
1979	4. 294	99.6	19	.4			4. 313
1980	4. 764	99.6	18	.4			4. 781
1981	5. 097	98.8	24	.5	40	.8	5. 161
1982	4. 818	98.4	32	.6	46	.9	4. 896
1983	5. 368	98.5	34	.6	48	.9	5. 450
1984	5. 681	97.5	83	1.4	62	1.1	5. 826
1985	5. 376	98.0	59	1.1	49	.9	5. 485
1986	5. 367	92.5	437	7.5			5. 804
1987	6. 336	99.4	37	.6			6. 373
1988	7. 066	99.5	38	.5			7. 104
1989	7. 240	99.3	47	.6			7. 287
1990	7. 213	99.4	46	.6			7. 259
1991	7. 449	99.4	41	.5			7. 490
1992	6. 463	99.3	31	.5			6. 494
1993	6. 870	99.5	36	.5			6. 906
1994	6. 867	99.5	36**	.5			6. 903*
1995	7. 605	99.5	37**	.5			7. 642*
1996	7. 988	97.7	186*	2.3			8. 174*
1997	9. 556	9. 550	99.1	81*	.8		9. 638*

*= Other Income. *=Rounded.

Table A14-APA Pilot Expense, Pilot Boat Exp., Dir. Overhead Exp. and Admin. Exp. (1972-97) ('000)

Year	Pilot Salaries & Benefits / *1		Staff Salaries & Benefits / *1		Transp & Travel / *1		Pilot Boats Op. Costs / *1		Accounting & Admin *1		Total Expenses
1972	993	42.6	161	6.9	71	3.0	506	21.7	599	25.7	2. 330
1973	1. 331	41.8	194	6.1	106	3.3	897	28.3	713	22.4	3. 181
1974	1. 559	48.3	204	6.2	147	4.5	1. 014	30.8	338	10.3	3. 292
1975	1. 932	52.4	232	6.3	117	3.2	1. 095	29.6	314	8.5	3. 703
1976	2. 044	51.1	254	6.3	127	3.2	1. 192	29.8	386	9.6	4. 003
1977	2. 060	53.4	280	7.2	100	2.6	1. 086	28.0	351	9.0	3. 877
1978	2. 049	49.9	309	7.4	130	3.1	1. 253	29.9	408	9.7	4. 189
1979	2. 179	49.1	310	7.0	163	3.7	1. 355	30.5	430	9.7	4. 437
1980	2. 439	49.4	331	6.7	221	4.5	1. 458	29.5	489	9.9	4. 938
1981	2. 571	48.9	326	6.2	211	4.0	1. 587	30.2	561	10.7	5. 256
1982	2. 795	51.0	314	5.7	185	3.4	1. 623	29.6	565	10.3	5. 478
1983	2. 714	49.5	306	5.6	211	3.8	1. 700	31.0	546	10.0	5. 477
1984	2. 969	49.7	391	6.5	239	4.0	1. 802	30.2	567	9.5	5. 968
1985	3. 019	49.3	366	6.0	243	4.0	1. 898	31.0	588	9.6	6. 114
1986	2. 977	49.0	367	6.0	247	4.1	1. 890	31.1	593	9.8	6. 074
1987	3. 144	48.3	375	5.8	287	4.4	2. 086	32.1	611	9.4	6. 503
1988	3. 338	47.4	394	5.6	358	5.1	2. 280	32.3	678	9.6	7. 048
1989	3. 458	47.7	434	6.0	392	5.4	2. 337	32.2	631	8.7	7. 252
1990	3. 647	48.0	476	6.3	356	4.7	2. 364	31.1	749	9.9	7. 592
1991	3. 967	49.5	491	6.1	360	4.5	2. 369	29.6	821	10.2	8. 008
1992	3. 822	48.0	500	6.3	342	4.3	2. 267	28.5	1. 029	12.9	7. 960
1993	3. 939	51.1	492	6.4	296	3.8	2. 375	30.8	612	7.9	7. 714
1994	3. 948	51.7	478	6.3	295	3.9	2. 312	30.3	602	7.9	7. 635
1995	3. 821	50.4	503	6.6	338	4.4	2. 267	29.9	655	8.6	7. 584
1996	3. 743	49.6	515	6.8	342	4.5	2. 325	30.8	613	8.1	7. 538
1997	4. 340	50.5	655	7.6	385	4.5	2. 495	29.0	720	8.4	8. 595

*= Other Income. *=Rounded.

Table A15-PPA Sources of Income (1972-1997) ('000)

Year	Pilotage Charge / %		Int. & Other Income / %		Total Revenues
1972	2, 658	99.6	10	.4	2, 668
1973	3, 825	98.3	66	1.7	3, 891
1974	4, 601	99.8	9	.2	4, 610
1975	4, 967	99.9	6	.1	4, 973
1976	6, 850	100	2	.0	6, 851
1977	8, 284	99.9	7	.1	8, 292
1978	9, 399	99.5	51	.5	9, 450
1979	9, 938	99.1	90	.9	10, 029
1980	12, 158	99.5	65	.5	12, 223
1981	14, 215	99.7	46	.3	14, 261
1982	16, 204	99.3	112	.7	16, 316
1983	18, 850	99.4	104	.5	18, 954
1984	20, 024	99.5	97	.5	20, 121
1985	21, 859	99.6	90	.4	21, 949
1986	23, 187	99.4	134	.6	23, 321
1987	26, 161	99.5	120	.5	26, 281
1988	27, 092	99.5	141	.5	27, 233
1989	25, 168	99.3	171	.7	25, 339
1990	29, 224	99.6	104	.4	29, 328
1991	33, 634	99.6	145	.4	33, 779
1992	32, 589	99.4	200	.6	32, 789
1993	30, 810	99.3	202	.6	31, 012
1994	33, 516	99.5	158	.5	33, 674
1995	34, 029	99.4	192	.6	34, 221
1996	35, 967	99.8	72	.2	36, 039
1997	39, 702	99.7	100	.2	39, 802

Table A16-PPA Operating Expenses (1972-1997) ('000)

Year	Pilot Salaries & Benefits / %		Staff Salaries & Benefits / %		Transp. & Travel / %		Pilot Boat / %		Accounting & Admin. / %		Total Expenses
1972	2, 558	78.2	223	6.8	9	.2	319	9.7	161	4.9	3, 270
1973	3, 241	75.4	263	6.1	27	.6	504	11.7	260	6.0	4, 295
1974	3, 657	75.3	331	6.9	28	.6	601	12.4	236	4.9	4, 856
1975	3, 518	65.9	375	7.0	485	9.1	715	13.4	243	4.5	5, 336
1976	4, 625	68.3	385	5.7	619	9.1	828	12.2	312	4.6	6, 769
1977	5, 380	69.1	427	5.5	743	9.5	931	11.9	309	4.0	7, 790
1978	6, 281	69.8	466	5.2	846	9.4	1, 067	11.8	342	3.8	9, 002
1979	7, 191	70.9	516	5.1	902	8.9	1, 176	11.6	352	3.5	10, 137
1980	9, 120	72.7	571	4.5	1, 081	8.6	1, 326	10.6	438	3.5	12, 536
1981	10, 101	70.3	675	4.7	1, 340	9.3	1, 671	11.6	553	3.8	14, 338
1982	11, 073	71.2	754	4.8	1, 450	9.3	1, 722	11.1	545	3.5	15, 544
1983	13, 031	71.4	813	4.4	1, 652	9.0	2, 149	11.8	587	3.2	18, 250
1984	14, 376	71.8	905	4.5	1, 709	8.5	2, 225	11.1	811	4.0	20, 026
1985	15, 679	72.1	1, 017	4.7	1, 912	8.8	2, 347	10.8	785	3.6	21, 740
1986	17, 011	72.3	1, 080	4.6	2, 193	9.3	2, 454	10.4	803	3.4	23, 541
1987	19, 345	73.6	1, 070	4.1	2, 368	9.0	2, 626	10.0	862	3.3	26, 271
1988	19, 607	72.3	1, 220	4.5	2, 633	9.7	2, 740	10.1	901	3.3	27, 097
1989	18, 210	70.5	1, 256	4.9	2, 604	10.1	2, 883	11.2	867	3.4	25, 820
1990	21, 559	72.4	1, 311	4.4	3, 007	10.1	3, 055	10.3	829	2.8	29, 761
1991	23, 513	72.5	1, 446	4.4	3, 214	9.9	3, 306	10.2	982	3.0	32, 491
1992	22, 201	71.4	1, 474	4.7	3, 183	10.2	3, 239	10.4	975	3.1	31, 072
1993	21, 824	70.5	1, 502	4.8	3, 209	10.4	3, 519	11.4	891	2.9	30, 945
1994	25, 411	72.0	1, 709	4.8	3, 427	9.7	3, 634	10.3	1, 096	3.1	35, 277
1995	25, 212	71.3	1, 661	4.7	3, 594	10.2	3, 872	10.9	1, 023	2.9	35, 363
1996	25, 867	72.1	1, 658	4.6	3, 605	10.0	3, 812	10.6	917	2.6	35, 859
1997	27, 390	71.1	1, 768	4.6	4, 180	10.8	4, 179	10.8	1, 002	2.6	38, 519

Table A17- Total Appropriations Received by all Authorities (1972-1997) ('000)

Year	Atlantic	Laurentian	Great Lakes	Totals
1972	-	1,067	634	1,701
1973	180	855	675	1,710
1974	1,220	1,959	2,082	5,261
1975	1,839	417	1,092	3,348
1976	1,918	350	1,163	3,431
1977	1,029	-	631	1,660
1978	944	-	198	1,142
1979	177	-	-	177
1980	52	-	-	52
1981	-	-	-	-
1982	527	-	639	1,166
1983	-	-	-	-
1984	74	966	250	1,290
1985	-	1,871	263	2,134
1986	611	2,456	3,361	6,428
1987	460	282		742
1988	444	1,543	1,019	3,006
1989	467	1,587	-	2,054
1990	-	1,673	-	1,673
1991	200	3,631	1,444	5,275
1992	1,294	6,263	850	8,407
1993	807	6,153	1,157	8,117
1994	920	4,970	648	6,538
1995	46	4,510	-	4,556
1996	-	730	-	730
Totals	13,209	41,283	16,106	70,598

Source: Transport Canada. Statistics in this Table provided by McDonald Gerard.

Towards Optimal Rural Road Abandonment and Upgrade Strategies for Saskatchewan[1]

Paul N. Christensen, University of Saskatchewan
Gordon A. Sparks, University of Saskatchewan

1.0 Introduction and Background

Rail branch line abandonment and consolidation of the grain elevator network is increasing the volume of truck traffic, haul distances, and the size of grain trucks operating on rural roads in Saskatchewan.[2] As a result, many rural roads in the province are literally falling apart. This is particularly true of Thin Membrane Surfaced (TMS) roadways subjected to excessive traffic loads during the spring period (when sub-grade soils are often thaw-weakened).

In response, roadway authorities in the province are considering massive rural road upgrade investments.[3] To aid the decision-making process underway, the authors have developed a straight-forward profit-maximizing model and applied it to a stylized grain shed area. The model is designed to facilitate two key decisions: (a) the point where additional roadway development is "unprofitable" (with clear implications for abandonment), and (b) where profitable, the optimal assignment of roadway type on a segment-by-segment basis.

The model performs these computations under two policy environments: no spring haul restrictions *versus* spring haul restrictions. This provides the means to determine optimal road cost allocation by "farm gate" as well as the incremental costs associated with alternative spring haul policies.

---

[1] To obtain the complete version of this paper, contact either author at Transportation Centre, College of Engineering, University of Saskatchewan, (306) 966-7007.

[2] For more information see Grant *et al* (1998).

[3] See Government of Saskatchewan *et al* (1999).

2.0 Literature Review

A literature search and review revealed two categories of literature pertinent to this study. The first category includes literature exploring the road-related impacts of structural changes in rural areas within North America. The second category involves more detailed investigations of road damage, pricing and investment *per se*.

2.1 Road Impacts of Structural Changes in Rural Areas

Martin *et al* (1978) applied a mathematical programming approach to determine the cost-minimizing number of grain delivery points for producers in south-west Saskatchewan. Five major cost components were examined: farm storage, trucking, roads, elevators and rail transport. By formally examining the trade-offs among each cost category, the authors were able to determine a cost-minimizing number of delivery points across alternative elevator closure and grain production assumptions.

Hamlett and Baumel (1990), Hamlett, Brennan and Baumel (1989), and Baumhover, McVey, Lipsman and Baumel (1990) applied simulation models and benefit-cost criteria to determine appropriate policy and investment strategies for rural counties in Iowa experiencing structural change (e.g., rural depopulation, branch rail line abandonment, longer truck hauls in larger trucks, etc.). Through an investigation of road and travel costs—and, where required, farm revenues—the authors were able to produce rational recommendations regarding roadway and rail line abandonment, maintenance standards for rural roads, bridge reconstruction, and roadway privatization.

Although the methodology adopted herein differs from those applied in these papers, the basic objective and circumstances are very similar. In each case, the objective is to construct and apply a model capable of analyzing the costs and/or cost savings of considered rural road policies and/or investments. Moreover, in each paper the circumstances motivating the work surround structural change in rural areas. However, none of the papers examine more closely the

implications of these changes in terms of segment-specific upgrade requirements or spring haul policy. Therefore, we are compelled to develop a unique methodology to satisfy our requirements.

2.2 Damage Pricing and Roadway Investment

Although there is a substantial body of material on congestion costs and related pricing issues, relatively few authors have focussed on road damage costs and their implication for roadway pricing and investment (see Hau (1992)). Since damage costs are an important characteristic of rural road use in Saskatchewan, however, it is useful to review the research completed by these authors.

Small *et al* (1989) and Newberry (1988, 1989) have successfully investigated both damage- and congested-related road pricing and investment issues. Applying sophisticated engineering and economic models, these authors have derived pricing and investment rules that lead to optimal roadway capacity and durability decisions while ensuring a full or near-full cost recovery.

Although the specific models applied by Small *et al* and Newberry are not readily applicable across roadway structures, environments and traffic conditions typical of rural Saskatchewan, the economic insights provided are universally applicable. For our purposes, their investigations regarding the appropriate allocation of damage costs provide a defensible basis on which to assign incremental road costs across users of our hypothetical roadway.

3.0 Model and Data

The modelling procedure presumes the existence of a single land owner contemplating the development of a Spring Wheat farming operation. In order to take advantage of a rail line passing through the area in question, the owner is investigating the development of a rail-side terminus (with adequate grain handling and other storage capabilities) and a roadway stretching linearly from the terminus to a discrete number of uniformly distributed "farm gates" (each producing the same quantity of grain and subject to identical cost

structures). To maximize profits, the owner must simultaneously determine: (a) the length of the road (i.e., the optimal number of farm gates worth serving), (b) the type of road structure best-suited to each road segment (i.e., as the operation expands, grain truck traffic on road segments nearest the terminal increase dramatically, necessitating the construction of more durable road types), (c) the type of truck best employed to transport grain, (d) pertinent spring haul restrictions, and (e) the quantity of on-farm and rail-side storage required.

Note that the farm gates are presumed to be spaced precisely 10 kilometers apart (i.e., a 10 kilometer road segment separates each additional farm gate). Farm lands are presumed to stretch 10 kilometers from either side of the road. Thus, each farm gate represents 200 square kilometers of farm lands dedicated to the production of Spring Wheat.

3.1.1 Model Assumptions

To facilitate modelling, a number of assumptions regarding the price, cost structures, and operational constraints of various components of the farming operation have been made. These include: (1) with respect to the price of farm output (grain) and rail freight charges, the owner is a price-taker, (2) grain production costs and level of output are presumed constant and identical across farm gates, (3) on-farm storage and rail-side "other" storage costs are subject to constant-returns-to-scale, (4) unit grain elevation costs are presumed a decreasing function of required capacity (i.e., returns-to-scale are present), (5) the sum of on-farm grain and rail-side elevator storage is sufficient to store all output, (6) on-farm and rail-side "other" storage facilities are independently capable of storing all material inputs required for crop production (fertilizer, seed, herbicides, etc.), (7) rail services at the local terminus haul all grain produced to market and deliver all necessary material inputs at a constant unit price, (8) the quantity of material inputs required are a constant proportion of grain output (i.e., for every tonne of grain produced, α tonnes of material inputs are required), (9) farm trucks are assumed to haul all grain from each farm gate to the elevator and haul all materials inputs from

the rail-side warehouse to each farm gate (all back-hauls are presumed empty), (10) two basic truck types are considered in the analysis: 3-axle straight trucks and 8-axle B-trains, (11) three types of two-lane roadways are examined: good gravel, C-pavements, and Asphaltic-Concrete (AC) structures, (12) road and truck costs are presumed to vary by road type, truck type and seasonal restrictions, (13) road costs are presumed an increasing function of truck traffic, and (14) seasonal restrictions encompass one of two choices: hauls permitted during the spring period, or hauls banned during the spring period.[4]

3.1.2 Profit and Cost Models

Based on the above, we can represent the profitability of the entire farming operation in terms of the following functional relationship:

$$\pi(Q,TT,SP,RT_i,TN_i) = pQ - C(Q,TT,SP,RT_i,TN_i) \; ; \; i = 1,2,3,\ldots,n$$

where, $C(Q,TT,SP,RT_i,TN_i) = cQ +$
$\Sigma r_1[TT,RT_i,SP,TN_i(TT,SP),TP_i(Q,TT)]d + r_2nk_2 + r_4(k_4)nk_4$
$+ (r_3+r_5)\alpha Q + \Sigma r_6[TT,RT_i,SP,TP_i(Q,TT)]d$

and, $Q = nq$
$c = c_1 + c_2(1+\alpha)$
$r_1 = r_{1U} + r_{1L}$
$TP_i(Q,TT) = [q(n-i+1)(1+\alpha)]/CAP(TT)$
$TN_i(TT,SP) = (id\Delta TP)/ [TDAYS(SP)TKM]$
$k_2 = q[1-(HD/TDAYS(SP))]$
$k_4 = n(q-k_2)$

where, q = grain output exiting each farm gate (tonnes/yr),
n = total number of farm gates,
Q = total grain output of farming operation,

[4] For our purposes, this policy suffices. In actual fact, spring weight restrictions in Saskatchewan typically involve reductions in allowable haul weights. Note, however, that some rural communities institute *voluntary* haul bans during spring months to avoid excessive damage to local roads.

$\pi(..)$ = total profit,
p = on-farm price of grain ($/tonne),
$C(..)$ = total costs of farming operation ($/yr),
c_1 = farm production costs (net of storage, road and trucking costs) measured in $/tonne of grain produced,
c_2 = rail charge ($/tonne for grain or material inputs),
α = proportion of material inputs (fertilizer, seed, pesticides and herbicides) to grain output,
c = combined farm production and rail charges,
$r_1(..)$= truck rental rate ($/km/yr), equals sum of empty (r_{1U}) and loaded (r_{1L}) rates,
TT = truck type,
RT_i = road type (varies by road segment corresponding to each farm gate),
SP = spring haul restriction (equals 1 if spring haul allowed, equals 0 if not),
$TP_i(..)$ = annual number of truck passes over segment i,
CAP(TT) = capacity of truck (tonnes),
$TN_i(...)$ = number of trucks required to transport materials and grain to/from farm gate i,
ΔTP = incremental annual change in truck traffic on each segment as another farm gate is added,
TDAYS(SP) = trucking days available throughout year (365 if spring hauls permitted; 320 otherwise),
TKM = maximum one-way distance any given truck can travel in one day,
d = length of road segment (kms),
r_2 = rental rate of on-farm grain storage ($/tonne/yr),
k_2 = on-farm grain storage capacity (tonnes),
HD = length of harvest (days/yr),
r_3 = rental rate of on-farm other storage ($/tonne/yr),
$r_4(..)$= elevator rental rate ($/tonne/yr)[5],

[5] To determine an appropriate elevator rental rate, a grain elevator model developed by the Canadian Grain Commission (1975) was modified and employed. The original Grain Commission model is described in Martin *et al* (1978, 22).

k_4 = elevator capacity (annual throughput), measured in tonnes,
r_5 = rental rate of rail-side warehouse ($/tonne/yr), and
$r_6(..)$ = roadway rental rate ($/km/yr).

In words, the profit function is modelled as the difference between annual revenue and annual cost. The objective of the owner is to choose a level of output (i.e., number of farm gates n) that maximizes this difference. At the chosen level of output, incremental profits will have been exhausted and the farming operation will cease expansion.

Total annual cost, in turn, is the sum of grain production costs, rail charges, trucking costs, on-farm storage costs (both grain and "other"), elevator costs, rail-side "other" storage costs, and road building and maintenance costs. The structure of the cost function reflects one of the key objectives of the paper: to determine the mix of truck type, spring haul restriction and road type (by segment) that minimizes the cost of transporting grain and materials to/from the rail-side. It should be noted that while the model is capable of determining necessary on-farm and rail-side storage capacities and costs (given the gross capacity of the truck fleet over the harvest period), no attempt has been made to minimize the combined costs of trucking, roadways, spring haul policy *and* storage.

3.1.3 Truck and Road Models

To estimate the rental rates associated with truck transport and roadways (i.e, $r_1(..)$ and $r_6(..)$), a number of empirical functions were developed based on data obtained through various sources. The functions are designed to distribute the costs of truck transport and roadway provision on a segment-by-segment basis. In this way, the model can capture the incremental cost of each additional farm gate by summing the incremental road and truck costs "suffered" by each segment joining farm gates and rail-side.[6]

[6] The empirical functions are outlined and described in the complete version of this paper. Please contact the authors for more information.

Rental rates for both B-train and 3-axle trucks were estimated across road type and spring haul policy. In all cases, available capital and operating cost data was augmented with expert judgement to obtain rough, but usable, rental rate estimates. For instance, it was estimated that trucking costs on unbound surfaces (i.e., gravel roads) were approximately 10 percent higher than trucking costs on bound surfaces (i.e., C- or AC-pavements). Moreover, if spring hauls were permitted, operating costs on gravel roads were increased by an additional 10 percent (since problems such as washboard occur more frequently under wet conditions).

Rental rates for roadways were presumed an increasing function of truck traffic and varied by truck type and spring haul policy. Again, available capital and maintenance cost estimates were augmented by expert judgement to determine crude rental rate estimates. For instance, if spring hauls are permitted, regraveling requirements for gravel roads are presumed to increase by about 50 percent. Similarly, major rehabilitation of C-pavements are presumed to occur twice as frequently if spring hauls are permitted. The maintenance costs associated with full-depth AC-pavements, however, are presumed invariant across spring haul policy. In all cases, the empirical relationships between rental rates and truck traffic volume are based on expenditures typically incurred on roadways experiencing varying levels of heavy truck traffic. Note that the expenditure estimates obtained are typical of clay/till sub-grades.

3.2 Model Data

Crop and storage data were obtained from a number of sources. Spring Wheat production, cost, and price data were contained in Saskatchewan Agriculture and Food (1999). It is instructive to note that land investment costs were excluded from the modelling procedure since land prices typically represent the capitalized value of future profitability. Property taxes were stricken as well since the farmer is presumed responsible for a range of costs typically undertaken collectively (e.g., roadway provision and maintenance). Also, since storage building costs are estimated independently within

our modelling exercise, building investment and maintenance cost estimates are excluded.

Grain and "other" storage costs were derived from estimates provided by a local supplier (Flaman Sales Limited (Saskatoon)). Elevator grain storage costs were estimated through the application of an empirical model (see footnote 5). Information regarding grain transport logistics and rail charges were provided by K.A. Rosaasen.[7]

Roadway capital and maintenance cost estimates were obtained from C. Berthelot and G.A. Sparks.[8] The empirical road cost models developed were based on these cost estimates as well information regarding typical maintenance treatments and procedures applied to each road type.

Truck cost estimates were obtained from Ash and Gardener (1997) and local truck and trailer dealers.[9] Professor C. Berthelot provided additional information regarding the influence of alternative roadway surfaces, spring conditions, and back-haul factors on vehicle operating costs. Combining this information provided the means to estimate our empirical truck rental functions.

Note that the "soft" spring period is presumed to last approximately 45 days. Although highly variable from year-to-year, this time period adequately captures the spring period for most years. Similarly, harvest period is estimated at 30 days.

---

[7] Professor, Department of Agricultural Economics, University of Saskatchewan.

[8] Assistant Professor and Professor, respectively, Department of Civil Engineering, University of Saskatchewan. It should be noted that all factors related to empty back-hauls and spring restrictions—for both road and truck cost functions—were estimated by professors Berthelot and Sparks.

[9] These dealers include Merlin Ford Lincoln Inc., Saskatoon, Freightliner Truck Centre (Saskatoon) Ltd., and Fort Garry Industries Ltd. (Saskatoon).

3.3 Computational Procedure

The relationships and data discussed above were encoded in a spreadsheet model. The spreadsheet model sums all costs on a segment-by-segment basis across all possible combinations of truck type, road type and spring haul restrictions. Exploiting available functional capabilities within Microsoft Excel, the spreadsheet is able to determine the profit-maximizing level of output given a presumed price for Spring Wheat (expressed in $/bushel). It is also able to determine the cost-minimizing arrangement of road type (on a segment-by-segment basis), truck type, and spring haul restriction. In this way, we can allocate either a gravel, C-pavement, or AC pavement structure to each segment leading to/from farm gate and rail-side.

4.0 Model Results

The model results can be divided into two categories: gross output determination, and segment-specific allocations. The latter category of model results provides the means to examine the incremental costs corresponding to alternative spring haul policies.

4.1 Gross Output Determination

Despite the adjustments to the cost information obtained from Saskatchewan Agriculture and Food (1999), the model demonstrates that—at current prices—Spring Wheat farming appears to be highly unprofitable. At time of publication, average on-farm Spring Wheat prices were estimated at $4.03 per bushel (approximately $148 per tonne). At this price, the costs of grain production *alone* is sufficient to outweigh the revenues earned and, therefore, discourage any production.

Only at a price of $5.68 per bushel (about $209 per tonne) does grain production prove profitable for a single farm gate.[10] It is worth

[10] According to Saskatchewan Agriculture and Food (1997, 29), such prices have not been experienced since the 1995-1996 crop year (when prices for Spring Wheat averaged about $214 per tonne).

noting that this arrangement leads to the adoption of a single gravel road segment and a single B-train operating under spring haul restrictions.

At a price of $5.95 per bushel ($219 per tonne), the profit-maximizing number of farm gates is 25. Beyond this point, the incremental revenues of expansion are insufficient to cover incremental costs. This arrangement leads to the purchase of 37 B-train trucks operating under spring haul restrictions. The rise in truck requirements reflects a general trend: as the farm operation expands and haul distances increase, the number of B-trains required to haul grain and material inputs increase geometrically. Hence, the proportion of costs allocable to trucking increases geometrically as well.

Similarly, the proportion of total costs allocable to roadways also rise as the farming operation expands (due to the punishing effects of rising freight traffic). Thus, the incremental road costs attributable to each additional farm gate tends to rise with the number of farm gates characterizing the entire operation. These incremental road costs reflect the long-run road damage costs attributable to each additional farm gate. From a policy perspective, these costs represent the incremental "road price" of shed area expansion.[11]

4.2 Segment-Specific Allocations

The profit-maximizing results discussed above are based on particular arrangements of road type, truck type, and spring haul policy. In all cases, "global" decisions involving truck type and spring haul policy led to a cost-minimizing choice of B-trains operating under a spring haul ban. While B-trains proved far more cost-effective than 3-axles, however, the model results suggest that the advantages of a spring ban are less evident.

---

[11] For example, the model predicts that expanding the operation from 24 to 25 farm gates leads to an incremental "road price" of approximately 135 thousand dollars. Note that such prices can be computed for any number of farm gates under either spring haul policy.

To adequately explore this result it is necessary to examine the model results on a segment-by-segment basis. This will reveal the cost-minimizing arrangement of road type across all roadway segments under either spring policy environment.

Table 4.1 compares the allocation of road types and annualized road costs under alternative spring haul policies given 25 farm gates (where the 25th farm gate is furthest from the rail-side terminus).[12] As can be seen, if spring hauls are permitted, the cost-minimizing roadway would include 11 gravel and 14 AC pavement road segments. If spring hauls are banned, however, the roadway would be composed of 13 gravel and 12 C-pavement road segments. As expected, the road segments nearest the rail-side terminus require superior roadway structures to accommodate higher traffic volumes.

As shown in Table 4.1, the annual incremental costs of permitting spring hauls range from 763 to approximately 60,000 dollars (where AC pavements as opposed to gravel roads are applied). In total, the annual incremental costs of permitting spring hauls are just under 400 thousand dollars. Given the scale of the farming operation at 25 farm gates, however, this amount is negligible (representing under 0.2 percent of total annual farm costs). Thus, where significant production volumes are involved, the advantages of spring bans are not altogether apparent given an optimal arrangement of road infrastructure.

5.0 Conclusion and Policy Implications

Rationalization of grain handling and rail transport is having a detrimental influence on the quality of rural roads in Saskatchewan. To help determine an efficient response to these changes, this paper addressed the following question: how would an all-encompassing, profit-maximizing owner behave?

[12] Although trucking costs also differ across policy environments, the differences are negligible due to the reallocation of road type by segment. Therefore, we need only focus on road costs.

Although a clear abstraction and simplification of reality, the model nonetheless provides important insights for policy-makers. First, no profit-maximizing owner would expand a roadway unless the incremental revenues of doing so exceeded the incremental costs incurred. In the face of changing traffic patterns and volumes, this has clear implications for rural road abandonment: why continue operating a road segment that no longer "pays for itself" (regardless of the policy environment imposed)?

Second, this method can be applied to analyze the implications of considered spring restrictions (at least in a "global" sense). Where spring haul restrictions impose little cost on farm operations—and yet reap huge road cost savings—such restrictions may prove justifiable. However, given the administrative and other costs involved, spring haul restrictions may not prove worthwhile in the long-run (i.e., where "optimal" upgrades have occurred).

Third, given reasonably accurate truck and road cost models (predicated on future traffic volume and pattern estimates), this method can be used to determine optimal upgrades on a segment-by-segment basis. In this way, "thresholds" separating the application of particular roadway technologies can be established and used to develop reasonable upgrade strategies.

Clearly, however, additional work remains before the results of this model can be brought to bear on real-world problems. First, the methods employed within the model should incorporate a specific accounting of benefits accruing to non-freight users of roadways. Second, better approximations of road performance and costs are required to satisfactorily emulate actual road costs and their relationship to freight traffic. Third, a range of technologies—both roadway and truck-related—providing a more accurate depiction of current traffic composition and roadway technologies requires consideration. Fourth, the model must be modified to account for real-world shed areas where traffic is collected over more complex networks than the linear roadway applied in this exercise. Finally,

Table 4.1
Incremental Road Costs across Spring Haul Policies

Total Incremental Road Costs: $ 395,676 per year

	Spring Haul:		No Spring Haul:		
Farm Gate	Road Type by Segment	Road Costs ($/yr)	Road Type by Segment	Road Costs ($/yr)	Incremental Costs ($/yr)
25	Gravel	56,680	Gravel	55,917	763
24	Gravel	63,138	Gravel	61,612	1,526
23	Gravel	69,595	Gravel	67,307	2,289
22	Gravel	76,053	Gravel	73,001	3,052
21	Gravel	82,511	Gravel	78,696	3,815
20	Gravel	88,969	Gravel	84,391	4,577
19	Gravel	95,426	Gravel	90,086	5,340
18	Gravel	101,884	Gravel	95,781	6,103
17	Gravel	108,342	Gravel	101,476	6,866
16	Gravel	114,800	Gravel	107,171	7,629
15	Gravel	121,258	Gravel	112,866	8,392
14	***AC Pvmt***	***178,730***	***Gravel***	***118,560***	***60,170***
13	***AC Pvmt***	***178,730***	***Gravel***	***124,255***	***54,475***
12	AC Pvmt	178,730	C-Pvmt	158,793	19,937
11	AC Pvmt	178,730	C-Pvmt	158,916	19,814
10	AC Pvmt	178,730	C-Pvmt	159,041	19,689
9	AC Pvmt	178,730	C-Pvmt	159,168	19,562
8	AC Pvmt	178,730	C-Pvmt	159,296	19,434
7	AC Pvmt	178,730	C-Pvmt	159,427	19,303
6	AC Pvmt	178,730	C-Pvmt	159,561	19,169
5	AC Pvmt	178,730	C-Pvmt	159,696	19,034
4	AC Pvmt	178,730	C-Pvmt	159,833	18,897
3	AC Pvmt	178,730	C-Pvmt	159,973	18,757
2	AC Pvmt	178,730	C-Pvmt	160,115	18,615
1	AC Pvmt	178,730	C-Pvmt	160,260	18,470

since existing roadway structures may prove viable under certain conditions, a "do nothing" option must be explicitly included within the modelling framework.

6.0 References

Ash, L.L, and B. Gardner (1997), Operating Costs of Trucks in Canada – 1996: A Synopsis, *Canadian Transportation Research Forum: Proceedings of the 32rd Annual Conference*, May, 1997, pp.461-475.

Baumhover, S.B., M.J. McVey, M. Lipsman, and C.P. Baumel (1990), Investment Strategies for the Rural Road and Branch Rail Line Systems, *Journal of the Transportation Research Forum* 31(1), pp.167-179.

Government of Saskatchewan, Saskatchewan Association of Rural Municipalities, and Saskatchewan Urban Municipal Association, Parallel Process on Roads: Saskatchewan Road Impact Analysis, October 1999.

Grant, R., M. Howat, and P. Rachar (1998), Saskatchewan Area Transportation Planning, *Canadian Transportation Research Forum: Proceedings of the 33rd Annual Conference*, May, 1998, p. 372.

Hamlett, C.A., and C.P. Baumel (1990), Rural Road Abandonment: Policy Criteria and Empirical Analysis, *American Journal of Agricultural Economics*, V.72, No.1, pp.114-120.

Hamlett, C.A., S. Brennan, and C.P. Baumel (1989), Local Rural Roads: A Policy Analysis, *Journal of the Transportation Research Forum* 30(1), pp.1-8.

Hau, T.D. (1992), Economic Fundamentals of Road Pricing: A Diagrammatic Analysis, WPS 1070, Infrastructure and Urban Development Department, The World Bank.

Martin, F.L., D.G. Devine, and S.N. Kulshreshtha (1978), Centralized Prairie Grain Collection: Savings Related to Market Efficiency, *Canadian Journal of Agricultural Economics* 26(2), pp.18-34.

Newberry, D.M. (1988), Road Damage Externalities and Road User Charges, *Econometrica*, Vol.56, No.2, pp.295-316.

Newberry, D.M. (1989), Cost Recovery from Optimally Designed Roads, *Economica*, 56, 165-185.

Saskatchewan Agriculture and Food, Agricultural Statistics 1997.

Saskatchewan Agriculture and Food, Agricultural Statistics 1986.

Saskatchewan Agriculture and Food, Farm Facts: Crop Planning Guide 1999: Black Soil Zone, February 1999.

Small, K.A., C. Winston, and C.A. Evans (1989), Road Work: A New Highway Pricing and Investment Policy, The Brookings Institution, Washington, D.C.

Update on Grain Transportation in a Continental Perspective

Javier Caceres and Darrell Richards
AgriTrade and Transport

Caceres and Richards presented a paper to the 1996 CTRF conference in Winnipeg on the topic of grain transportation in a continental perspective. It concluded: "There could be as few as two or three main North American Railroads within five years. Many short line railways will depend on these main line carriers for revenue sharing and car supply. Globalization will result in downgrading of Canadian grain grading and inspection standards. Changes to the Canadian Wheat Board marketing system and to hopper car ownership and allocation will be introduced over time. The end result will be harmonization of the Canadian and U.S. grain systems in a continental grain market. Canada's export grain system will be integrated into that of the major transnational companies."

This paper will examine the changes that have occurred in the grain system since the previous paper was written late in 1995, and discuss where current trends may take grain transportation in the coming three to five years.

Canadian National and Burlington Northern have announced a transaction to create the largest railroad in North America. Archer-Daniel-Midlands has taken over UGG. Saskatchewan Wheat Pool has been privatized. The elevator and branch line systems continue to consolidate. The Canadian Grain Commission is restructuring its inspection services. Grain exports via the West Coast ports have declined 35 per cent while direct sales to the domestic U.S. market increased 65 per cent between the 94/95 and 98/99 crop years.

The development of a continental market in transportation and grain is well underway. The remaining institutional barriers such as the Wheat Board and Grain Commission will soon be removed.

Continental Railway System

On December 20, 1999, Canadian National and Burlington Northern Santa Fe announced a transaction to create the largest railroad in North America. The continental railway would have $18.5 billion in annual revenue, 80,000 kilometres of track and 67,000 employees Through a complicated share exchange, shareholders of BN will own approximately 70 per cent of the North American Railways, Inc. while CN shareholders will own the remaining 30 per cent. The deal still needs to be approved. There is opposition to the level of concentration being achieved in the North American rail system.

This deal reflects the change in focus from an east-west system in Canada to a north-south system and attempts to enhance the railway's ability to compete more effectively with trucks in the continental market.

Canadian Government policies pushed grain east-west for over 100 years: construction of the Canadian Pacific Railway 120 years ago; the financial rescue of the bankrupt Grand Truck Pacific and Canadian Northern infrastructure after the First World War; and the regulated grain freight rates and Crow Benefit subsidy. These interventionist rail policies have all collapsed under the forces of free trade, deregulation and globalization.

Grain on CN lines will no longer be captive to B.C. West Coast ports as the new railway can rationalize use of its infrastructure across the border.

CN will now be in a stronger position than CPR in the Western transborder market. This will force CPR to position itself in the new megarailroad system, and it has already been strengthing its position in the East through agreements with CSX and Norfolk Southern. In the West, CPR could integrate either with BN-CN (which would trigger more shipper pressure for government intervention) or with Union Pacific.

There are now two main railroads in the Western U.S. and two in the East. Although the Union Pacific-Southern Pacific merger created service problems, and there are still problems in the fallout of the Conrail breakup, it would be logical for the four to consolidate to two transcontinentals.

Continental Grain Market

At the global level, agriculture is no longer a biological industry, but a normal industry in which some corporations control the supply of commodities. Transnational corporations require the harmonization of standards across borders and total deregulation in order to apply a global sourcing, lowest cost system.

The remaining obstacles to the full integration of grain transportation, marketing and handling into the transnational model are the Canadian Wheat Board export controls, the Canadian Grain Commission grading and inspection standards, and the grain car ownership and car allocation process. Since the 1996 CTRF conference, removal or restructuring of these obstacles is well underway and irreversible.

The Federal Government's participation in the 1994 Blue Ribbon Commission on cross-border grain issues has started a policy reform process that will eventually allow the grain of one country to have full access to the rail, elevator and port systems of the other. This is already the case with other bulk commodities such as potash and coal.

As more grain crosses the border, the Canadian Grain Commission will come under increasing pressure to downgrade Canada's grading and inspection standards. These standards make it more expensive to build and operate export grain terminals in Canada than the U.S. In 1999, the Grain Commission announced it would have to make changes to its inspection services on grain exports due to a financial crisis. Its revenue from weighing and inspection services declined sharply as grain exports declined 20 per cent following repeal of the Western Grain Transportation Act and Crow Benefit subsidy.[1]

Federal Government policies are leading to the dismantling of the Canadian Wheat Board. The Government passed legislation which would effectively transfer the political fall-out for dismantling the Board to a new Board of Directors, some of whom are elected by farmers. A December, 1998, agreement between Canada and the U.S. on cross-border grain movement will undermine the Board. American farmers will be able to sell or store grain at a number of Canadian elevators in the Southern prairies. Canadian farmers will still need a Board export license to deliver grain to the U.S. Market-oriented farmers will resent this restriction. As the only State grain trading entity in the world, the Board will not survive international trade rules.

In 1997, the Federal Government commissioned a report on grain transportation and handling from Justice Estey. His December, 1998, report recommends taking the Wheat Board out of transportation on the prairies. Instead, the Board would buy grain from the grain companies at port position. This would further isolate the Board from farmers and increase the ability of the transnational grain companies

[1] Canadian Grain Commission, news release, January 4, 1999

to integrate their logistics and infrastructure across the border. The Board buying at port is a transition to full deregulation of the Board later on. Eliminating the Board would allow the Government to reduce its deficit on paper by no longer having to be responsible for the credit that the Board offers to customers.

Transnational grain companies are expanding their reach in Western Canada. Cargill purchased 50 per cent of the Alberta Wheat Pool terminal in Vancouver and has entered into partnership with the Saskatchewan Government for a $350 million fertilizer plant. ConAgra is building inland terminals and Archer-Daniel Midlands took control of United Grain Growers, a former cooperative. Saskatchewan Wheat Pool is now selling shares on the stock market. Agricore (Alberta and Manitoba Pools) is competing with Saskatchewan Pool. The Canadian Pools are relatively small companies compared to the transnationals and could be acquired by them as United Grain Growers was acquired by ADM.

The grain car allocation process protects the share of cars available to Canadian grain companies. The Estey report would deregulate this process, and accelerate the rate at which the transnationals can increase their share of the market. The public ownership of grain hopper cars in Canada remains a hindrance to the ability of transnationals to integrate their grain logistics systems across the border. This is because, generally speaking, the Canadian system is first priority for these cars. The Government has put sale of the cars on the back burner for now, but even if they are not sold in the near future, the fleet is wearing out over time.

Branch Line and Elevator Consolidation

As of December 31, 1998, the railway three year plans proposed discontinuing 1,680 kilometres of track and transferring to short lines 2,300 kilometres of track, 42 and 58 per cent respectively. Of the total rationalization, 78 per cent would be in the Western Provinces. [2]

[2] Transport Canada, Transportation in Canada, 1998, p. 174

Fifty-five per cent of the track proposed for discontinuance is in the Province of Saskatchewan, which produces the majority of export grain.

The following table illustrates the amount of trackage discontinued or transferred to short lines since January 1, 1996. Three times as much track was transferred to short line as discontinued. However, the vast majority of track transferred to short lines had commodities such as forest or mineral products. Although there are some examples, it has been much more difficult to create short lines where grain is the only commodity.

Kilometres of rail line rationalization[3]

	Alberta	Sask	Manitoba	Prairies
Discontinue 97	267	87	370	724
Discontinue 98	35	270	134	439
Discontinue	302	357	504	1163
Transfer to short line 97	325	448	1308	2081
Transfer to short line 98	1029	56		1085
Transfer to short line	1354	504	1308	3166

The 89 inland terminals built or planned for Western Canada will be able to handle 84 per cent of grain shipments. Elevator capacity is being and will be reduced drastically. Farmers will have to provide more storage and deliver grain as required. The transition to inland terminals will have serious consequences for the current car allocation system.[4]

The consolidation of branch lines and elevators will continue to occur, even with the Wheat Board border controls in place. However, deregulation of the Board export controls and the Grain Commission

[3] Transport Canada, Transportation in Canada, 1997, 1998
[4] Sparks Companies, Inc., Grain Handling Infrastructure Rationalization Study, March 1998

grading and inspection standards would accelerate current trends as it would advance the integration of grain infrastructure across borders.

Impacts on Grain Movement

Elimination of the Western Grain Transportation Act Crow Benefit subsidy on July 31, 1995 has reduced the amount of overseas grain exports. This change encouraged different types of crops, increased sales to the U.S. market and increased the feeding of grain to livestock on the prairies.

These changes have greatly increased the amount of trucking on the prairies. Local trucking hauls grain an average 26 kilometres from the farm to the elevator and accounts for 90 per cent of the grain supply in 1995/96. Intermediate distance trucking hauls grain or oilseeds an average 480 kilometres from farms, country elevators and inland terminals to processing plants such as feed mills, malt plants, canola plants, feedlots, flour mills or distillers. It accounted for 8.1 million tonnes in 1995/96, or 17 per cent of grain supply, including 1.2 million tonnes shipped to the U.S. The additional processing of grain also results in increased trucking of products such as meat and livestock to market.[5]

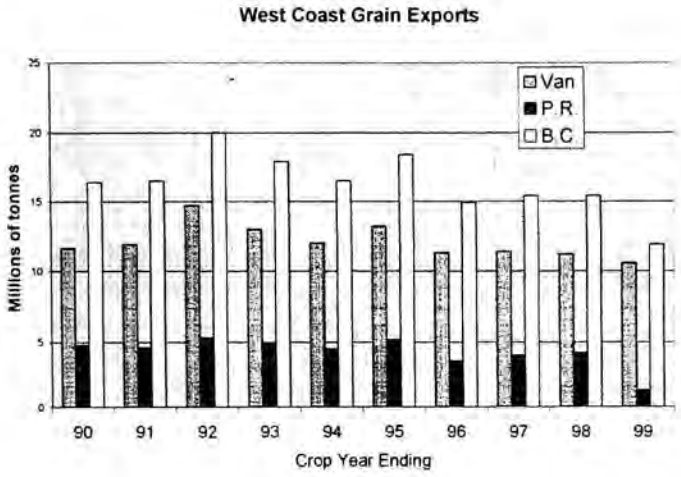
Grain exports through West Coast ports declined 35 per cent between 1994/95 and 1998/99. Prince Rupert exports declined 75 per cent and Vancouver by 20 per cent. Prince Rupert, built with the promise of a $2 per tonne cross subsidy, has now become a residual or overflow port. Direct exports from the prairies to the U.S. domestic market increased 65 per cent in the period.[6] The following chart illustrates the ten year trend in grain exports through B.C. ports. Exports as a portion of grain supply are declining.[7]

---

[5] Trimac, Review of Grain Transportation by Truck in Western Canada, undated but probably 1997

[6] Grain exports from Canadian Grain Commission statistics.

[7] Sparks



Large scale exports of Canadian grain via U.S. West Coast ports will not occur until the Wheat Board and Grain Commission controls are deregulated, but we expect this to happen in the next two-three years. The transnationals would then rationalize their infrastructure by making better use of their existing and subsidized terminal elevators in the U.S.

A continental grain market implies that the transnationals will rationalize disposition of grain irrespective of borders. For example, the U.S. will export more grain and increase imports from Canada for its domestic consumption.

There remains the thorny issue of occasional disruptions to the flow of Canadian grain through U.S. ports due to U.S. domestic politics or U.S. foreign policy such as sanctions against countries with which Canada trades.

Another unknown in future grain movement trends is the Montreal convention affecting genetically modified organisms (gmo's). Federal and provincial governments have aggressively promoted the introduction of genetically modified varieties, without rigorous market analysis of the consumer response in importing countries. Overseas consumer reaction may affect the composition of the western grain and oilseed production and create new regulatory controls, for example segregation of altered and conventional crops. In the continental grain market, Canada will be influenced by the U.S. regulatory and political response.

Government Situation

Because the Canadian Government considers the grain sector as part of the global economy, it will implement policies such as deregulation, privatization and competition to achieve such integration. The political support and culture that favoured the regulated Canadian system is declining. Because this breakdown in cultural values is still in transition, the Government is deregulating the system incrementally rather than all at once.

Communities are working to acquire branch lines that are slated for abandonment, but there does not appear to be a coordinated response that will significantly change the general direction of government policies. Transnationalization of marketing and handling will continue to influence transportation and grain collection.

The deregulation process began with the Western Grain Transportation Act of 1983 and the repeal of the Crow Subsidy in 1995. The process for the current round of deregulation started with a meeting involving three Federal Cabinet Ministers and grain industry stakeholders in 1997 which agreed to accelerate a review of the grain handling and transportation system. The Federal Government appointed Mr. Justice Estey to conduct this review. However, grain marketing was outside his terms of reference.

Key recommendations of the December, 1998, Estey report were to replace the grain rate ceiling with a ceiling on overall grain revenues, stimulate competition with more open access to the rail system and move the Canadian Wheat Board to buying grain at port position instead of from farmers on the prairies.

The Minister of Transport then appointed Arthur Kroeger to work with the grain industry to develop a consensus plan to implement the Kroeger recommendations. There was no consensus on the amount of the revenue cap or on open access to rail lines.

In late 1999, the Western and Northern caucus of Liberal MPs requested that the Minister reduce rail revenues from grain by 18 per cent, implement a five year trial of open running rights, but leave the Wheat Board buying grain on the prairies.

The Government is currently considering the Kroeger report, the Liberal caucus report, and the merger of CN and BN. There is a political conflict within the Government between those who want to leave the Wheat Board to buy on the prairies and those who want to move it to port position.

Whether the Government moves the Canadian Wheat Board to port position this year or next will not change the long-term situation. It is not possible to partly deregulate the system. Partial deregulation starts a process with a self-feeding dynamic that leads to total deregulation and continental integration of the grain system.

Introducing open rail access or revenue caps are also a short-term solution unless similar policies are adopted in the U.S. Continental railroads will shift investment in infrastructure where it earns the highest return. This could lead the Government back in to subsidizing the system as the infrastructure deteriorates.

Conclusion

The trends toward continental integration of the grain and transportation markets are continuing while the Government considers what to do with the Kroeger report. If current trends continue, within three to five years the Western Canadian grain system would be dominated by the transnationals. Any remaining Canadian grain companies or local elevator companies would depend on the transnationals to access international markets.

The development of a continental market in transportation and grain is well underway. If current trends continue, the remaining institutional barriers such as the Wheat Board and Grain Commission will be deregulated.

A Looming Crisis for Western Canadian Grain?

by
Erica Vido[1], Mark Ojah[2], Jake Kosior[3]

Abstract

The proliferation of Genetically Modified Organisms (GMO's) and the public backlash concerning these foods may require separate supply chains to meet new anti-contamination guidelines. Coupled with changes in global markets and developments in food processing, this has led to fragmentation of the traditional approach in providing homogeneous products in bulk quantities, to smaller quantities of identity preserved grains.

While the Canadian grain industry continues to tinker with the bulk system by rationalizing the network, other countries such as Australia and the United States are establishing Identity Preserved supply channels to take advantage of niche markets. The assumption of the Canadian grain industry that it can accommodate Identity Preserved Grain, particularly GMO's, within the confines of the bulk system is presumptuous in light of increasingly stringent consumer protection requirements.

The result may be that the looming crisis of Western Canadian grain logistics may become reality unless separate IPG channels are established.

---

[1] Master's Student, Agricultural Economics, University of Manitoba.
[2] Research Affiliate, The Transport Institute, University of Manitoba.
[3] Senior Research Associate, The Transport Institute, University of Manitoba.

1.0 Introduction

Bulk transport systems work best with homogeneous products in large volumes. Commodities such as coal, potash and sulfur are examples of industries that abide by this fundamental principle. Grain is no exception. During the past one hundred years of existence, barring several hiccups, the grain transport system has performed relatively well. However, developments within global agriculture sectors may require a wholly new approach to grain transportation rather than tinkering with the bulk system to extract incremental efficiencies. This paper will outline several of these developments and their impact on the bulk grain handling system. The primary focus will be on, 1) the proliferation of new varieties through biotechnology, 2) the unanticipated consumer backlash of Genetically Modified Organisms (GMO's), 3) the shift in food processing to Just In Time production techniques, 4) supply chain considerations in the context of de-commodified world markets and, 5) shift in market structure by the decommissioning of central buying agencies.

2.0 Biotechnology – Boon or Bust ?

Biotechnology is revolutionizing grain production, handling and consumption through the introduction of genetically modified organisms. The number of new varieties that are in production have necessitated logistics systems capable of preserving their identity.

Identity preserved grains (IPGs) are any grains that have added value from segregation. Users of these grains are willing to pay a premium for their procurement because of their superior attributes. Value added features of identity preserved grains are severely compromised in the bulk system, segregation is imperative. Fulfilling the requirements of niche markets, IPG systems currently function within traditional commodity systems – they do not replace them.

Increasingly, genetically modified organisms (GMOs) are joining the ranks of other IPGs. The benefits of GMOs however, are not easily

measured. Premiums associated with IPGs are based on the novel traits of specific varieties and the economic value of these traits to producers, processors and end users. However, some GMO traits do not afford benefits to either consumers or processors. For example, GMO varieties with traits such as herbicide tolerance provide benefits only to the producers who grow them. The advantages of these varieties are that they simplify agronomic practices and lower perceived risk to the producer. The public's skepticism about the safety of GMOs has significantly contributed to the fragmentation of the grain market.

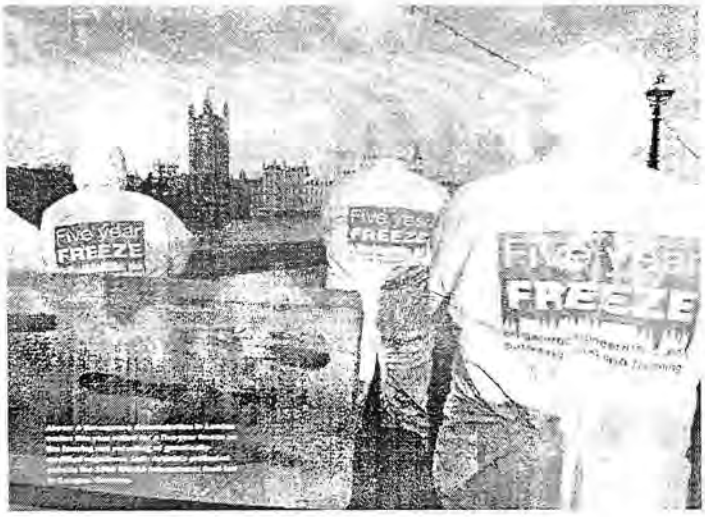


Figure 1: Protesters in London, England demanding a five-year freeze on the introduction of GMO's in Europe.

Concerned over the potentially dangerous trickle-down effects of biotechnology in agriculture, consumer groups and grain-purchasing entities are demanding that governments and the agriculture industry take steps to ensure the safety, quality and purity of the food being produced. Well-publicized cases of safety debacles such as the

proliferation of Creutzfeld-Jakob Disease (more commonly known as Mad Cow Disease) in the UK have weakened already fragile consumer confidence in the agriculture industry's willingness to make safety its top priority. Figure 1 demonstrates the public's mistrust of corporations involved in biotechnology is generating a consumer backlash, ranging from mild to militant, that has never before been seen in the agriculture industry. Due to the potential for contamination in bulk grain handling, these issues have had enormous implications for Canadian grain logistics.

Maintaining the value of particular segregations is the goal of an IP system. However, with respect to GMOs, a new justification for identity preservation has surfaced. Increased attention to IPG issues is expected in connection with GMOs for four reasons. First, the set of GMOs approved in different countries is not the same. The European Union, for example, has implemented a suspension of all GMO imports until new regulations are agreed upon. This moratorium has resulted in a significant reduction in market share for Canadian product.

Second, there is a need to develop consistent and informative GMO labeling requirements. Countries such as Australia, New Zealand and Japan have announced plans to introduce mandatory labeling for GMO foods in the near future. This raises the question of what the standard for determining adequate and universal tolerance levels should be. Tolerance levels must satisfy consumer uncertainty but be liberal enough to afford profit potential for producers, handlers and marketers. These tolerance levels are vital considerations to the nature and costs of the IPG system that is consequently developed.

Third, the demands of consumers that desire non-GMO food must be satisfied. Processors and distributors are obliged to provide this segment of consumers with GMO-free food. But the size of this market is growing rapidly. Canada's bulk grain logistics system is not equipped to handle this growth. The cost of supplying non-GMO food could be substantial, given the many opportunities for contamination and commingling that exist along the supply chain (Moschini, 1999).

Finally, GMOs have effectively doubled the number of segregations handled by primary elevators and the transport system. This will reduce the storage capacity of high-throughput elevators (HTEs) and their ability to quickly and efficiently handle large amounts of blended grain. The drive to increase HTE inventory turns to 15 per year (from the current 8) is unrealistic in light of the rapidly growing number of grain segregations in the handling system (Kosior, 1999).

The impact of GMOs and increased segregation on HTEs carries over to transportation. HTEs are built to capture economies of scale and can thus accommodate 75 to 100-car unit trains. The railways offer rate reductions to shippers who are able to fill a unit train, increasing margins for handlers. These benefits are frequently passed on to producers in the form of delivery incentives. Increasing the number of types of grain will make it more difficult for one elevator to accumulate enough available non-GMO grain to load a unit train. This underscores the need to develop a suitable IP system. Potential efficiencies in the bulk system are lost when IPGs are pushed through a system designed for high throughput and homogeneity.

The major problem in exporting GMO grain will occur at export ports (Baumel, 1999). In Canada, grain is moved to export position by rail. At the ports, it is transferred to terminal elevators and stored where it awaits transfer into the holds of ocean-going vessels. The terminals have limited storage capacity and will have difficulty handling many segregations of grain at the same time. One way to avoid this problem is to load direct from railcar to vessel. However, this is more costly because it requires terminals to tightly schedule inbound loaded hopper cars and vessels. The high transit time variability will place extraordinary constraints on the ability of terminals to achieve this. Moreover, if importers strictly prohibit the import of GMO grains, how will the exporter know if all the grain is non-GMO grain and/or approved GMO grain? What does the exporter do if the wrong variety of grain has been loaded in the hold of a ship while it is still at the port or, even worse, in a ship that has already set sail? (Baumel, 1999)

This leads us to the question of how issues concerning documentation and testing will be addressed. As previously mentioned, the emergence of a larger number of segregations the bulk handling system will greatly increase the risk of contamination and commingling. As a result, there must be a system in place to economically test the contents of each hopper car. Presently, Canada's grain industry relies on Kernel Visual Distinguishability (KVD) testing method. GMOs, however, cannot be distinguished from non-GMO varieties by simple visual means. How are we to detect GMOs from non-GMOs in a fast and efficient manner? The fact that the desired testing technology is still under development is a further obstacle faced by Canada's current grain logistics system.

Another important issue is where the testing should take place. At the farm? At the primary elevator? At the terminals? Ideally, testing should take place at every point of transfer along the entire supply chain, with documentation following each grain shipment. While this would improve accountability and reliability, such a system would become prohibitively expensive and time consuming.

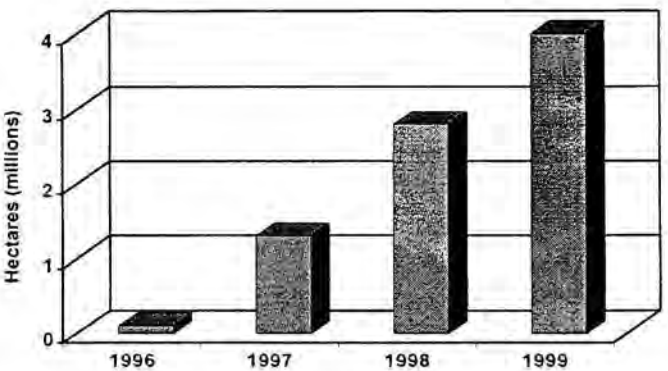


Figure 2: Growth in hectares of Canadian trans-genetic canola.

Genetically modified crops will become more significant as biotechnology continues to change the face of agriculture. Realizing benefits to be gained through their use, producers are planting more GM crops. Figure 2 shows that in 1996, 5 percent of Canada's canola acreage was of GMO variety. By 1999, this number had jumped to 66 percent, an increase of 61 percent in four years. Substantial growth in GM varieties of other grains has also occurred. The impact of biotechnology on agriculture and the safety concerns it has created are key issues driving change in modern agriculture. As witnessed with Mad Cow Disease, many of these concerns are warranted. Biotechnology in agriculture, however, is not waning. These disparate forces will necessitate changes in Canada's approach to grain logistics.

3.0 Consumer Demands - the customer is always right

The growing sophistication of consumer demands and the impact these have had on the food processing industry has become an important market driver for identity preserved grains. Increasingly, consumers are demanding more varied food products from processors. Typically, these food products require more specialized inputs. As with the emergence of a greater number of grain segregations in the bulk handling system, an increased variety of food products requiring highly specialized inputs and processing techniques has necessitated changes in the food processing system. In their quest to meet minimum tolerance levels for contamination and to satisfy more discerning consumer tastes, processors have sought out greater varieties of IP grains in smaller quantities. Due to the superior homogeneity, purity and overall quality of identity preserved grains, processors benefit from improved process yields and greater product consistency (Clarkson, 1999). The sheer number of segregations in the handling system today, prevents the bulk system from effectively delivering these benefits.

With the added value provided by IP systems come certain cost considerations which must be taken into account. The fundamental point is that variety exacts its price. IP grains are processed in small

batches requiring the production system to be chemically cleansed and sanitized between each production run. Strict quality control measures must be instituted to ensure that the quality and safety of the food is maintained throughout the production system. While the affluent North American, European and Japanese consumers who demand these IP products have been willing to pay premiums for them, the higher production costs they involve have also driven processors to seek greater operational efficiencies.

Processors utilizing a growing variety of specialized inputs in production must be concerned with contamination during on-site storage and problems related to storage capacity and input supply. The responsive, synchronized nature of Just-In-Time (JIT) food processing requires a fast, efficient and reliable supply chain. It is dubious whether a bulk system is capable of delivering small quantities of specialized IP grains at short notice or on an as-needed basis.

4.0 Supply Chains and "De-Commoditization" of Agriculture

As discussed earlier, the advantages of bulk grain logistics systems lie in their ability to efficiently handle large quantities of relatively homogeneous grains. The principle factor responsible for the erosion of this efficiency in recent years has been the number of new grain segregations being handled in the system. This fragmentation or de-commoditization of the grain industry has negatively impacted elevator throughput, storage space utilization and handling and transportation efficiency in the bulk system. Further increases in the number of segregations moving through an already constrained handling and transportation system will increase the stress on the system's ability to preserve the identity of segregations (Demmans & Roth, 1998). The response of the Canadian grain industry is to tinker with the bulk system by rationalizing the network. All indications are, however, that the problem is getting worse. For wheat, in 1985 there was a total of 12 possible segregations, as of 1995 there were 68 possible segregations of wheat. (Canadian Grain Commission, 1998). With the number of segregations expected to continue rising in the

years to come, clearly, continuing to funnel identity-preserved grains through the bulk system is not tenable.

The obvious solution is to provide separate logistics channels for product streams (IPG, GMO, organics, etc.). However, the question is how should a mixed logistics network be configured to derive maximum efficiency? The goal of a mixed logistics strategy is to pull smaller segregated IPG shipments out of the high-throughput bulk system where they create congestion problems and redirect them through a specialized IP system. The return on investment will be determined not by an isolated cost/benefit analysis of the IP system alone, but through an assessment of the overall efficiency gains in the entire grain logistics system including the benefits accruing to the bulk system. Investment in IP facilities and equipment should only occur where supplies of identity-preserved grains and the subsequent congestion they cause warrant it.

Second, a viable IP logistics system will require facilities in areas of Canada where grain handling has been severely rationalized in recent years. In some areas, rationalization is scheduled to continue in the years to come. Rather than continuing to dismantle older elevators, designation of these facilities for dedicated IPG handling may enable the establishment of identity preserved infrastructure at minimal cost. Through greater specialization of handling activities, higher productivity and less congestion, a mixed HTE and IP system could generate overall efficiency gains.

Third, a specialized IP system will improve product flow and boost efficiency through the improved utilization of facilities currently operating below capacity. The potential for improvement in this area begins at the farm. Canada's commercial grain storage capacity is low relative to its on-farm storage capacity. Taking full advantage of farm storage infrastructure will further reduce congestion in the handling system. Establishing dedicated IP handling facilities will ease some of the burden increased segregation has placed on the handling system, but additional action must be taken. More emphasis will have to be placed on farm storage as a means of optimizing storage

efficiency. As with the exclusive dedication of non-utilized infrastructure such as rationalized grain elevators to IP activities, the goal is to achieve the greatest operational gains with the least capital expenditure.

Increased reliance on underutilized ports such as Prince Rupert and Churchill could also significantly benefit Canada's grain logistics system by providing shipping alternatives which take pressure off the Port of Vancouver and Thunder Bay during the peak shipping season. In light of the trend towards increased segregation from GMO's versus traditional crops, potential designation of Prince Rupert and Churchill as "GMO-Free" facilities may prove attractive to discriminating consumers.

The emergence of containerization as a viable option for transporting small shipments of grain provides further impetus and justification for the establishment of a dedicated IP system. Only recently has the economical movement of containers worldwide become a reality. During the past twenty years, the capacity of container ships has risen from 2,000 TEUs[4] to over 6,500 TEUs. Growth of the world's container slot capacity has out-paced demand and rates have fallen steadily. While producers of specialty crops have been taking advantage of containerization for some time, rates have now reached the point where significant potential exists for lower-value grains such as wheat. Due to increased segregation, the accumulation of large quantities of grain which was once easily obtained through blending are now more difficult to achieve. Current scenarios involving smaller quantities of segregated grain grown on a contract basis for overseas buyers present opportunities which are ideally suited to containerized IP systems. Further substantiating the need for a dedicated IP system is the fact that international grain purchasing is changing and customers are demanding smaller shipment sizes.

[4] A TEU stands for Twenty-Foot Equivalent Unit, a forty-foot container is 2 TEU's.

5.0 The Rise of Market Forces – The Decommissioning of Central Buying Agencies

The 1990s brought a shift in international grain importing functions from primarily large central buying entities to smaller, more numerous independent private buyers. Figure 3 shows that private buyers now represent over half of the market for high quality Canadian wheat.

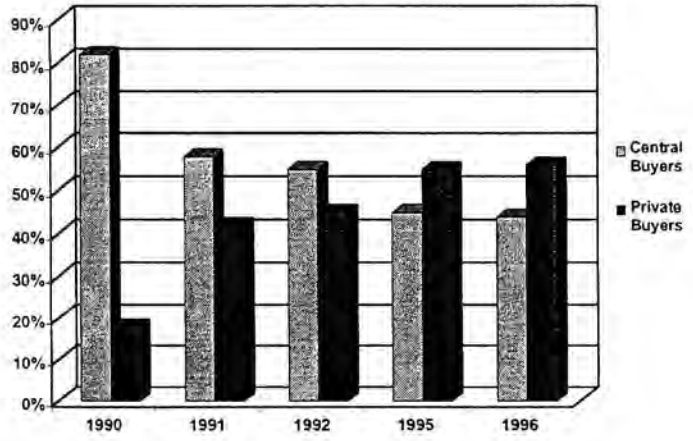


Figure 3: Percentage of Canadian export grain purchases by central versus private buyers, 1990 to 1996. Source: Mckinsey, 1998.

At the same time, globalization and the liberalization of trade has spurred market reform in many countries with the privatization of state-owned enterprises. Greater self-sufficiency in China and the dismantling of the Former Soviet Union are two key developments that have negatively impacted Canadian bulk grain exports in the past

decade. The inability of the of the bulk system to efficiently handle greater numbers of customers purchasing smaller quantities of more specific grains is a recurring theme in an assessment of Canada's grain logistics system. With regard to international grain purchasers, the problems are similar to those of local food processors. Smaller grain purchasers cannot afford to tie their capital up in large inventories of bulk grain. Moreover, they require quick delivery of specific varieties of grain which, increasingly, can be more efficiently procured through a specialized bulk or containerized IP system.

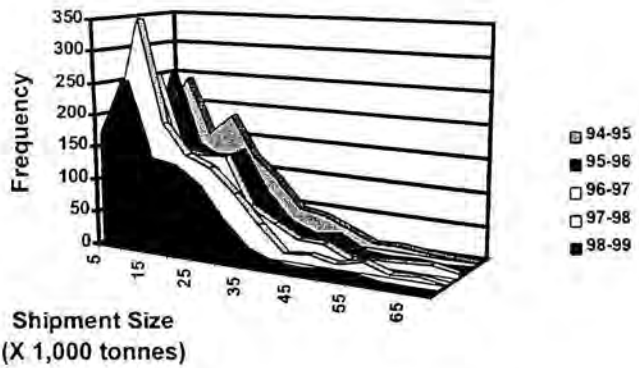


Figure 4: Frequency of Export Consignment Sizes by Tonnage Category for Canadian Wheat, 1994/95 to 1998/99 crop years.

Figure 4 shows Canadian wheat exports by shipment size for the 1994/95 to 1998/99 crop years, confirming the trend towards smaller consignments. However, this does not necessarily mean that large vessel loads of grain will wane. Rather, industry sources state this is on the rise. In the past, government controlled central buying agencies purchased and stored grain in bulk on behalf of national millers and processors, usually in 30,000 tonne consignments or more. Processors within the nation would purchase their requirements from the central agency. Today, many of these

individual companies must fend for themselves on world markets. Individual companies are forming buying associations or utilizing the services of freight forwarders to consolidate and co-ordinate shipments to lower transport costs.

For example, a typical practice would be if four buyers chartered a 40,000 tonne bulk vessel to move four 10,000 tonne consignments. The first 10,000 tonnes would be placed in the hold with a plastic tarp over it and jute sacks stuffed on the periphery of the hold to prevent leakage between layers. The second layer of 10,000 tonnes is placed on top the first layer and so on. This practice is becoming more common in grain transport. However, several industry sources confirm that this method of "grocery boat" operation has a high material handling cost to prepare the vessel and reduce potential for contamination between layers. It is not well suited for transporting GMO's and traditional crops in the same hold. An entire shipload of grain could be rejected on the whim of one buyer.

6.0 Conclusion

Grain logistics has become much more complex over the last decade. Despite the rationalization of the Canadian bulk grain-handling network it cannot be assumed that the grain logistics system will be able to cope with the changes taking place in the global marketplace. Biotechnology has revolutionized the grain industry from both the producer's and consumer's perspective. While providing farmers with improved yields, biotechnology has also greatly increased the diversity of grains in the system. In addition to being concerned about the safety of genetically engineered food products, more consumers are now demanding more varied food products. As a result, they are much less willing to accept uniform grades of grain, particularly when they have been genetically modified or exposed to GMOs. The subsequent de-commoditization of the grain industry has had far-reaching effects in the supply chain. Due to concerns over contamination, new consideration must be given to the storage, handling and transportation of grain. Central buying agencies that once consistently purchased bulk shipments of grains from Canada,

have been replaced by more numerous and discriminating private buyers soliciting smaller quantities.

When assessed simultaneously, these issues raise serious questions as to how well prepared Canada's grain logistics system is for the future. Countries such as Australia have already proven that a dedicated IPG system working alongside an established bulk grain logistics system can operate efficiently and profitably. By taking pressure off the bulk system and allowing the IP system to capitalize on expanding niche opportunities in the marketplace, overall efficiency gains are realized. Recognizing the necessity and potential of preserving the identity of grains, the United States has begun to establish dedicated IP systems of its own. Having delayed commitment to a mixed logistics strategy, Canada remains at the crossroads. If our agricultural products are to remain competitive with other world suppliers, our logistics system must avoid debilitating congestion. A dedicated IP system must be established in the near future. Failing to do so may result in a looming crisis in the Canadian grain industry becoming a reality.

References

Babcock, Bruce & Beghin, John. "Potential Market for Non-GMO Corn and Soybeans." *Economic Perspectives of GMO Market Segregation*, Staff General Research Papers, Department of Economics, Iowa State University, September, 1999.

Baumel, C. Phillip. "Transportation Issues." *Economic Perspectives of GMO Market Segregation*, Staff General Research Papers, Department of Economics, Iowa State University, September, 1999.

Canadian Grain Commission. "Identity Preserved Systems in the Canadian Grain Industry" A Discussion Paper, December, 1998.

Christofore, Dave. "Creating Opportunities for Non-GMO Segregation." *How to Establish Container and Identity Preserved Grain Marketing Channels*, Fargo, ND, November 30 – December 1st, 1999.

Clarkson, Lynn. "The Economics of IP." *Identity Preservation, The Challenges and Opportunities for Producers, Traders and Processors of GM, Specialty and GM-Free Agricultural Crops and Food Products*, London, England, December 2 – 3, 1999.

Cullinane, K., Khanna, M., and Song, D. "How Big is Beautiful: Economies of scale and the optimal size of containership." *International Association of Maritime Economists*, Halifax, Nova Scotia, September 13 and 14, 1999.

Demmans, Maurice & Roth, Clarence. "Meeting Customer Quality Requirements with Quality Segregations – Executive Summary." *A Report Prepared for the Canadian Wheat Board*, February 25, 1998.

Kosior, Jake. "A Mixed Logistics Strategy for Canadian Grain A Discussion Paper." 23rd Australasian Research Forum, Perth, Australia, September 29 – October 1st, 1999.

Moschini, Giancarlo. "GMOs and Identity Preservation: The Roots of the Problem." *Economic Perspectives of GMO Market Segregation*, Staff General Research Papers, Department of Economics, Iowa State University, September, 1999.

Prentice, Barry E. "Emerging Trends in Western Canadian Grain Transportation" *Proceedings of the Canadian Transportation Research Forum*, Alberta, Canada, May 25-28, 1998.

Rawling, Ruth. "Impact of Identity Preservation on the Trading System." *Identity Preservation, The Challenges and Opportunities for Producers, Traders and Processors of GM, Specialty and GM-Free Agricultural Crops and Food Products*, London, England, December 2 – 3, 1999.

Wolfson, Richard. "All the Facts you Need to Avoid Heartache: Genetically Modified Food." *Genetically Manipulated Food News*, November 29, 1998.

Governance and Commercialization: Delivering the Vision

Mary R. Brooks (Dalhousie University),
Barry Prentice (University of Manitoba)
Tonya Flood (Dalhousie University)

Abstract

Governments internationally have been devolving responsibility away from the public sector to the private sector for transport support entities. In Canada, this has happened to airports and ports through the implementation of the *National Airports Policy 1994* and the *National Marine Policy 1995*. The intention of such devolution[1] was to secure the benefits of commercially-driven business decision-making in organizations previously run by government and, at the same time, secure compensation for prior taxpayer investments. Whether or not the commercialization of such entities has delivered the vision government intended is unclear.

Space limits the examination of this large topic. The purpose of this paper is to begin the discussion with a small but readily discernible issue—the structure of the Boards of Directors of these newly created entities. Considerable variation exists in their Board structure and in their accountability for results. These variations provide an excellent opportunity to examine differences in both structure and outcomes achieved. Specifically, the paper lays the foundation for a discussion and subsequent research agenda for determining whether the Board structure is appropriate to deliver the vision of the policies noted above, from both government and local community perspectives.

Introduction

The commercialization of public transportation infrastructure in Canada has yielded a variety of different board policy frameworks. The air navigation system (NavCanada), the Canadian Airports Authorities (CAA) and the Canadian Ports Authorities (CPA) have very different

rules regarding appointments eligibility and accountability for results. In the end, it is these two aspects that provides the focus for this paper and its proposed research agenda.

The unique character of transportation provides a lens to examine these approaches to commercialization. The experiment owes its origin to the public-private separation of way ownership and operations in transportation. A mixed ownership model has been followed in air, road and marine; planes, trucks and ships are owned and operated privately, while the way (the shared fixed infrastructure, e.g., airports, roads and ports) was publicly owned and operated. The economics of transportation has led to this because the fixed infrastructure is subject to both joint consumption and monopoly provision.

Monopoly power is not to be dismissed easily. The one method of transport in which ownership is totally integrated is the railway. Governments have more firmly regulated railways because of shippers' concerns about the potential for abuse. As airports and ports can have monopoly pricing power, governments have been reluctant to simply turn these assets over to for-profit private entities. The joint consumption aspect of public infrastructure is different than the railways. An airport or port is not exclusionary in terms of access, and, in fact, there is a growing demand to require competitive access of track to other operators. Maximizing utilization, rather than controlling supply to maximize profits, becomes the goal of the infrastructure manager.

Airports and ports are recognized as "growth poles" (Parr, 1981) that can serve as economic catalysts to attract industry to locate and/or invest in their vicinity. Consequently, the shift of governance to not-for-profit authorities better able to market the facilities is viewed as a progressive policy step. In general, these Authorities are empowered to charge user fees to finance the maintenance and improvement of the infrastructure.

Government has been able to indirectly raise taxes through commercialization without negative reaction from taxpayers. In addition, the government is receiving a cash-payment, or lease rent in the place of fiscal expenditures. During the 1990s, transportation changed from a net drain of $1.4 billion per year in 1989-90 from the Treasury to a projected $3 billion surplus in 2000 (Derkson and Shurvell, 1999: 4).

Relevance of Authority Governance to Canadian Policy

Interest in the role of Boards of Directors, both public and private, has increased during the 1990s. The Toronto Stock Exchange released its report on corporate governance in 1994; the "Dey Report" concentrated on the role of directors on boards of publicly traded companies, asking tough questions about what led to some very high profile public company failures. While it examined the role and effectiveness of boards in publicly-traded shareholder-driven corporations, it proposed a set of governance principles generally applicable to not-for-profit boards.

Carver (1990) examined the functions of not-for-profit Boards of Directors. At one time, Board positions were viewed as having much less responsibility than they now have been shown to carry. Law suits with sizable settlements against individual Board members for negligence have had a sobering impact on Board participation.

Boards are often empowered to undertake decisions that are disproportionate to the training and preparation of individual members. While the members may be highly successful in their fields, if a Board does not individually and collectively understand its role in corporate governance, it can fail. Boards can receive a low grade because they fail to seize opportunities, or because they become too involved in micro-management of the enterprise. Thain and Leighton (1995) identify six factors behind board failure or success; four of these can be influenced through board selection: board culture, competence, board management and board leadership.

Finally, there is the separate element of non-share capital Boards, as is the case with NavCanada, CAAs and CPAs. When a Board does not have shareholders, the mission is also broader. The for-profit Board of Directors is often composed of owners or outside directors representing shareholder interests. Non-share capital not-for-profit entities should serve a broader social mission that is not as easily defined. The setting of that broader social mission is devolved and stakeholders may conclude that their interests are no longer protected.

The Devolution Process in Canada

When Transport Canada began to contemplate devolution, what was its vision? It is exceedingly difficult to divine this from the "tea

leaves" of policy speeches. The popular press surmised the true intent to be one of simply downloading costs rather than a vision of greater Canadian competitiveness. Some have argued that the vision was to secure the benefits of commercially-driven business decision-making in organizations previously run by government and, at the same time, secure compensation for prior taxpayer investments. A review of the policy statements of the day suggest that the federal government saw devolution as providing a means of enhancing competitiveness while reducing costs.

> *What this nation must have is an integrated and affordable national transportation system. One that emphasizes safety and reliability. One that is efficient. And one that builds strong, viable companies in all modes.*[2]

At the same time, Transport Canada made it clear that it "will not abandon its responsibly to ensure safe and secure transportation standards, rules and regulations."[3] It has been argued by many that policies, regulation and oversight are the responsibilities of government and that they should not be devolved. Specific objectives consistent with these policies were articulated in the *National Airports Policy 1994* and the *National Marine Policy 1995*.

The government also recognized that there were two significant challenges to the devolution tasks it faced:

> *The first is for government to learn how to significantly increase efficiency and effectiveness—to operate with fewer resources, while maintaining or improving the quality of service. The second challenge is for government to learn how to work with growing demands and capacity for participation in the treatment and resolution of public issues, while retaining the power to act in the overall public interest.*[4]

Airports

In April 1987, the Federal Government announced its intention to transfer management of Transport Canada airports to Local Airport Authorities (LAAs) if interest was expressed by the local community. It took until 1992 for the first four transfers to take place—Vancouver (International), Edmonton (International and Municipal), Calgary (International) and Montreal (Dorval and Mirabel). These LAAs were

private sector community groups that leased the airport from the federal government, and were mandated to manage and operate it in the interests of the local community on a "non-profit" basis. The Federal Government did not define any policy with respect to membership on LAA Boards of Directors, except that provincial and municipal governments could not participate, and Directors were required to be Canadian citizens and appointed through a process mutually acceptable to national and local government. None could be elected officials or employees of the government.

The proposed transfer of Pearson International Airport in Toronto to an LAA became a contentious issue in the federal election of 1993. After the Liberal party defeated the Conservatives, the Federal Government did not transfer Toronto airport but instead released a new airport policy that created Canadian Airport Authorities (CAAs). The LAA model had not incorporated public accountability principles into the transfer agreement. This deficiency was corrected with the CAA model, promoting "cost-efficiency and the provision of services matched to user needs."[5]

Ports

As for ports, the process of devolution was more political. While the initial philosophy appeared to follow in the footsteps of early devolution policy from Transport Canada with respect to airports, the execution was quite different. Ircha (1999) explained how this happened:

> *In December 1994, the Minister of Transport tasked the Parliamentary Standing Committee on Transport (SCOT) to review marine policy through a series of public hearings across the country. The SCOT recommendations disappointed many observers of the port reform process who had expected significant change. Instead the SCOT recommended minor modifications to the status quo in their compromise to satisfy everyone. ... A January 1996 federal cabinet shuffle bringing a new, but junior minister onto the scene coupled with the federal government's reticence to cause further division in Quebec in the ongoing unity debate may result in the adoption of a modified port reform package - one that reflects the SCOT recommendations rather than the proposed national marine policy.*[6]

Airport Boards were structured in ways unique to each community through letters patent that were not defined by Ottawa. However, when the federal government moved to devolve Canada's ports, control by Transport Canada was more rigid, and as a result port boards were predominantly appointed by the Minister.

Literature Review

Decreasing the role of government in the management of transport entities is predicated on the belief that the private market is the most efficient means of allocating resources; this tenet underlies the port privatization initiatives undertaken in the United Kingdom (Thomas, 1994), the moves towards corporatization of ports in New Zealand, as well as commercialization in Canada.

Privatized entities, finding themselves in a monopoly position, may not actually pass the benefits achieved onto customers of the entity in the form of reduced charges or improved services. Sundry and Turnbull (1997) in particular noted the large profits made by former managers when a number of trust ports were privatized. In their view, the benefits of privatization in UK ports were weighed against the short term returns to shareholders and the potential for excess capacity development in the industry. They concluded that privatization did not transform the financial and economic performance of UK ports sufficiently to justify the private gains of port management shareholders; improvements in economic performance were attributable more to the abolition of the National Dock Labour Scheme than to gains from privatization.

The argument that corporatized entities are more entrepreneurial may not be borne out in reality. Studies of Australian waterfront reform found improved productivity at the stevedore level (BTCE, 1995). However, according to Dick and Robinson (1992), these entities were unable to deliver aggressive port management because they failed to alter the fundamental structure of port authorities and embrace the need for change. The culture within port authorities discouraged innovation and initiative. One of key reasons Dick and Robinson recommended privatization as the preferred option was the limited accountability of the Australian public sector port authorities.

Rodal and Mulder (1993) developed a typology to examine the full range of public-private power-sharing relationships. Devolution is at one end of a control-consultation-partnership-devolution continuum; each move along the continuum decreases government financial and administrative involvement as the other party's commitment and responsibility increase. They argue that government accountability is greater in partnerships, noting that with devolution the private sector or another level of government becomes accountable to citizens.

Two primary managerial issues arise from Rodal and Mulder's discussion: **accountability** and **tension and balance in leadership**. The former is explained using the airport example. As accountability is devolved, "the minister is no longer responsible or accountable if the airport taxi service does not work."[7] However, they conclude that the minister remains responsible and accountable "for ensuring that activities conform to government legislation and policy."[8] Therefore, it is the responsibility of government to ensure that the quality of the agreement signed in the process of devolution ensures responsible management. Accountability is no longer just political; newly created entities must be responsible to their community stakeholders, their financiers, as well as those they directly service, be they tenants, suppliers or users. The role of these stakeholders creates a tension in leadership as well as a pressure for transparency.

The Role of Stakeholders

Stakeholder theory deals with questions of corporate governance, the legitimacy of who serves on boards and the appropriate roles of boards vis-à-vis stakeholders. Stakeholders are groups affected by the decisions of the corporation, e.g., employees, customers, the greater community, advocates for the environment or for product safety. When an organization is devolved, stakeholders raise concerns that their interests will no longer be considered, and that social interests will be ignored in the pursuit of greater efficiency and profits. Traditionally, stakeholders enjoy greater protection when an organization is managed by a government.

According to Berman *et al.* (1999), stakeholders have strategic value to a firm; they represent part of the environment that must be considered to assure revenue, profits, and ultimately, returns to shareholders. Other stakeholder interests have a more direct relationship with

traditional notions of corporate responsibility. If a firm has certain fundamental moral values that guide how it does business, then stakeholder principles may set the foundation on which corporate performance is based. Before managers can make decisions that take into account stakeholder relationships, they must know what interests stakeholders consider important. It is the authors' premise that stakeholder consultation is a minimum feature of effective governance.

Luoma and Goodstein (1999) argued that if a corporation places legitimate value in stakeholder governance, then representation at the board level is key; it promotes procedural fairness by providing a way to ensure stakeholder considerations are directly represented in corporate decision-making. Formal stakeholder representation means non-economic considerations are discussed and incorporated into board decision-making. A more open governance process assures that the interests and well-being of constituents other than shareholders are given due consideration before board decisions are made.

Agle *et al.* (1999) concluded that CEOs take greater account of stakeholder concerns when stakeholders possess a high number of power and legitimacy attributes. They concluded that until stakeholders achieve legitimate representation in corporate governance, management may perceive their role as largely symbolic.

Berman *et al.* (1999) tested the idea that firms address stakeholder concerns because of a moral commitment to stakeholder groups. No support for this "intrinsic stakeholder" model was found; stakeholder relationships did not empirically drive strategy. However, when they tested a "strategic stakeholder management" model, a number of stakeholder concerns demonstrated relevance to financial performance. In this model, firms address stakeholder concerns when they believe doing so will enhance firm performance. Five stakeholder variables were tested: employees, product quality, diversity, natural environment and community. The first two showed a direct relationship between management attention and financial performance; the latter three exhibited no direct effects, but positively affected the strategy-performance relationship. They concluded that when managers pay attention to stakeholder concerns in a strategic way, firm profitability is increased.

What Makes an Effective Board?

Proceeding on the assumption that governments wish to move forward with further devolution of government-managed entities, how should Boards be structured? It is not the number of people that makes an effective Board but rather the commitment of Board members to meet the objectives established, and their willingness to champion the local public interest. No guarantees exist that a Board will function in the best interests of the entity's stakeholders.

Leighton and Thain (1997) reasoned that an effective board begins with an effective chairman, one with the right attitude about the board's role. As the Board elects the Chairman from among its members, the quality of the Chairman can only be as good as the quality of the Board in general. Alfred Powis, Chairman of Noranda, argued in *Business Quarterly* (1993) that the most critical factor in board performance is the composition of the board; that is, if its members have integrity, experience and dedication, it will be effective. How do we get integrity, dedication and experience? If a board appointment is seen as a plum or reward, effectiveness will be compromised. If the choice of Board member is not made to balance the experience and skill set of directors, it will not be as effective as it might otherwise be. Leighton and Thain (1997) argued that boards must be empowered, responsible, effective and involved or the outcome will not meet the standard desired, whether it is the Dey Report's standard, that sought by the Department of Finance (1996) or Carver (1990).

> *Good corporate governance can contribute to the corporation's achievement of both its public policy and commercial objectives.*[9]

Board Accountability

A review of organizational design literature indicates that an effective board needs an orientation to community objectives, a solid reporting system to its community, guidelines on transparency in tendering, collegiality within and between the Board and management. A board needs to set policy and not become involved in micro-management. It needs to be open to its stakeholders.

By creating non-share capital corporations, the government removed the element of accountability to shareholders. The creation of not-for-profit entities removed the profit motive as well. However, performance of the entity must still be subject to scrutiny and it is accountable, at minimum, to its financiers, and to the Canada Customs and Revenue Agency in order to maintain its status as a not-for-profit entity.

Accountability can also be imposed (such imposition may not be considered desirable) by incorporating dispute resolution mechanisms to deal with monopoly aspects of the corporation. While the LAA model did not incorporate a dispute resolution mechanism, both the *Civil Air Navigation Services Commercialization Act 1996* creating NavCanada, and the *Canada Marine Act, 1998* creating Canadian Port Authorities provided for dispute resolution on pricing issues to the Canadian Transportation Agency.

Canada's devolution policy intended that Boards also become accountable to their community stakeholders. The nomination process for airports created a tie between nominators and Board Members. In the devolution of ports, this link was removed and stakeholders did not see accountability preserved. For example, the trade press reported on users' dissatisfaction with the Board selection process in the Port of Halifax:

> *Four more [directors] are to represent the commercial users of the port. It sounds fair and sensible, but federal Transport Minister Collenette has a veto over the theoretically independent four. He has rejected the local shipping association's highly qualified nominee, one endorsed by other port user groups. He has likewise nixed all three names put forward by the Metropolitan Halifax Chamber of Commerce. He will rely instead on other advisors, all with Liberal ties going way back.10*

Section 4.18 of the Letters Patent for Halifax Port Authority, which specifies the nomination process for "user directors." The four user groups were determined to be: (1) inland transportation; (2) labour, non-terminal operators, and other port service providers; (3) terminal operators and shippers; and (4) tenants, shipping lines and agents. Dissatisfaction stemmed from the perceived lack of accountability to

10 Brooks, Prentice, Flood

the user groups, and the appointment rather than nomination of user directors. As for the former, there was no defined regularly-meeting group representing these individuals for nominators to report to or to be held accountable by.

Delivering the Vision

The vision **of government** was to shift to a user pay system and develop alternate service delivery models, while maintaining safety standards. The vision held **by many local communities** was to exploit the economic development potential of the facility, gain local control so that local initiatives could move forward to achieve that economic engine potential, ensure proper management of the facility through responsive and responsible local boards, and quite unlikely, although unstated, to minimize central political control. Section 3(d) of the *National Transportation Act 1987* had declared that transportation was recognized as a key to regional economic development; this vision of transportation as a tool of economic development was not altered with the passage of the *Canada Transportation Act 1995*.

Most important was the decision by the Federal Government to implement devolution in Canada via non-share capital not-for-profit entities. While the UK opted for a privatization route to deliver the benefits of productivity and financial responsiveness, Canada decided not to take the route of for-profit privatization with regulatory controls but rather to invoke community responsiveness through the not-for-profit stakeholder-focused entity.

The Objectives of Board Design

One of the premises of devolution is that efficiency gains will result from better management of the resources of the entity devolved. The commercialization of Canada's ports in 1983 with the passage of the *Canada Ports Corporation Act* went some distance down this road but failed to fully deliver its promise as the

> *bureaucratic rules, regulations and financial strictures of the 1984 Financial Administration Act prevented major ports from operating as true commercial entities. ... [T]he legislation did not create commercialized and market-responsive institutions required to meet the turbulent pressures of continental and global economic competition of the 1990s.*[11]

11 Brooks, Prentice, Flood

The *Canada Marine Act, 1998* section 4(e) notes that one of the objectives of the Act is to "provide a high degree of autonomy for local and regional management of components of the system of services and facilities and be responsive to local needs and priorities." Furthermore, section 4(f) sets, as an objective, management that "encourages, and takes into account, input from users and the community in which a port or harbour is located." Was that autonomy realized with the governance structure that was imposed?

The Realities of Board Structure

On the airport front, the operating By-Laws of each airport specify the Board selection process and it is a nominee process. This process holds nominees accountable to local groups. There is no requirement for the Minister of Transport to appoint the nominees, and therefore dissatisfaction with nominee performance can be addressed by the local nominating stakeholder. Nominee reporting systems also become important; for example, while not formally required to do so, nominees to the Halifax International Airport Authority Board by the Chamber of Commerce are requested to appear before the Chamber Board each quarter to report and answer questions. Other communities experience different relationships with their airport Boards.

The selection process for port boards was somewhat different. Section 4.3 of the Letters Patent for the Halifax Port Authority (HPA) specified that the Board shall consist of seven directors, with their appointment specified in section 4.6 to be by Governor-in-Council (with the exception of the appointments of one provincial and one municipal director). The Letters Patent for Montreal (section 4.7) is similar with a Board of seven directors appointed in the same manner while those for Vancouver (section 4.6) are different; the Board in Vancouver has nine directors, with the additional two being appointed to represent the Prairie provinces and an additional user class.

The operation of a commercially-oriented entity usually requires the appointment of a Board of Directors to set the policy for the entity and provide advice and guidance to the management team. It is interesting to note that, in his study of port reform, Ircha (1997) found that bureaucrats and industry associations favoured board appointments by provinces, municipalities and private sector organizations, while port managers favoured directors appointed by the Minister of Transport or

a majority appointed federally. In other words, the model in use for airport appointments was not favoured by port managers. Ircha concluded the "the port managers' perspectives may reflect imprinted institutional values developed from decades of strong federal presence ... in Canada's ports."[12]

Indeed, it is quite clear from informal discussions undertaken in the course of this research that "enthusiastic prospectors" are the ideal when economic development is held to be the community's primary objective.

A Research Agenda is Needed

What is needed is a study to compare how the different commercialization strategies for transport entities were implemented and what governance mechanisms work best to deliver the vision. The research agenda needs to define the objectives held by the various players, the board structure that was put in place, the accountability mechanisms and pressures each board faces from its stakeholders, and, most important, define what constitutes an outcome acceptable to serve the public interest (including to define what is in the public interest).

> *The major divergence between the NAP [National Airports Policy] and the National Ports Policy lies in their governance system. Locally appointed directors at Canadian airport authorities have full autonomy to manage their facilities. This may not be the case in Canadian port authorities because of the different appointment process for the directors.*[13]

The research methodology should be a two-step process. First must be further exploration of the literature on stakeholder theory and effective board design, followed by the identification of the objectives and expectations of stakeholder groups, the Board members themselves and the government personnel that worked on commercialization. The second phase is to take these expectations, construct performance measures to evaluate the achievement of these expectations and then evaluate the performance of the commercialized entity to determine if expectations and objectives were achieved. The outcome will be an evaluation of the basic parameters of board design, reporting structures and perhaps even an assessment of the success of the Canadian models

of commercialization. Whether stakeholder representation on the Board is required or whether regularly reporting to stakeholder groups is effective is one element which should be examined.

Endnotes

1 For the purposes of this paper, devolution is defined as the transfer of responsibility for program/service design and delivery.
2 Transport Canada (1994), Transport Minister Douglas Young Speech: National Transportation Day, June 3.
3 Transport Canada (1994), *2001: A Transportation Odyssey*. Address by Transport Minister Douglas Young to the Toronto '94 Conference, Toronto, Ontario, June 13.
4 Rodal and Mulder (1993), p. 27.
5 Transport Canada (1994), Op. Cit. (*2001: A Transportation...*).
6 Ircha (1997), p. 123.
7 Rodal and Mulder (1993), p. 37.
8 Rodal and Mulder (1993), p. 37.
9 Department of Finance (1996), p. 1.
10 Cayo (1998).
11 Ircha (1997), p. 125.
12 Ircha (1997), p. 134.
13 Ircha (1999), p. 129.

References

Agle, B. R., R. K. Mitchell and J. A. Sonnenfeld (1999), "Who Matters to CEOs? An Investigation of Stakeholder Attributes and Salience, Corporate Performance and CEO Values," *Academy of Management Journal*, 42, 5, 507-25.

Berman, S. L., A. C. Wicks, S. Kotha and T. M. Jones (1999), "Does Stakeholder Orientation Matter? The Relationship Between Stakeholder Management Models and Firm Financial Performance?" *Academy of Management Journal*, 42, 5, 488-506.

Bureau of Transport and Communications Economics (1995), *Review of the Waterfront Industry Reform Program (Report 91)*, Canberra: Australian Government Publishing Service.

Carver, John (1990), *Boards that Make a Difference*, San Francisco, CA: Jossey-Bass Inc.

Cayo, D. (1998), "The Politics of a Super-port," *The Globe and Mail*, 2 November, A17.

Crawford, P., W. Dimma, A. Powis, H. MacDougall and C. Taylor (1993), "Dialogue: Improving Board Effectiveness," *Business Quarterly*, 57, 3, 11-8.

Department of Finance and Treasury Board of Canada (1996). *Corporate Governance in Crown Corporations and Other Public Enterprises*, Ottawa, September.

Derkson, W. and S. Shurvell (1999). *Federal Transportation Spending & Revenues: A Report Documenting the Fiscal Changes to Canada's Federal Transportation System, 1987-1997 and a Five Year Forecast*, Winnipeg, MB: Transport Institute.

Dick, H. and R. Robinson (1992). *Waterfront Reform: The Next Phase*, Presented to the National Agriculture and Resources Outlook Conference.

Ircha, M. C. (1997), "Reforming Canadian Ports," *Maritime Policy and Management*, 24, 2, 123-144.

Ircha, M. C. (1999), "Port Reform: International Perspectives and the Canadian Model," *Canadian Public Administration*, 42, 1, 108-32.

Leighton, D. S. R. and D. H. Thain (1997), *Making Boards Work: What Directors Must Do to Make Canadian Boards Effective*, Toronto: McGraw-Hill.

Louma, P. and J. Goodstein "Stakeholders and Corporate Boards: Institutional Influences on Board Composition and Structure," *Academy of Management Journal*, 42, 5, 553-63.

Parr, J. B. (1981), "The Distribution of Economic Opportunity in a Central Place System: Dynamic Aspects and Growth Poles," in *Polarized Development and Regional Policies: Tribute to Jacques Boudeville*, A. Kuklinski, ed., The Hague: Mouton Publishers.

Rodal, A. and N. Mulder (1993), "Partnerships, Devolution and Power-sharing: Issues and Implications for Management," *Optimum, The Journal of Public Sector Management*, 24, 3, 27-48.

Saundry, R. and P. Turnbull (1997), "Private Profit, Public Loss: The Financial and Economic Performance of U.K. Ports." *Maritime Policy and Management*, 24, 4, 319-34.

Toronto Stock Exchange Committee on Corporate Governance (1994). *"Where Were the Directors?" Guidelines for Improved Corporate Governance in Canada*, Toronto: Toronto Stock Exchange. (Also known as *The Dey Report*)

Thain, D. H. and D. S. R. Leighton (1995), "Why Boards Fail." *Business Quarterly*, 59, 3, 71.

Thomas, B. J. (1994). "The Privatization of United Kingdom Seaports." *Maritime Policy and Management*, 21, 2, 135-48.

Safety—A Critical Success Factor in Trucking

Intense public scrutiny and the high cost of accidents have ensured that safety has become critical to the success of trucking companies. Safety has been an important aspect of the trucking business for as long as companies have been operating, however company owners and managers are realizing that safety initiatives can result in lower costs, more loyal staff and customers, and positive public perception. Each in their own way, these can contribute to higher profits.

Canadian trucking companies offer a wide variety in the complexity and size of safety initiatives. While some companies devote great time, effort and money to safety, others devote resources only on initiatives that they feel offer the most "bang for the buck". Whether a company chooses to incorporate all the safety initiatives currently available or only those aspects that resolve current issues, safety is well respected in today's trucking companies. In all cases, the programs are worthwhile and offer benefits beyond the safety of equipment and staff.

As coordinators of the annual Canadian Trucking Alliance / Royal & SunAlliance Fleet Safety Award Contest, KPMG has gained insight into the safety initiatives that are judged to be "over and above" the normal safety practices in the industry. These initiatives fall under categories such as:

- safety management structure and responsibilities
- driver selection
- training and driver supervision
- accident and risk management

- measurement of the success of safety programs.

In this presentation, we will outline the features that were judged to be exemplary safety practices. We will also demonstrate how these initiatives result in lower costs, more loyal staff and customers, positive public perception, and, ultimately, increased profit. Our research included interviews with safety managers at companies who applied for the award, as well as secondary research using trucking publications and recent studies. The results of the CTA/Royal & SunAlliance National Fleet Safety Award provided the starting point for this study while the rest of the research attempted to provide a deeper understanding of the effects of safety initiatives.

Objectives of the CTA/Royal & SunAlliance Award

The Canadian Trucking Alliance and Royal & SunAlliance initiated this award contest with the following goals in mind:

- to honour the recipient's commitment to fleet and road safety
- to promote the trucking industry's commitment to safety
- to recognize and support the recipient's productivity.

Applicants were asked to provide a description of the following eight topics for their company:

Company Overview and Safety Policy
Safety Management Structure and Responsibilities
Driver Selection Process
Training and Driver Supervision
Accident and Risk Management (Vehicle Management and Control)
Measures of the Success of Safety Programs (what do you measure and what is your measure)
Additional Safety Activities (awards).

The five categories highlighted here provided the most progressive practices overall.

The Results of the Fleet Safety Award

The judges highlighted many important features that supported the winning submissions. An important finding was that companies who involve their staff, at all levels, in the creation and implementation of safety programs were perceived to have the most pro-active safety programs. The judges also rated highly any companies who demonstrated a strong communication strategy for all aspects of safety. Other significant findings are outlined in the following section.

1. Safety Management Structure and Responsibilities

The companies who scored highly in this area were companies who have a dedicated safety manager on staff who reports directly to the President or to a senior management position other than operations. Companies who reported to have a safety manager reporting to an operations manager were scored lower because of a perceived conflict in the goals of the positions. Since most operations managers are evaluated based on on-time deliveries, fleet utilization and cost per delivery, they may not be motivated to pull a rig out of commission because of a possible safety risk. On the other hand, the President will have a broader view of the company and will be more likely to balance between safety and profit.

One company reported to have more than one safety manager, with the responsibilities distributed between training, safety and loss prevention, and regulatory affairs. The service centres, maintenance shops, line haul, and general office all report to the three safety managers and all contribute to establishing and managing safety policies and practices. The involvement of all staff was considered to

be an effective implementation of the safety program which would contribute to employee buy-in and the facilitation of new safety initiatives.

Another company has two Assistant Safety Supervisors and a committee which meets monthly to address concerns and provide solutions. The committee has representation from all aspects of the business.

One of the largest applicants has 18 employees in safety across North America. The Vice President, Quality Assurance is responsible for safety and reports directly to the President. They use Driver Observers / Enhancers who are experienced drivers who promote safety at the driver level. All employees have safety performance measures as part of their annual performance evaluations.

Another finalist has three levels of safety staff that are all removed from operations. The group is responsible for driver selection, communication, training, evaluation, accident investigation, management of the Accident Review Committees, and coordination of recognition programs. They also implement programs that apply safety standards, codes and legislation.

2. Driver Selection Process

A rigorous driver selection process was appraised highly by the judging team. Almost all companies specified a certain amount of experience, a limit to the number of accidents or incidents on a driver's abstract, the ability to understand spoken and written English, and a general cleanliness and manner of presenting oneself.

The companies that won top marks went beyond these types of requirements and won based on the procedures they use to select and hire drivers. This included such practices as involving experienced

drivers in the interview and road test stages of driver selection. In this case, all potential drivers are panel interviewed, with at least one existing driver on the panel. Road tests and pre-trip testing are done by senior drivers, a supervisor or someone from the safety department. Driving evaluations are conducted on a minimum of 1,000 miles by two or three different senior drivers.

Another company has a procedure whereby a new applicant is first interviewed by a member of senior management. The second interview is performed with the safety department, then testing and reference checks are completed. The candidate is interviewed a third time by another member of senior management.

Another applicant hires experienced drivers only. Their hiring criteria are in excess of regulatory requirements. They believe that communication of the job requirements is essential to ensuring a good fit. Interviews are conducted with a branch manager, supervisor or another driver.

Another companies reduces its risk to new drivers through their "promote from within" ethic. The company only hires package delivery drivers from outside, because the long haul drivers are promoted up. Applicants are tested before they are interviewed, then are interviewed first by Employee Services and then by Operations Management. After the road test is passed, the driver is hired.

3. Training and Driver Supervision

Companies that excelled in this category provide clear, open communication throughout the career of their drivers. Again, the involvement of the drivers also contributed to high marks.

One company provides training sessions four times per year which are approximately 3-4 hours in duration. Drivers are met with

individually to review log books and to discuss any current problems. These sessions are intended to act as corrective action, but also to provide support. In the case of an accident, the session can take the form of re-evaluation on the road and further development in class. Supervision is done by the dispatch supervisor, although when operational problems arise, the terminal manager becomes involved.

Another company provides the initial training in an orientation training session. Drivers are also provided with product stewardship training for the materials they haul. The training material is compiled with input from teams of drivers. The Driver Observer / Enhancer is used for training and for performing refresher rides. Post accident training is provided. Many generic driver training packages are used, such as Professional Driver Improvement Course, Transportation of Dangerous Goods, WHMIS, first aid, fire extinguishers, and defensive driving training. This company also offers a fatigue management program. Tachographs or on-board computers are used to monitor hours of service.

4. Accident and Risk Management

The winning companies reported a multi-faceted approach to accident and risk management. They see this component as an all-encompassing initiative that extends from driver selection, driver training, accident review and communication, and even the sale of the carrier's services.

One finalist manages risk through training programs, documented maintenance standards that exceed Ministry standards, equipment audits and an accident reporting procedure that determines preventability and establishes corrective action.

Another company reviews accidents to determine if further issues can be resolved and the findings are used in training. An Accident

Review Committee is made up of two drivers and two managers. This committee uses the standards established by the National Safety Council to determine accident preventability. The company offers profit sharing and a safe driving bonus as incentives for careful driving habits. The company monitors driver abstracts, logs, CVORs and U.S. Carrier Profiles. They also use a preventative maintenance program to manage risk.

Another company believes that risk management begins with the sale of a service. A full understanding of the products being handled, equipment requirements, driver training requirements, loading and unloading equipment, drivers' personal protective equipment and preferred routes is essential. In event of an accident, an emergency response contingency plan is used. Investigations are completed on all accidents and Region Safety Managers audit all elements of branch safety and communicate the results up the chain of command. A Field Support System provides information on drivers, equipment and customers, and is used to monitor regulatory compliance.

Another company captures statistical data by operating centre, division and district. Conference calls are held weekly to review safety issues and monthly reports are distributed and made available on the intranet site. A computer program is used to analyze trends and provide up to date safety information. Pre-work communication meetings are held between drivers and supervisors and includes at least one safety tip. One meeting per week is dedicated to safety issues. This company ensures equipment is safe through their preventative maintenance program and through driver pre and post trip inspections. A computerized system monitors the equipment and maintenance requirements.

5. Measurement of the Success of Safety Programs

This part of the award is intended to determine whether companies really know how effective their safety programs are. If results are not measured, then how is management to know how useful the initiatives are? How can safety be improved without some benchmark of accident frequency, cost and the impact on staffing? At the very least, the measurement of the success of safety programs provide justification for the cost of implementing the program, and can be used to request more safety initiatives.

One company uses a point system for safe driving habits. Demerit points are assessed for preventable vehicular accidents, while merit points are earned for safe driving and /or taking PDIC courses. Monthly frequency reports of accidents and injuries are sent to all management and posted for drivers and workers.

Another company measures the success of their safety programs in five different ways: the company insurance loss ratio, CVOR, US DOT Carrier Profile, WSIB Claims, and driver retention. All measures are well below the standards of acceptable loss.

Key Findings of the Award Program

A common theme among all the winners in this contest (as in last year) was the involvement of employees and a strong communication strategy to disseminate safety information. Ensuring that all policies are clearly written, processes are well defined, and all employees are informed encourages safe practices and accountability for safety. Allowing input and participation from all levels of employees, and in particular the drivers, ensures ownership and buy-in in the programs and promotes a sense of pride in the company.

Other Effects of Safety Programs

To a bottom-line oriented manager or owner, all of this sounds great, but what does it cost and what are the financial benefits? Safety programs can cost whatever amount a company is willing to spend. Even small scale safety programs can offer some degree of benefit. The benefits are increased profit through lower costs, improved driver and customer loyalty, and improved public perception.

Lower Costs

The cost of safety initiatives is somewhat difficult to measure because of the blurry line between operating efficiently and operating safety. At what point is the cost of maintaining equipment a safety issue as opposed to sound operating practice? Everyone agrees that proactive maintenance is a cost effective way of running a company, but at what point does the effort exceed normal operating procedures. There is no universal answer to these questions.

The initiatives that were outlined in the award submissions included:

- Safety programs including training, communication, etc.
- Awards and bonuses for safe driving
- Safety management salaries
- Some portion of hiring costs
- Some portion of maintenance costs
- Time taken to spec new equipment
- Added equipment to increase safety (i.e. specialized bumpers for animals, fog lights, etc.)

The cost of training includes more than just the cost of the course. It also includes the wages of the drivers for that period of time that they are being paid but are not out on the road, the facility, and any miscellaneous and preparatory costs.

The companies we surveyed reported spending anywhere from $20,000 to $100,000 per year on awards ceremonies. These events included such things as company barbeques where spouses and children are invited, to full scale dinner and dance celebrations. These programs can be customized to the size of the company and the resources that management wants to dedicate.

Comparatively, the costs to operate unsafely include:

- Liability
- High insurance premiums
- Cost of loss and damage to equipment
- Cost of loss and damage to freight
- High repair costs opposed to preventative maintenance
- Downtime for equipment
- Rental of equipment to replace equipment that is being repaired
- Possible price discounts for late freight
- Drivers' wages for excessive down time (ie. Broken down on the side of the road)
- WCB implications
- Increased fuel costs for a vehicle operating at sub-standard conditions
- Cost of replacing drivers who leave the business after an accident
- Retraining those drivers who do choose to stay
- Cost of replacing customers that choose to switch carriers
- The cost of a life in the case of fatality accidents

For some companies, the cost of investigating accidents alone can run between $100 - $200k annually. This includes the cost of conducting fact finding exercises, suspending drivers from work, communicating the results of the fact finding, and the corrective actions required, such as retraining.

Although it is difficult to assign prices to any of these initiatives or lack thereof, it is intuitively obvious that the cost of operating safely far outweighs the costs associated with an unsafe operation. All safety managers that we spoke to would agree with this statement.

More Loyal Staff

While this measure is also difficult to put a dollar figure beside, staff loyalty is important to the profits of a trucking company. One company predicted that it costs approximately $5,000 U.S. every time a driver leaves. This includes the costs of hiring and training a new employee to replace the displaced driver, as well as the downtime between employees.

Many applicants to the CTA / Royal & SunAlliance Fleet Safety Award program stated that driver turnover is a measure of the success of their programs. The level of effort expended in driver selection and driver training is a testament to the level of importance attributed by management.

According to the Canadian Trucking Industry "Human Resources Challenges and Opportunities" sector study update performed in 1997, driver turnover is a concern in the industry. Although the study uncovered conflicting reports of turnover rates, the results of a survey indicated that 37% of respondents reported 5-25% turnover and 14% reported more than 26% turnover.

Drivers were surveyed to determine their reasons for leaving, which included:

- Dissatisfaction with the hours of work away from home,
- Low pay
- Problems in company relations.

Drivers were also asked what incentives would encourage them to stay at their current company, and answers included:

- Good working conditions
- Improved salaries and benefits
- Regular hours of work
- Availability of good equipment
- Good working relations.

Although drivers rate hours, pay and relations as reasons for leaving, they quote safety related issues as reasons they would stay. So although safety initiatives alone may not cause a driver to leave, it may prevent him from leaving.

Of the companies surveyed for this paper, 57% felt that safety is extremely important to driver turnover. The remaining 43% felt that safety is "important" to driver turnover. This reflect the same belief that other factors including time away from home and pay contribute more towards driver turnover.

More Loyal Customers

The loyalty of customers was also quoted as a measure of the success of safety programs in the CTA / Royal & SunAlliance Fleet Safety Award. Indeed, the fact that companies apply for awards is indicative of the importance they place on the ability to advertise an award winning dedication to safety.

The importance of safety to customer retention is a harder to measure because the type of product hauled adds variability to the answers. Of those companies that answered this question, 50% felt that safety is extremely important, 25% belief that safety is very important, and 25% felt that safety is important. Many respondents indicated that for some goods (for example chemicals, natural gas and other dangerous goods) the company's safety rating will be more important

to the customer. Other companies may still be looking to the lowest cost service provider with little or no consideration for the safety practices of the company.

However, safety managers felt that if a trucking company was involved in an accident, and particularly a fatality or injury accident, customers may choose to take their business elsewhere. The general perception is that safety is only moderately important to customers until it hits the news or until questions of liability are raised.

Positive Public Perception

The question of the importance of safety to public perception follows the logic of the importance of safety on customer retention. Trucking company managers are well aware of the unfairness of a system that reports accidents without reporting award winning safety programs.

Until a company receives bad press, public perception is not an important consideration. However, a well publicized crash can cause a company to lose customers, drivers, and therefore profit. In fact, some accidents can cause a company to go out of business due to lack of confidence and an unwillingness to partner with a company with a bad public reputation.

Because of increased enforcement of maintenance, public perception is much more important because companies are forced to take responsibility. The public is also much better informed than they once were. Organizations such as CRASH help to keep public awareness of unsafe operations high.

Increased Profit

Profit is the difference between a company's expenses and revenues. Those things that help to decrease expenses and increase revenues are

the drivers of profit. Do safety initiatives increase profit? I would argue that they do.

Expenses are lowered through rigorous hiring practices, efforts to keep those employed drivers loyal to your firm and maintaining equipment before expensive repairs are necessary.

Revenues are increased by maintaining a loyal customer base and positive public perception. It costs much more to obtain new customers than it does to maintain long standing customers. Negative public perception can cause customers to leave, inspectors to become unfairly burdensome, and regulators to implement new, ineffective regulations.

Conclusion

The CTA / Royal & SunAlliance Fleet Safety Award program recognizes trucking companies who operate safely. They are given the opportunity to demonstrate their high standards in operational safety and to be rewarded and recognized for that effort. The submissions have shown us that significant efforts are being extended in the realm of safety. We have shown that these efforts are cost effective and, in fact, can contribute to the profits of progressive trucking companies.

Bibliography

Canadian Trucking Human Resources Council, "Canadian Trucking Industry Human Resource Challenges and Opportunities – Sector Study Update", The Trimension Group, 1997.

KPMG, "Canadian Trucking Alliance and Royal & SunAlliance 1998 National Fleet Safety Award Contest Final Report", Bowland, Jan and Shannon Dykstra, December 9, 1999.

KPMG, "North American Trucking Industry Survey: Key Indicators and Best Practices", September, 1997.

PriceWaterhouseCoopers, "Alberta Economic Development: Alberta Trucking and Bus Review, April 14, 1999.

CTRF Proceedings, "Truck Safety: Assessing the Impact of the National Safety Code", Fred Nix, 1999

Crashes in Construction Areas Derived from a Case Study

Richard A. Raub, Omar B. Sawaya, Joseph L. Schofer,
Athanasios Ziliaskopoulos

1. Introduction to Workzone Safety

Analysis of workzone traffic crashes traditionally has depended upon historic data generally maintained in central government crash files and rarely has been based upon examination of the actual reports. More importantly, researchers have depended upon general "investigation" of the crash. The problem with this approach has been, and will continue to be, that most police investigation is perfunctory and done to meet a statutory requirement that an official report be filed. Except where there are dedicated crash investigation teams, such reporting is not directed toward discovering and eliminating causes.

The problems arising from police crash reporting are well documented in the literature (Cromack and Barnewell 1978; Hargroves and Hargroves 1981; Hauer and Hakkert 1988; Pfefer, Raub, and Lucke 1993; O'Day 1993, and Raub and Sawaya 2000). Generally, reports provide relatively accurate information about dates, times, number of vehicles involved, and weather conditions, but increasingly less accurate data in terms of injury severity, manner of collision, vehicular damage, location, and (near the bottom) contributing circumstances. This creates a situation in which researchers attempting to use these reports, especially to identify cause and location within a workzone may have very limited valid data from which to make judgement. Drawing conclusions about what occurred in the workzones, especially where in the workzone and the contributing cause can be problematic. Work by Hall and Lorentz (1989), Nemeth and Rathi (1983), and Richards and Faulkner (1981) had used these "contributing circumstances," especially vehicle speeds within the working area, to establish corrective actions.

However, Wang, *et al.* in 1990 questioned what was really known about construction zone crashes, and the Nemeth (1990) case study of crashes in Ohio workzones complimented the findings. For example,

Nemeth suggested that driver maneuvers rather than speed were the primary contributor.

2. Basis for Study, Illinois Workzone Crashes

Building on the work by Nemeth, the authors developed a two-step approach to recording traffic crashes in workzones. First, they designed a short, check-off supplemental report to be completed when the police prepared a crash report. They provided detailed instructions for police to collect data at selected workzones. Most importantly, the authors in conjunction with police management, stressed the need to collect data from all four portions of the workzone: approach, transition, construction area, and exit. Further, they were to collect the data regardless of work in progress. Reports, received from the participating agencies were reviewed as received and, when needed, advised police management of problems. However, most of the reports appeared complete, and given a comparison of narrative and diagram with the other reporting elements, appeared reasonably accurate and precise. The analyses using these specially reported crashes showed far different results than available from the workzone crash data made available from the State of Illinois, in part, because the historic data had many quality deficiencies.

This paper identifies where crashes appear most likely in workzones, their severity, and most importantly, examines contributing circumstances. While the latter depended upon police reporting, the work of these officers was being reviewed initially by their commanders and then at the researcher level. The feedback available from the field suggested that those officers participating had made a concerted effort to provide their best estimates based on at-scene observations and interviews.

Through the use of on-site observations and videotaping, the authors also attempted to identify motorists' behavior which may have led to the crashes. The results of this work is coupled with the findings from the crash reporting.

3. Summarizing Workzone Crashes with Supplemental Reporting

3.1 Crashes reported

The supplemental form which accompanied the Illinois Police Crash Report (PCR) provided more information about crashes occurring at a

select number of sites in the north and western portions of the State in 1998 and 1999 than would have been available from the PCR itself. Police reported 110 crashes at seven sites; however, in their opinion, the workzone played a role only in 103 of them (for example, a crash caused by a sleepy driver running off the road would be excluded). Nine of the crashes occurred on 4-lane state numbered arterial roadways; the remainder occurred at five Interstate locations.

On the form, the reporting officer was asked to indicate where in the workzone (using a diagram from the back) the crash occurred based on four locations: approach, taper, construction area, and exit. The officer also recorded the distance from the end of the taper. Each officer also recorded one or more elements of the environment, and one or more actions by the drivers that contributed to the crash. Finally, the police agency completing the supplemental report also provided a copy of the PCR. Both the crash reports and accompanying forms provided the basis for the analysis reported in this section.

3.2 Description of crashes

Data taken from the 103 specially prepared reports were compared to those reported to the state in 1994 and 1995 (the latest complete set of data available at the time of the study). As had been discussed by Raub and Sawaya (2000), police coding of crash reports which had been used in the database had numerous errors. The most significant one was that the police did not always code a crash as workzone related, even though it had occurred within a workzone. In some of the workzones selected for that study, as few as 15% of crashes occurring were coded properly.

As shown in Table 1, crashes reported in workzones from the 1998 and 1999 "special reporting" were less severe than those reported from the 1994 and 1995 data. The 22.3% of the crashes reported as injury producing was similar to the percent from the State database on similar types of roadways when there were no workzones. With the exception of Hall and Lorentz (1989) findings for New Mexico, all other studies of crash experience in workzones have shown them to be more severe than when the zone was not there.

Some cross tabulations were performed to describe the crashes in greater detail. In Table 2, approximately 60% of the crashes occurred

Table 1
Differences in Workzone Crash Severity, State Database and Special Reporting

Severity		1994 Non-WZ	1994 WZ	1995 Non-WZ	1995 WZ	1998/9 Special Reporting
Fatal	Frequency	1,369	26	1,376	26	0
	Percent	0.3%	0.3%	0.3%	0.4%	0.0%
Injury	Frequency	97,233	2,575	97,328	1,982	23
	Percent	21.8%	33.2%	21.4%	31.9%	22.3%
PDO	Frequency	346,544	5,148	357,114	4,198	80
	Percent	77.8%	66.4%	78.3%	67.6%	77.7%
Total		445,146	7,749	455,818	6,206	103

within the working area, 22% on the approach, and 17% in the taper (one crash was recorded as having occurred in the exit area). Those crashes outside the working area were substantially more likely to result in a injury than those within the zone; however, the chi square test of differences was not significant. This injury percentage, even though obtained from a small sample, mirrors the percentage computed when adjustments were made to the Illinois 1994/5 data to account for crashes obviously occurring within active workzones but not recorded as such.

Only one pedestrian was involved, and he was a motorist who had exited his vehicle in the approach area. This also is contrary to the findings from other studies of workzone crashes.

The most frequent manner of collision, overall, was rear-end followed by sideswipe, both vehicles traveling in the same direction (see Table 2). The rear-end collisions happened significantly more frequently than even those reported as workzone crashes in the State database. Collisions with objects, on the other hand, closely agreed with statewide percentages, and both were substantially lower than findings from other research. Limitations to the sample, and the fact that it involved all four-lane, suburban or rural roadways without intersections would affect the types of collisions recorded.

Within the work area, the largest percentage of crashes were rear-end. This manner of collision was over-represented in the working area

Table 2
Workzone Crashes (Special Reporting) by Severity and Manner of Collision

Location in Workzone	Severity			All Crashes	
	Injury	PDO	Injury as Percent	Freq.	Percent
Approach	7	16	30.4%	23	22.3%
Taper	5	13	27.8%	18	17.5%
Work Area	11	50	18.0%	61	59.2%
Exit	0	1	0.0%	1	1.0%
Total	23	80	22.3%	103	
IDOT Data (1994 and 1995) % Injury			33.5%		

Location in Workzone	Manner of Collision (selected)				
	Pedest.	Object	Rear-end	Sidesw.	Other
Approach	1	1	15	5	1
Taper	0	0	4	13	1
Work Area	0	10	39	8	4
Exit	0	1	0	0	0
Total	1	12	58	26	6
Percent of Crashes	1.0%	11.7%	56.3%	25.2%	5.8%
IDOT Data	2.2%	15.8%	33.1%	8.0%	16.7%

with 39 of 58 (67%) of the crashes represented. Given the narrower lanes, and "Jersey" type concrete barriers, there was no escape. However, rear-end collisions also occurred approximately as frequently in the approach. Sudden, and unexpected slowing of vehicles for the queue formed as a result of merging traffic probably was the most likely contributor.

In the taper, the most frequent crash was sideswipe, same direction with 13 of 18 (72%) occurring. Improper merging likely would account for most of the crashes recorded.

Because precise location within the workzone is not available from statewide data, this analysis is the first time distinctions can be drawn between the specific sections of the construction zone.

3.3 Contributing factors

3.3.1 Work and no work in progress. In addition to locating the crashes, reporting officers completing the special reports were asked two questions:

1) Was activity in progress within the construction zone when the crash occurred, and
2) Could changes have been made to the design or traffic control devices that might have helped prevent the crash?

In 60% of the crashes reported, no work was occurring at that time. When there was no work in progress, the collision most often occurred outside of the working area and was a sideswipe. On the other hand, rear-end crashes were significantly higher when work was in progress. Injuries were equally likely to occur whether work was in progress or not.

The officers checked "changes needed" in 15% of the crashes, but no follow-up was made of what changes the officer believed important. Although the Resident Engineer (RE) in charge of the project also should be identifying needed changes based on reports of crashes, the investigating officer is aware of conditions present at the time of the crash which might not be known to others. Therefore, the officer's recording of needed changes and providing this with a copy of the PCR to the RE could be useful for identifying potential corrective action.

Most of the time a change was recommended, the crash also occurred within the work area. In any future supplemental reporting, the officer should be asked to state what changes could be made, or the officer contacted later for his or her recommendation.

3.3.2 Driving environment. Reporting officers were asked to indicate, based on their assessment of the crash, which elements from a list related to the driving environment may have contributed to the crash. They also were asked to indicate contributing driver actions. In each crash, the officer could check more than one element and action.

The average number of environmental elements checked was 1.1; an average of 1.5 driver actions were indicated.

Of the 114 indicated contributing elements, 24% (27) were the lack of escape (Table 3). Interference from traffic control devices (TCD), narrow lanes, and construction activity each accounted for approximately 12%. The category of "other" represented a wide variety of elements. Most frequently indicated was "stopped traffic."

Table 3
Contributing Elements to Crashes (External)

Contributing Elements[1]	All Crashes	Severity of Crash		Location			
		Injury	PDO	Apprch	Taper	WZ	Exit
Interference							
TCD	13	2	11	6	0	7	0
Activity	14	3	11	0	2	12	0
Constr. Equip.	5	2	3	1	1	3	0
Obstructed View	7	0	7	0	3	4	0
TCD Problem	6	1	5	0	1	4	1
Pavement	6	1	5	0	0	6	0
Narrow Lanes	14	6	8	1	5	8	0
No Escape	27	6	21	4	6	17	0
Other	22	7	15	9	4	9	0
Total	114	28	86	21	22	70	1

[1] Police could check one or more contributing elements

3.3.3 Driver actions. Police checked 152 driver actions that contributed to the crash (Table 4). Stopping or sudden slowing was checked 38 times or 25% of all crashes. Second most frequently checked was "following too closely" 16% of the time. Both of these actions should have been indicated given that as many as 68% of the crashes were rear-end which results from the interaction of these two driver actions. Failure to yield and distractions from within the vehicle accounted for 13% and 11% of the driver elements. On the other hand, excessive speed (above the speed limit) was checked only 4 times; once in the working area and three times outside. This action represented 3% of all contributing driver actions and was substantially lower than reports

from most other researchers except the case studies by Ha and Nemeth (1995). Yet of the 54 citations issued for crashes (of the 103 crashes recorded), the violation was "speed too fast to avoid an accident" (ILCS 11-601a) which would has been interpreted as "speeding" elsewhere. These findings from driver actions may have implications for how enforcement should be performed.

Table 4
Contributing Driver Actions to Crashes

Driver Actions[1]	All Crashes	Severity of Crash		Location			
		Injury	PDO	Apprch	Taper	WZ	Exit
Sudden Slow/Stop	38	10	28	7	4	27	0
Drive Outside Lane	9	1	8	5	2	2	0
Improp. Lane Chg	13	2	11	3	5	4	1
Failure to Yield	19	2	17	1	11	7	0
Exceed Speed Lim.	5	2	3	1	1	3	0
Exit Behavior	1	0	1	0	1	0	0
Following Too Close	25	6	19	6	1	18	0
Improper Approach	2	0	2	2	0	0	0
Distract Inside Veh.	17	8	9	6	2	10	0
Alcohol/Drugs	1	0	1	0	0	1	0
Vehicle Defect	3	1	2	0	1	2	0
Other	19	2	17	3	0	15	0
Total	152	34	118	34	28	89	1

[1] Police could check one or more contributing elements

3.3.4 Drivers. Some data also were recorded describing the at-fault drivers involved in crashes (traditionally the first listed driver on the crash report). Male drivers were involved in almost 70% of the crashes and were significantly over-represented. Based on data from the State database, male drivers were the at-fault driver in 56% of all crashes. Likewise, 42% of the at-fault drivers statewide were ages 26 to 65 as opposed to 52% of the at-fault drivers in the workzone crashes, the latter over-represented. More importantly, this same age grouping was responsible for 70% of the workzone injury crashes, but only 52% in all injury crashes statewide.

In terms of involvement in crashes by location within the workzone, drivers 66 and older were at fault 12% of the time in those collisions

occurring in the approach and the taper as opposed to 9% overall (which also is approximately twice the rate for involvement by this age group in statewide crashes).

Crashes involving three or more vehicles occurred approximately 18% of the time. This is 2.5 times the percentage of such crashes statewide, and even 150% more than had been reported using the workzone crash reports contained on the IDOT database. Moreover, when crashes involving three or more vehicles occurred they were twice as likely to result in an injury than crashes involving less vehicles. On the other hand, single-vehicle crashes were under-represented in the special workzone crash reporting.

4. Driver Behaviors

Given that 40% of workzone crashes occurred in the approach and transition, and that they were more likely to be injury producing, the project team filmed driver behaviors at three of the locations for which the special crash reporting had been done. More than 4 hours of film were taken during periods of congested conditions when queuing was occurring. From the videotaping, the authors established and measured several classes of driver behavior both in the merging and through lanes.

Table 5 shows for the videotaped sites the percent a given behavior was observed. The behaviors were classified as those from drivers of merging vehicles (in the closed lane) and those in the through (open) lane. Specifically, five separate classifications were employed for the merging drivers:

a. Early merge (early enough that no apparent slowing of traffic occurred); this was considered the normal or "safe" pattern.
b. Mid merge (into the queue of the through lane, but not near the taper - at least 100 meters prior).
c. Late (immediately before or into the taper).
d Forcing (more than one driver attempting to enter the same gap in the through lane).
e. Using shoulder (moving to the shoulder to pass others and then merge at a later point)

Note: behaviors d. or e. were used instead of a. through c.

Table 5
Driver Behavior Classification

Behavior Type	IL 120 – 1st Visit	IL 120 – 2nd Visit	Inter-state 94	Dundee Rd
Merging Vehicles				
Est. Merging Volume (%)	19.9%	16.5%	47.8%	30.3%
a. Early	48.7%	55.6%	53.7%	17.1%
b. Mid Merge	41.7%	29.0%	5.8%	12.2%
c. Late Merge	9.2%	14.5%	40.3%	65.8%
d. Forcing Merge	0.4%	0.9%	0.2%	4.9%
e. Using Shoulder	0.0%	0.0%	0.0%	0.0%
Through Lane				
a. Normal Behavior	98.2%	97.1%	90.9%	94.6%
b. Vigilante	0.6%	2.9%	2.7%	1.8%
c. Failure to Yield	1.2%	0.0%	6.4%	3.3%
d. Stopping in Lane	0.0%	0.0%	0.0%	0.3%
Rapid Approach to the Merge or End of Queue	0.9%*	4.8%*	4.9%*	0.3%*
Flow (vph)	**1,300**	**1,300**	**1,800**	**1,800**
* Percent of all vehicles approaching merge				

Those in the through lanes were given four classifications:

a. Normal (allowed alternate merge when another driver attempted the merge).
b. Vigilante (the driver who does not allow merging vehicle to move to the head of the queue).
c. Failure to yield (failing to provide a gap for a merging vehicle).
d. Stopping in lane (stopping to allow one or more drivers to merge).

Finally, one behavior applied equally, and in addition to those in both the through and merging lanes, the driver who approached the end of the queue at an apparent high rate of speed. These actions were noted more often in the merging lane.

4.1 Merging traffic

4.1.1 Early merging. An early merge generally occurs without any noticeable interruption of the traffic flow. Under conditions where no

queue exists (or at the minimum, one consisting of two or three vehicles in the through lane), most drivers have been observed to merge early. However, as the traffic volume increased (and queues lengthened), the percent decreases, especially on the four-lane arterial roadway, IL 68.

4.1.2 Mid merge. The term "mid merge"was given to those drivers who tended to wait before merging, but who did so prior to the start of the taper. They had completed their merge by the beginning of the taper. However, their merge was made at very low speeds and into a gap that opened for them in the through lane. This type of merging behavior causes interruptions to the traffic flow, but normally only to the through lanes.

Mid merge along with early merging when a queue has formed in the through lanes allows other drivers to proceed to the merge point. The net effect is that often two or more vehicles merge for every vehicle in the through lane. Both Pesti, *et al.* (1999) and the Orth-Rogers report (1995) suggest that the net result of such multiple merging behavior is a reduction in maximum flow through the merge point which would translate into increased delays.

4.1.3 Late merge. This is the driver who may complete the merge as late as the transition from the taper to the construction area delineation. Often, the driver appears to be making a gap and then entering. Under saturated conditions, the late merging driver may improve flow provided that alternate merging takes place (see also Pesti's work). However, when motorists in the through lane fail to create a gap it causes the merging vehicles to stop. The impact on the system can be added delays along with additional rear-end and sideswipe same-direction crashes.

The higher volumes such as found on IL 68 probably are more likely to encourage use of the available capacity near the merge because the drivers might believe that the geometrical characteristics on such a road allow them to negotiate the late merge easier and safer than it would be on other types of roadways. Late merging could be prevented using physical obstructions such as concrete barriers. Such measures, however, can migrate the problem further upstream or increase the number of vehicle collisions with objects.

Late merging probably cannot be eliminated. Two approaches can be taken. The first is to reduce or eliminate it through a traffic control plan modeled after the "Indiana merge." Here, motorists are prohibited from passing queued vehicles.

However, as recent work by Pesti suggests, late merging may improve the flow through the transition area. Their work in Pennsylvania showed an increase of approximately 300 vehicles per hour when signs directed motorists to alternate merge at the taper. Further testing of both the Indiana and Pennsylvania approaches is needed.

4.1.4 Forcing merge. This behavior occurs when two vehicles in the merging lane attempt to enter the same gap opened in the through lane. The second driver is forcing an opening rather than waiting for the next gap (or alternate merge). When this behavior was observed on film, both the merging lanes and the through lanes came to a halt. This has a significant effect on delay. By requiring alternate merge, this behavior then falls under an enforceable action.

4.1.5 Using shoulders. Use of the shoulders for passing occasionally is observed. It can cause significant disruptions to both lanes along with creating a danger to any motorist who decides to pull off to the shoulder. Placing cones or barrels along the shoulder, especially near the head of the merge would help eliminate this behavior where it is observed. It too is subject to police action.

4.2 Through Traffic

4.2.1 Vigilante behavior. The vigilante drivers cooperate with the warning signs and move to the through lane, but out of frustration or "civic duty," place their vehicles in the middle of the two lanes to prevent any vehicle in the merging lane from overtaking them. Drivers of semi-trailers often travel side-by-side, The result of this behavior, which is frustrating to others, may lead to aggressive driving including passing on the shoulder, and potential crashes inside or at the end of the workzone.

Such behavior might happen less frequently if alternate merging was required and posted. However, vigilante behavior is a violation of traffic law, and given its potential to aggravate other drivers, needs to be controlled through education and enforcement.

4.2.2 Failure to yield. Failure to yield to merging traffic exhibits aggressive behaviors which also have negative effects on the traffic movement. As seen in the videos, as long as the merge is continuous, even with drivers merging at the taper, traffic tends to flow smoothly. Failure to yield has a result similar to the driver who forces a merge. Stoppage occurs, especially in the through lane, and is for a longer period than what would have occurred had each driver shared the

merging. Requiring and posting alternate merge should help reduce some of this behavior.

4.2.3 Rapid approach to end of queue and to the merge. Drivers who rapidly approach the end of the queue are disregarding early warnings to reduce speed, and may be unaware of the exact location of the end of the queue because of sight distance limitations. Fortunately, as was shown in Table 6, these extreme behaviors requiring evasive actions were observed very rarely elsewhere.

Providing the drivers with visual information on the conditions ahead might encourage them to follow the warning sign recommendations. One method could be to provide large screen displays to traffic conditions in the merging area, especially if that merging area is blind to the approaching driver. Also, enhanced enforcement of speeds in the approach could be beneficial, especially if coupled with the use of variable speed limit signs.

5. Conclusions from Analysis of Crashes and Driving Behavior

The above analysis suggests several promising approaches. First, the narrow lanes and lack of escape are serious problems. Yet, this configuration is most likely to occur at locations where there is a need to maintain as much capacity as possible. What probably can be done is to provide escape off-travel-lane spaces wherever possible (which also can serve to get disabled vehicles off the roadway).

On higher speed roadways such as the rural Interstate system which also carry high truck volumes, a reduction in lane width after the merge may be a dangerous practice. Truck drivers who merge at the last moment may need more road width than the 3.3 meters often used in the working areas.

An examination of the narratives on the crash reports suggested that a possible contributor to crashes occurring in the approach and taper were higher speeds. Although the driver may have been within a commonly accepted tolerance for the given speed limit, e.g., 10 kph faster in a 105 kph zone, the speed limit itself may have been too high leading up to the zone. Given that approximately 40% of the crashes in this study occurred on the approach and taper, more specific attention needs to be given speed at these locations. However, reducing the speed limit without providing an external stimulus for the motorist to slow, the likelihood of the decreased limit being obeyed may be low (Graham,

Migletz, and Harwood 1993). Additional attention can be given to other traffic calming devices.

That older drivers are also more likely to be involved in collisions in these locations may suggest a need to provide better guidance for the motorist approaching and entering the taper. Lastly, the large number of sideswipe collisions apparently resulting from failure to yield in the taper indicate a need to better understand merging behavior and why it leads to harmful consequences.

This refusal to merge is an important issue. It not only sets the stage for crashes at the merge itself, but may lead to irritation or anger on the part of the "harmed" driver. Current research directed toward aggressive driving is suggesting that anger often plays an important role in dangerous driving behavior. It also suggests the possibility of requiring alternate merge (including signing establishing such requirement) backed by adequate enforcement.

Giving more attention to driving behavior and speed outside the working area appears contrary to the prevailing workzone traffic control philosophy, that speeds inside the workzone (and their enforcement) are the most important strategy for reducing crashes. Yet, given the lack of severity of crashes and the manner of crashes, enforcement within the working area may not be as effective as enforcement in the taper and approach sections.

The videotape captures the drivers' behavioral randomness under different types of merging conditions and traffic control devices. It shows that some drivers rely more on their judgement rather than on the TCD recommendations, while the majority of drivers comply with the recommendations. The outcomes suggest that more attention needs to be paid to the traffic control devices, their messages, how they are placed, and how they operate may be beneficial. Additionally, enforcement may also play a role, especially if 1) the behavior occurs frequently, and 2) the crash rate could be reduced where the contributions are not external factors.

6. References

Benjamin, T. E. A. "Les Systemes D'Information Sur Les Accidents: Resultats D'Une Enquete Effectuee Dans Treize Pays." 22-26. *Transport, Environnement, Circulation* 62 (January/February 1984).

Cromack, J. Robert, and George M. Barnewell. "A Critical Analysis of Traffic Accident Data."750916. Warrendale, PA: Society of Automotive Engineers, (1978).

Freeway Construction Work Zone Safety Enhancement Report . Philadelphia, PA: Orth-Rogers & Associates, Inc., (January 1995).

Graham, Jerry. L., James. Migletz, and Douglas. W. Harwood. "Procedure for Determining Workzone Speed Limits." *Compendium of Technical Papers, ITE 63rd.* 214-18. Washington, DC. Institute of Transportation Engineers, (September 1993).

Ha, Tae-Jun and Zoltan A. Nemeth. "Detailed Study of Accident Experience in Construction and Maintenance Zones." *Transportation Research Record 1509.* 38-45. Washington, DC: Transportation Research Board, (1995).

Hall, J. W. and V. M. Lorentz. "Characteristics of Construction Zone Accidents." *Transportation Research Record 1230.* 20-27. Washington, DC: Transportation Research Board, (1989).

Hargroves, B. T., and J. M. Hargroves. "Accuracy of Virginia Accident Data."VHTRC-82-R13. Charlottesville, VA: Virginia Highway and Transportation Research Council, (1981).

Hauer, Ezra and A. S. Hakkert. "Extent and Some Implications of Incomplete Accident Reporting." *Transportation Research Record 1185.* 1-10. Washington, DC: Transportation Research Board, (1988).

Nemeth, Zoltan A. *A Study of Accident Experience in Construction and Maintenance Zones.* Columbus, OH: Ohio State University, (December 1990).

Nemeth, Zoltan A., and Ajay Rathi. "Freeway Work Zone Accident Characteristics." 145-159. *Transportation Quarterly* 31, no. 1, (January 1983):

O'Day, James. *Accident Data Quality, National Cooperative Highway Research Program Synthesis of Highway Practice.* Washington, DC: Transportation Research Board, (1993).

Pesti, Geza, Daniel R. Jessen, Patrick S. Byrd, and Patrick T. McCoy. "Traffic Flow Characteristics of the *Late Merge* Work Zone Control Strategy." *Transportation Research Record 1657.* 1-9. Washington, DC: Transportation Research Board, (1999).

Pfefer, Ronald C., Richard A. Raub, and Roy E. Lucke. *Economic Analysis of Highway Safety Data.* DTFH61-91-C-00051, Evanston, IL: Northwestern University Traffic Institute, (January 1996).

Raub, Richard A. and Sawaya, Omar B. "Effects of Under-reporting Construction Zone Crash Data." *Preprint, Transportation Research Board Annual Meeting,* Washington, DC, (January 2000).

Richards, S. H., and M. J. Faulkner. *An Evaluation of Work Zone Traffic Accidents Occurring on Texas Highways in 19977.* 263-3, College Station, TX: Texas Transportation Institute, (July 1981).

Wang, Jun, Warren E. Huges, Forrest M. Council, and Jeffery F. Paniati. "Investigation of Highway Work Zone Crashes: What We Known and What We Don't Know." *Transportation Research Record 1529.* 54-64. Washington, DC: Transportation Research Board, (1996).

The Rural Elderly: Driving Patterns and Accident Involvement

Eric D. Hildebrand, Ph.D., P.Eng.
Benjamin Myrick, B.S.
Tanya Creed, B.Sc.E.

University of New Brunswick
Transportation Group
Fredericton, N.B.
Canada

1.0 Introduction

There have been a number of studies which explore accident rates and characteristics of elderly drivers as a whole, but there has been little research into the accident characteristics and travel needs of the rural elderly. This group is delineated since they have few transportation alternatives and would be most adversely affected by imposed restrictions on licensing. Several jurisdictions either have or are considering implementing relicensing/retesting programs for the elderly (CCMTA, 1999).

This paper focusses on the characteristics of rural drivers over the age of 65 in New Brunswick. This group of drivers is examined on the basis of driving patterns and accident rates. This paper's premise assumes that significant differences exist between those who reside in rural versus urban areas. Comparisons are made with younger rural drivers and urban drivers in the same age groups.

2.0 Background

In the near future, demographic trends in the Canadian population will result in significant increases in the numbers and proportion of elderly people. Statistics Canada projects that the number of Canadians age 65 and over will increase from 3.8 million to 7.8 million by 2026 (2000). The corresponding percentage of the population age 65 and over will increase from 12.4 percent to 21.4 percent in 2026.

Future elderly populations are also likely to include higher percentages of licensed drivers. The main reasons for this include cohort effects of greater percentages of licensed females, and a more car-dependent, suburbanized population. There are also indications that future elderly populations will be more dependent on driving and less likely to self-impose restrictions on their driving (Zhou 1997).

During the aging process, numerous physiological and psychological changes occur which impair a person's ability to drive safely. Vision is the most important sense used in driving. Aging drivers are likely to experience losses in acuity, depth perception, light intensity, glare recovery time, and field of vision. These changes make it particularly difficult for older motorists to drive at night. Loss of hearing and range of motion are also likely the be problems for older drivers. A loss in musculature also results in a greater probability of injury or death when the elderly are involved in accidents (Evans 1991).

As a result of psychological changes elderly people have a reduced capacity to process multiple stimuli. The elderly also tend to make decisions more slowly, which can seriously inhibit their ability the take emergency actions. Loss of memory is another characteristic of aging which can affect driving skills.

3.0 Study Scope

Data for this study came from three sources. The first data set included 1342 responses from a 1988 University of New Brunswick (UNB) Transportation Group survey. This survey provided detailed information on the travel behaviour of New Brunswick drivers. Accident information was made available by the New Brunswick Department of Transportation (NBDOT) who provided files of accidents from 1997 and 1998. The NBDOT Motor Vehicle Branch contributed a list of all registered drivers in the province.

Using the date of birth from each data set, drivers were divided into five age categories. Younger drivers were considered those aged 16 to 25. Early middle-age included those 26 to 45 years, and late middle-

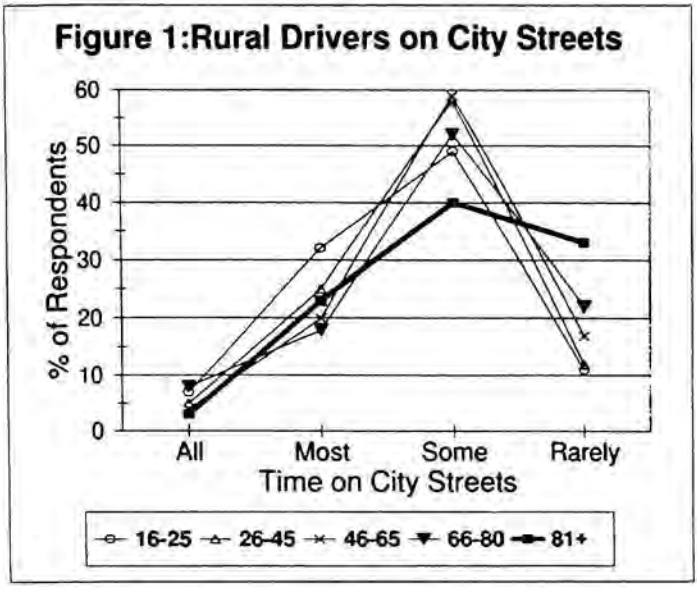
age covered ages 46 to 65. Although most studies define elderly drivers as those over 65, a fifth group was delineated for those over 80 to reflect dramatic changes in driving and accident patterns associated with the very old.

All of the data were divided into rural and urban categories based on postal code. The second character in a postal code is a number from "0" to "9". Codes with a "0" for this character indicate rural locations. Numbers from one to nine indicate urban locales of increasing size (Canada Post, 2000).

4.0 Driving Patterns of the Rural Elderly

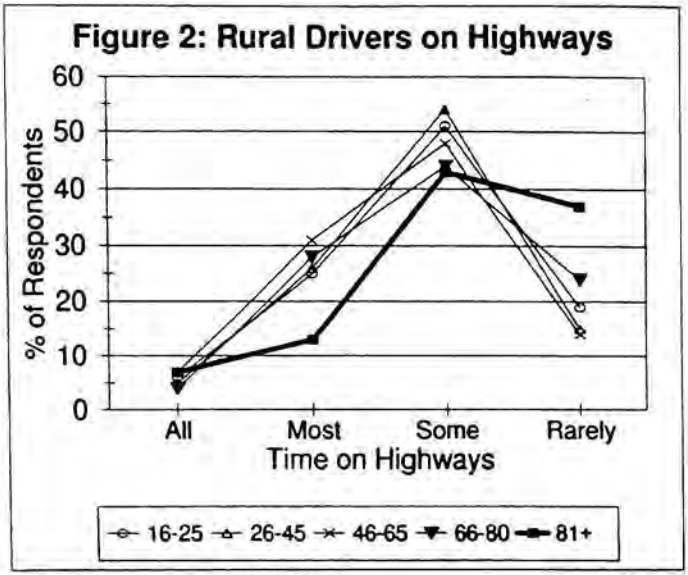
In the first part of this study, the driving patterns of rural residents were compared for the five age groups. Drivers were compared by exposure to city driving, exposure to highway driving, time spent driving after dark, and most common times of day driven. All of the data for these comparisons came from the UNB Transportation group survey. The purpose of these comparisons is to identify changes related to aging and to gain insight into true exposure to the risk of an accident (beyond simple mileage estimates). Although all survey responses are subjective, the results do provide insight into changes related to aging.

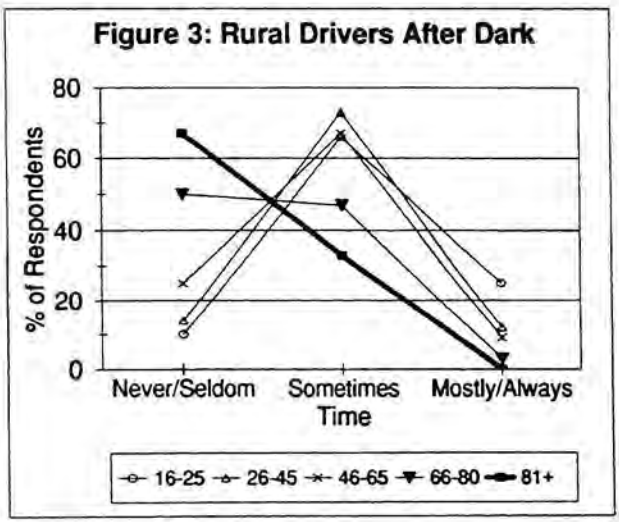
The frequency of rural residents' use of *city* streets was compared for all age classes. The results are presented in Figure 1. The results show similar usage between all age groups except for those over 80 years. A disproportionately large percentage of very old drivers indicated that they rarely use city streets. Drivers in the 66 to 80 age group were also slightly less likely to drive on city streets. This suggests that elderly drivers are recognizing deterioration in their skills and restricting their exposure to city driving. This is supported by evidence that older drivers are involved in a disproportionate number of urban context collisions including failure to yield the right of way and improper turning, and less involved in single vehicle accidents involving speed (Taylor 1994). This indicates that aging drivers will face greater hazards on city streets.



Rural residents' use of *highways* showed trends similar to the previous comparison. Results are presented in Figure 2. Interestingly, elderly drivers indicated an even greater aversion to highway driving, than to city driving. Older drivers (66 to 80) were significantly less likely to respond that they use highways 'most of the time', but were only slightly more likely to 'rarely' use highways. This analysis also illustrates that elderly drivers are self-imposing restrictions on their driving. Those drivers aged 66-80 years appear to make some adjustments to their highway use, but their adjustments are minor compared to those over 80 years.

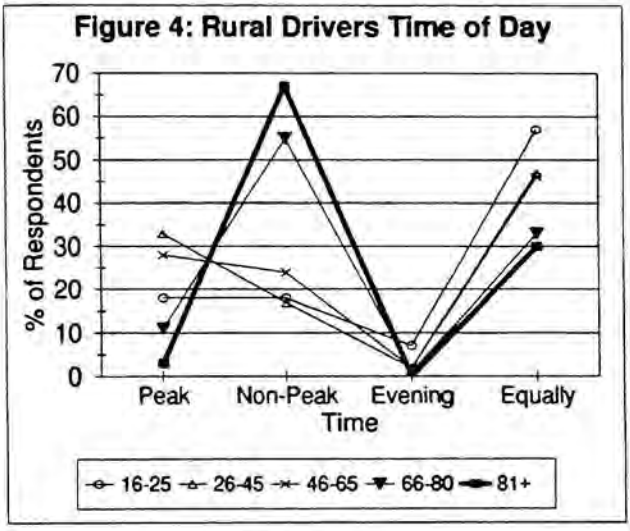
There were significant differences between age groups in their frequency of driving after dark. More than half of elderly drivers indicated that they 'seldom or never' drive after dark, and almost no drivers in these age groups indicated that they 'mostly or always' drive after dark. Elderly drivers were also less likely to drive after dark than older drivers. The results of this comparison are shown in Figure 3. Again, there are strong indications that elderly drivers are recognizing their limitations and adjusting their driving habits to compensate. In


Figure 2: Rural Drivers on Highways
60
50
40
30
20
10
0
% of Respondents
All
Most
Some
Rarely
Time on Highways
16-25
26-45
46-65
66-80
81+


Figure 3: Rural Drivers After Dark
80
60
40
20
0
% of Respondents
Never/Seldom
Sometimes
Mostly/Always
Time
16-25
26-45
46-65
66-80
81+

the case of driving after dark, the age group 66-80 years differs from younger groups more significantly than in previous comparisons.

Figure 4 presents a comparison of the differing amounts of driving undertaken by each age group according to the time of day. Not unexpectedly, a majority of elderly drivers indicated that they drive primarily during off-peak periods. This may be largely a function of retirement rather than any conscious decisions made by drivers. By avoiding peak traffic, older and elderly drivers are also reducing their risks of collision. Despite this reduced risk, Taylor found that the distribution of accidents shift from single to multi-vehicle collisions as drivers age.



Based on the preceding comparisons, it is possible to draw some conclusions about how elderly rural drivers behave compared to other age groups. Older rural drivers do not demonstrate characteristics which are substantially different from younger age groups. The younger elderly group (66-80) of rural drivers are nearly as likely as younger drivers to venture onto urban streets and highways. They do

differ from younger age groups in that they are more likely to drive during daytime and non-peak hours. Both of these distinctions should work to offset risks caused by deterioration of driving skills.

The older elderly group (81+) of rural drivers differs substantially from all other age groups. They are less likely than other groups to expose themselves to city and highway driving. Substantial majorities of elderly drivers also avoid driving during peak hours and after dark. Clearly, there is a propensity among rural drivers to lower their exposure to difficult driving conditions. These results are consistent with surveys in which elderly drivers indicated increasing difficulties with intersections, turn movements, and vision after the age of 65 (Bishu, 1991).

5.0 Comparison of Travel Behaviour Between Rural and Urban Elderly Drivers

The driving behaviour of elderly rural drivers was compared with the behaviour of urban drivers in the same age groups. The purpose of this exercise was to identify any substantial differences between the rural and urban groups. Data for this part of the study came from the 1988 UNB Transportation Group driver survey.

In the first part of this analysis, rural driver exposure to city streets was compared to urban driver exposure to rural roads. The results for drivers aged 66-80 years are shown in Table 1A and for those over 80 in Table 1B. The survey data indicate that rural drivers in both age groups are more likely to drive on city streets than urban drivers are to drive on rural roads. This is probably caused by the greater need of rural drivers to use city-based services. Conversely, urban residents on aggregate likely have less need to travel into rural areas. This is shown by the relatively large percentages of urban drives who 'rarely' use rural roads. It is also noteworthy that a more significant pattern shift is shown between both elderly age groups for those living in rural areas versus urban.

Table 1A: Exposure to Classes of Roads Different Than Near Residence, 66-80 yrs.

	Percent of Respondents			
	All	Most	Some	Rarely
rural	8	18	52	22
urban	2	7	48	43

Table 1B: Exposure to Classes of Roads Different Than Near Residence, 81+ years

	Percent of Respondents			
	All	Most	Some	Rarely
rural	3	23	40	33
urban	0	14	45	41

The survey data were then used to compare rural and urban exposure to highway driving. The results are shown in Tables 2A and 2B. While both urban and rural elderly drivers show a decreased propensity to use highways with advancing age, the shift seems more prevalent among those living in rural areas.

Table 2A: Exposure to Highways, 66-80 years

	Percent of Respondents			
	All	Most	Some	Rarely
rural	4	28	44	24
urban	5	16	49	20

Table 2B: Exposure to Highways, 81+ years

	Percent of Respondents			
	All	Most	Some	Rarely
rural	7	13	43	37
urban	2	24	45	31

The next comparison documented in Tables 3A and 3B contrasted exposure to driving after dark among those living in urban versus rural areas. For both elderly age groups, rural drivers indicated that they are less likely to drive after dark than their urban counterparts. A possible explanation for this disparity is that urban drivers use mostly city streets which are often artificially illuminated, therefore alleviating some of the difficulties associated with driving after dark.

Table 3A: Driving After Dark, 66-80 years

	Percent of Respondents		
	Never/Seldom	Sometimes	Mostly/Always
rural	50	47	3
urban	41	55	4

Table 3B: Driving After Dark, 81+ years

	Percent of Respondents		
	Never/Seldom	Sometimes	Mostly/Always
rural	67	33	0
urban	58	34	7

The final comparison, summarized in Tables 4A and 4B, contrasted the times of day driven by rural and urban drivers. The data show that the rural and urban drivers aged 66-80 years distribute their driving almost identically. For elderly drivers over 80 years of age, both groups heavily concentrate their driving in non-peak hours. This increased use of non-peak hours is slightly more evident among those living in urban areas.

Table 4A: Peak Hour Exposure, 66-80 years

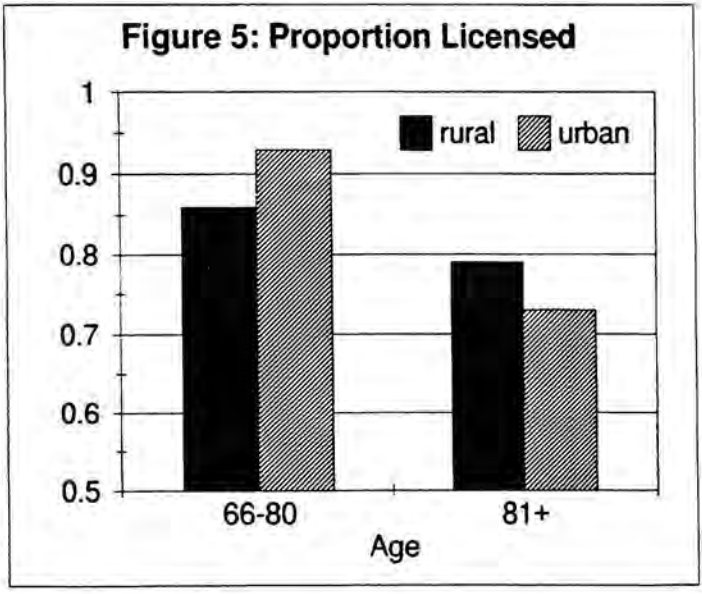
	Percent of Respondents		
	Peak	Non-Peak	Equally
rural	11	55	33
urban	11	52	37

Table 4B: Peak Hour Exposure, 81+ years

	Percent of Respondents		
	Peak	Non-Peak	Equally
rural	3	67	30
urban	10	72	17

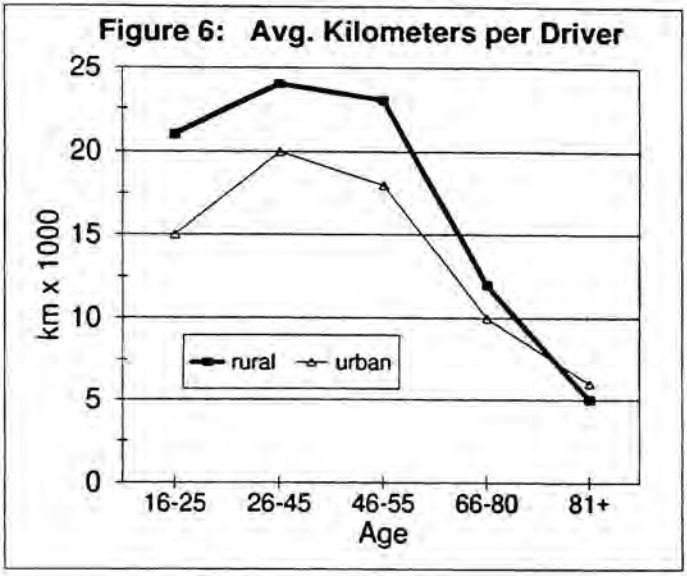
6.0 Rural Elderly Demand for Driving

An indication of the demand or need for driving among older rural drivers is the likelihood that drivers will relinquish their licences. This demand was estimated by comparing the proportion of rural (and urban) drivers to the total provincial population for each elderly age group. The results of this analysis are synthesized in Figure 5.



It is shown that the rate of attrition of licensed drivers is less for rural drivers compared to their urban counterparts. This implies that the rural elderly have a greater demand/need for driving than the urban elderly perhaps due, in part, to the lack of alternative transportation resources in rural areas.

Another indicator of demand for driving and exposure to the risk of an accident is the number of kilometres driven per year. Data from the survey were used to calculate the average distance driven by the rural and urban populations of each age group. The results are summarized in Figure 6.



Not unexpectedly, it was found that rural residents tend to drive greater distances overall than urban drivers. This is not surprising since rural residents must travel greater distances to reach services and workplaces. A significant finding was that among those over 80 years of age, it was shown that urban residents actually drive more than rural residents.

It is suggested that a number of factors contribute to the reduced amount of driving observed among the very old living in rural areas. In the absence of convenient transportation alternatives, rural residents are likely to be highly dependent on driving and were shown to retain their licences longer than their urban counterparts. It is not unreasonable to assume that this group compensates by driving even fewer annual kilometres despite the necessity for longer individual trips to access services. This means that the rural elderly make fewer total trips than the urban elderly. It would be interesting to understand whether they sacrifice participation in discretionary activities requiring travel (in favour of mandatory activities) as part of their compensation for decreased abilities. Hildebrand has demonstrated that engagement in all activities away from the home dramatically begins to decline beginning at about age 75, however, the proportion of mandatory activities (versus discretionary) remains constant (1998).

The relatively low average kilometres driven by the rural elderly in New Brunswick can be interpreted to mean that this group experiences unmet demand for mobility assuming their desire to access activities outside the home does not wain relative to their urban counterparts.

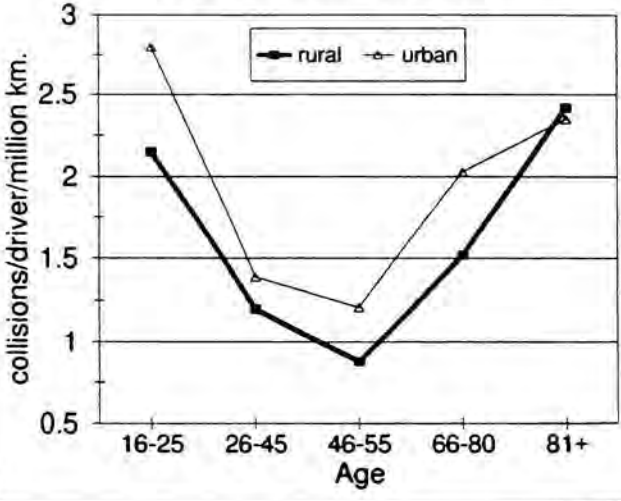
7.0 Safety of Older Rural Drivers

In order to provide an estimation of the safety of older rural drivers, accident rates per million kilometres were determined and contrasted with other age groups. The number of accidents for each age group was determined using the 1996 and 1997 accident files provided by NBDOT. Accidents were delineated for those residing in both rural and urban areas based on postal code, and into age groups based on

date of birth. The total numbers of drivers by age group used in determining the accident rate were extracted from the file of New Brunswick drivers provided by the NBDOT Motor Vehicle Branch. The average kilometres driven per year for each age group was estimated from the UNB Transportation Group survey results.

The resulting pair of "U" shaped curves is shown in Figure 7. The overall pattern closely resemble those of other studies including McKelvey (1988), TRB (1988) and NHTSA (1999). In the younger age group, the accident rate is high due to inexperience. The accident rate decreases through the middle age groups as driver experience increases. In the older age groups the accident rate increases due to a loss of driving skills caused by the aging process.

Figure 7: Collision Rates



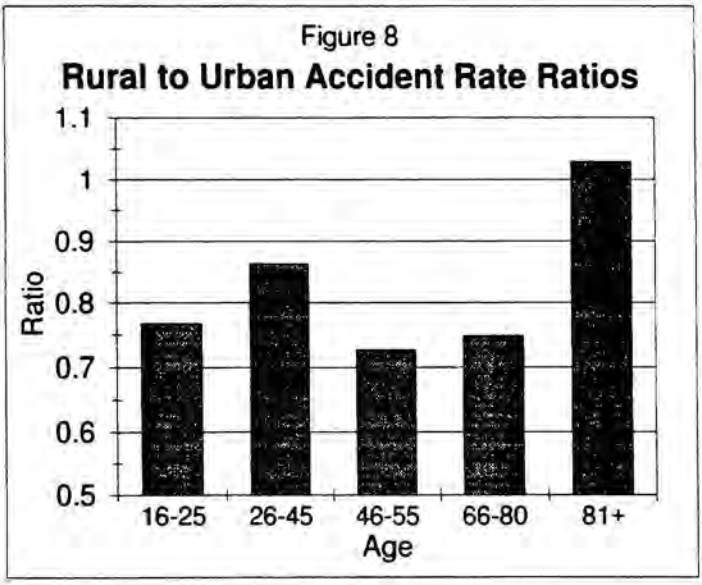
An important characteristic of these U- shaped curves is that all groups of rural drivers have lower accident rates than urban drivers. This is not surprising since those residing in urban areas are exposed to higher

traffic volumes and more vehicle conflict points resulting in increased risk levels. It is significant that the accident rates of rural versus urban drivers *converge* for those over 80 years of age. This is further evidence of a problem area associated with the mobility needs of this specific group.

To further explore the relationship of rural and urban drivers, the ratios of rural to urban accident rates were calculated. The results are shown in Figure 8.

The calculated ratios suggest that the accident rate for the rural elderly is higher than it should be. The ratio for all other age groups is between 0.73 and 0.85, however, for the elderly this ratio increases sharply to 1.03. Based on the rates of other rural drivers and urban drivers, one would expect the accident rate for the rural elderly to be around 1.70, not the observed value of 2.42.

Figure 8



There are some probable explanations why the rural elderly have a disproportionate number of accidents compared to the urban elderly. Previous findings suggest that a disproportionate percentage of very old rural drivers maintain their licenses relative to urban drivers. This means that it is likely that there are more drivers with significantly diminished skills among the rural elderly. Since the rural elderly drive fewer kilometres on average than the urban elderly, it is possible that they do not drive enough to keep their skills sharp. It should be noted that the accident rate for older drivers increases despite notably less exposure to peak traffic and driving after dark.

8.0 Conclusions

The behaviour and accident rates of older rural drivers are comparable to those of older urban drivers. As with other age groups, rural older drivers have a lower accident rate and drive farther than the corresponding urban age group. Compared to younger age groups, rural older drivers have a higher accident rate despite somewhat less exposure to hazardous conditions.

The behaviour of rural elderly drivers in New Brunswick suggests that they are substantially less likely than other age groups to expose themselves to unfamiliar and challenging driving conditions. Despite these precautions, the rural elderly have a higher accident rate than middle-aged groups and are disproportionately over-represented compared to their urban counterparts.

There are three significant trends which emerge when rural elderly drivers are compared to urban elderly drivers. First, the attrition rate of licensed drivers due to aging seems to lessen among those living in rural areas. Secondly, on average, the rural elderly drive fewer miles than the urban elderly. Finally, very old (81+ years) rural drivers were shown to have the highest accident rate, and were the only age group to exceed their urban counterparts. These trends suggest that the rural elderly are highly dependent on driving, but drive fewer miles than expected and have a disproportionately high accident rate.

There are some probable explanations why the rural elderly have a disproportionate number of accidents compared to the urban elderly. Previous findings suggest that a disproportionate percentage of very old rural drivers maintain their licenses relative to urban drivers. This means that it is likely that there are more drivers with significantly diminished skills among the rural elderly. Since the rural elderly drive fewer kilometres on average than the urban elderly, it is possible that they do not drive enough to keep their skills sharp. It should be noted that the accident rate for older drivers increases despite notably less exposure to peak traffic and driving after dark.

8.0 Conclusions

The behaviour and accident rates of older rural drivers are comparable to those of older urban drivers. As with other age groups, rural older drivers have a lower accident rate and drive farther than the corresponding urban age group. Compared to younger age groups, rural older drivers have a higher accident rate despite somewhat less exposure to hazardous conditions.

The behaviour of rural elderly drivers in New Brunswick suggests that they are substantially less likely than other age groups to expose themselves to unfamiliar and challenging driving conditions. Despite these precautions, the rural elderly have a higher accident rate than middle-aged groups and are disproportionately over-represented compared to their urban counterparts.

There are three significant trends which emerge when rural elderly drivers are compared to urban elderly drivers. First, the attrition rate of licensed drivers due to aging seems to lessen among those living in rural areas. Secondly, on average, the rural elderly drive fewer miles than the urban elderly. Finally, very old (81+ years) rural drivers were shown to have the highest accident rate, and were the only age group to exceed their urban counterparts. These trends suggest that the rural elderly are highly dependent on driving, but drive fewer miles than expected and have a disproportionately high accident rate.

References

Bishu, Ram. Foster, Betty. and McCoy, Patrick. 1991. *Driving Habits of the Elderly: A Survey.* in Proceedings of the Human Factors Society 35th Annual Meeting.

Canada Post. The Postal Code. Http://www.canadapost.ca/CPC2/addrm/pclookup/pcinfo.html, February 2, 2000.

Canadian Council of Motor Transport Administrators (CCMTA). 1999. National Maturing Driver Workshop, Ottawa, Oct. 22.

Evans, Leonard. 1991. *Older-Driver Risks to Themselves and to Other Road Users.* in Transportation Research Record, No. 1325. Transportation Research Board, Washington D.C.

Hildebrand, Eric. 1998. *An Activity-Based Travel Needs Model for the Elderly*, Ph.D. dissertation. University of Waterloo Department of Civil Engineering, Ontario, Canada.

McKelvey, Francis. Maleck, Thomas. Stamatiadas, Nikiforos. and Hardy, Daniel. 1988. *Highway Accidents and the Older Driver.* in Transportation Research Record, No. 1172. Transportation Research Board, Washington D.C.

NHTSA. 1999. Traffic Safety Facts 1999: Older Population. National Center for Statistics and Analysis. Washington D.C.

Taylor, William. Ahmad, Zubair. and Stamatiadis, Polychronis. 1994. *Profile of the Accident Prone Older Driver.* Journal of Advanced Transportation. Vol. 1, pp. 89-105.

TRB. 1988. Special Report 218. Vol. 1, Committee Report and Recommendations. Transportation in an Aging Society: Improving Mobility and Safety for Older Persons. National Research Council, Washington D.C.

Zhou, Min. and Lyles, Richard. 1997. *Mobility Patterns of the Next Generation of Older Persons.* in Transportation Research Record, No. 1573. T.R.B., Washington D.C.

THE IMPACT OF DEMAND-RESPONSIVE DELIVERIES ON THE STABILITY OF VEHICLE ROUTING OPERATIONS

by

Michael A. Haughton
Division of Operations and Logistics
Faculty of Commerce and Business Administration
University of British Columbia

Abstract

An outbound logistical system that is designed with the flexibility to readily dispatch and route delivery vehicles in response to randomly fluctuating (stochastic) customer demand quantities is valuable from a customer satisfaction perspective. However, a concern about such systems is that the day-to-day changes in the delivery routes might be highly erratic, and lead to similarly erratic changes in several aspects of the dispatcher's vehicle routing operations. One of these aspects is the routing assignments for drivers. Thus, full assessment of the value of demand-responsive delivery/routing operations to a firm must include measurement of the effect of the day-to-day changes on drivers. Although this effect is often mentioned in previous studies, no thorough study to measure it has previously been done. This research helps to address this gap in the literature by using computational experiments to help estimate the effect under a variety of conditions. The research also explains the use of the estimates in evaluating demand-responsive routing systems. Another key finding of the research is that regression analysis appears to have the potential to enable easy and accurate estimation of the effect.

Introduction

Planning the dispatch and routing of road delivery vehicles to satisfy the objective of minimizing the cost of transporting goods to a set of spatially dispersed customers is a central logistics activity for firms such as product distributors. In contexts where customer demand exhibits random fluctuations from day to day, this activity is more difficult than in contexts where demand is stable. A key source of the difficulty is that the manager of dispatch/routing operations has to evaluate the pros and cons of either maintaining stable routes in the face of stochastic demands or constantly adjusting the dispatch and routing plans in response to the fluctuations. If, for example, a distributor chooses to maintain stable delivery routes, one of the advantages is that the demands on drivers to learn new routes will be low. By plying a stable set of routes each day, drivers should easily attain a high level of efficiency in carrying out their delivery duties.

However, against this benefit is the risk of delivery shortages during periods of demand surges, and hence, a lower than maximum level of customer service performance. A more demand-responsive strategy of reoptimizing the delivery routes each day overcomes this problem and incurs the minimum average daily transportation cost of doing so.[1] The concern with this strategy is that the routes have to be replanned daily. This raises the question of whether the likely outcome of each driver being required to learn a large number of routes will materially worsen the cost-effectiveness of demand-responsiveness. Although several studies have raised concern about the *existence* of this outcome[2], progress towards its *measurement* in ways that can be of practical use is lacking.[3]

This paper proposes a metric for measuring it and estimates it through the use of computational experiments based on features of grocery distribution. The paper also presents a method for easily estimating the metric. The metric is based on the idea illustrated on a segment of a co-ordinate map in **Figure 1**. This map shows the driver's route (which has the typical shape of routes derived by vehicle routing heuristics) that would be followed every day if the quantity demanded

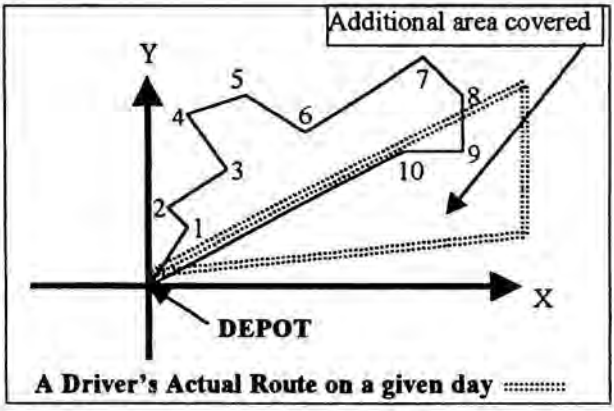


Figure 1
Illustrative Impact of Demand Fluctuations on a Driver's Routes

by each customer remained fixed over time; i.e., it would be the driver's usual or fixed route. As indicated by the solid line, this route would involve dispatching the vehicle from the depot, then routing to customers 1 through 10 before returning it to the depot. However, because of demand fluctuations, a driver might, on any given day, be required to make deliveries to customers in places that are beyond the perimeter of that route. In Figure 1, the double dotted line depicts what the driver's route might be on such a day. The portion of this route that is beyond the perimeter of the driver's usual route is the net additional area that the driver would have to learn about to do his job effectively *on that day*. A premise of this research is that the relative size of this additional area is a practical metric for measuring the extra learning requirements that a demand-responsive delivery system places on the drivers of delivery vehicles. Because the size of the additional area is likely to fluctuate with the day-to-day demand

fluctuations, this paper presents estimates of its likely and maximum values.

The necessary details of the research are described in the next three sections. The first of these outlines the research methodology. This is followed by a discussion of the findings, including their practical implications for the management of dispatch/routing operations. The paper's closing section presents the main conclusions, including an overview of possible extensions of the research.

Methodology

The essence of the computational experiments involved using a full factorial design covering two variables that have been shown to affect dispatch/routing decisions in stochastic demand settings: the capacity of each delivery vehicle (Q) and the probability with which each customer places an order each day (p). Their experimental levels, as well as the other experimental conditions are presented in **Table 1**. Since, as indicated earlier, these variables are known to affect dispatch/routing decisions, their selection need not be justified here[4]. The choice of experimental conditions represents an attempt to replicate as closely as possible, particulars of actual cases involving grocery distribution.[5]

The experimental process to generate the required data will now be described. First, for each of the 25 combinations of p and Q, the well known Clarke-Wright[6] vehicle routing heuristic was run to determine what the "optimal"[a] delivery routes would be if each customer's demand stayed at its average level; i.e., what each driver's fixed or usual route would be. For each of these combinations, a uniform random number generator was used to simulate 30 days of demand for each customer based on a Bernoulli distribution with parameter, p.

---

[a] Since, like all existing vehicle routing methods, the Clarke-Wright method is a heuristic, it does not guarantee that the routes found will be optimal in terms of minimizing transportation cost.

For each day, the Clarke-Wright heuristic was run to determine the day's best delivery routes. Each driver's routes over the simulated 30-day period were then analyzed on coordinate maps in order to compute the relative size of the geographic area that fell outside of what would have been his fixed route. The observed estimates (measured as a percentage of the area covered by his fixed routes) as well as related findings are discussed in the next section.

Table 1
Experimental Conditions and Assumptions

Factor	Levels/Values
Q: Capacity of delivery vehicles in number of units of the product	1 2 5 10 20
p: The probability with which each customer places an order each day	0.1 0.2 0.3 0.4 0.5
N: Number of customers served by the Depot	Set at 1,000 throughout the experiment
A: Area of the region served by the Depot	Held constant as square region with area = 100x100 square miles

Key Assumptions
Each customer's demand follows the same Bernoulli process with probability p; i.e., each day, each customer either places an order for 1 unit of the product (with a probability of p) or does not place an order (with probability 1-p). Thus, each customer's average daily demand is p units. Note that a unit may correspond to a batch of, say, 100 units. An example might be where a unit is a package of say 100 cases of beer.

Findings and Discussion

Table 2 summarizes the statistical results. To put these results in more concrete terms, consider the value of 27.13% in the cell of this table corresponding to a vehicle capacity (Q) of 5 units and an order probability (p) of 0.2. For this combination, if each customer ordered his average daily requirement of 0.2 units, then the average number of the customers on each route would be 25 (2.5% of the total number of customers). So, with fixed routes, each driver would be responsible for an average of 2.5% of the total area of the service region (or 250 square miles). But, with demand-responsive deliveries, each driver would be required to visit an additional area averaging 67.83 square miles per day (27.13% of 250). Over all the cases in the experiment, the maximum was 100%; i.e., in terms of geographic area size, the demand responsive strategy of route reoptimization will not require a driver to know an *additional* area that is larger than the area he would have to serve if demand remained constant.

Table 2
Average Additional Area Traveled by Drivers
(as a Percentage of the Area Covered by their Fixed Routes)

Order probability (p)	***Vehicle Capacity (Q)***				
	1	**2**	**5**	**10**	**20**
0.1	28.19	28.28	28.45	32.37	39.33
0.2	23.73	24.29	27.13	30.67	37.01
0.3	20.25	20.93	25.08	26.32	32.13
0.4	17.27	17.74	19.05	22.37	26.83
0.5	15.58	16.62	17.05	19.14	22.78

Another finding, which is quite conspicuous in Table 2, is that the average additional area increases with increases in vehicle capacity (Q) but decreases with increases in the order probability (p). The explanation for the capacity effect is as follows: with larger vehicles (for a given value of p), it is less likely that enough customers will be found within the driver's usual area to fully utilize the vehicle's capacity.[b] Thus, better utilization of dispatched vehicles often requires routing them to adjacent areas. This phenomenon, reflected in the statistics, was consistently depicted in the route maps that were analyzed. The explanation for the effect of p on the averages is similar in that for a given vehicle capacity, lower order probabilities also means having to access a larger average area in order to fully utilize the capacity of the dispatched vehicles.

This insight into the behavior of the average led to another interesting finding. In particular, for each of the 25 combinations of p and Q, the probability of a driver having to go outside his usual area to aid full vehicle utilization was calculated. That is the probability that the number of customers in the driver's usual area is less than vehicle capacity. The coefficient of linear correlation between these probabilities and the values in Table 2 was 0.7465. This is large enough to suggest the use of regression analysis in estimating the averages for any (p, Q) combination of interest. That is, since one can readily compute these probabilities from the binomial distribution function in any electronic spreadsheet, and the estimated averages seem valid, one can develop a regression equation in which these probabilities are used to predict the averages. The development of such an equation is a matter for future research when more extensive experiments can be conducted.

The key managerial implication of the findings is that it provides an estimate of the extra learning requirements that demand-responsive delivery systems place on drivers. Of interest to a dispatcher/router

[b] With vehicle routing heuristics, a common concomitant objective to transportation cost minimization is to maximize the utilization of the dispatched vehicles.

would be the cost of a driver learning to master the routes within a specified size geographic area. A firm's existing data might permit it to derive cost estimates from, say, the time it took drivers to master their routes in specified geographic area sizes. These cost estimates can then be used to translate the estimates from Table 2 to route-learning cost estimates for demand-responsive delivery systems. This would enable a more complete evaluation of those systems.

Conclusions

The present research develops and estimates a metric for measuring the extent to which demand-responsive delivery systems require the delivery vehicle drivers to learn delivery routes in less than familiar areas. The research also shows how the metric is affected by two vehicle routing parameters: the frequency of customer demand and vehicle capacity. The research results indicated that regression analysis has the potential to provide the required estimates easily and accurately. This potential was not fully explored for this paper, and is a matter for future research. Also, although all indications are that the estimates are valid, further research can be undertaken to evaluate their reliability more extensively. Such future work would have to be done under experimental conditions that cover a wider range than those presented in this paper.

Endnotes

[1]Bertsimas, D.J. (1992), "A vehicle routing problem with stochastic demand". *Operations Research* **40**:3, 574-585.

[2]C. D. J. Waters (1989) Vehicle scheduling problems with uncertainty and omitted customers. *Journal of the Operational Research Society* **40**, 1099-1108.

W. C. Benton and M. D. Rossetti (1992) The vehicle scheduling problem with intermittent customer demands. *Computers & Operations Research* **19**, 521-531.

[3]Haughton, M. A. (1999), "Determining the stability of route reoptimization". *Proceedings of the 5th International Conference of the Decision Sciences Institute*, Athens, Greece.

[4]Haughton, M. A. and Stenger, A. J. (1999), "Comparing strategies for addressing delivery shortages in stochastic demand settings". *Transportation Research (E)* **35**:1 25-41.

[5]Carter, M.W., Farvolden, J.M., Laporte, G, Xu, J. (1996) Solving an integrated logistics problem arising in grocery distribution. *Information Systems and Operations Research* **34**:4, 290-306.

[6]Clarke, G. and Wright, J.W. (1964), "Scheduling Of Vehicles from a Central Depot to a number of Delivery Points", *Operations Research*, **12**: 568-581.

Evaluating Advanced Pickup and Delivery Systems: A Simulation Study

Liping Fu, Ph.D.
Department of Civil Engineering
University of Waterloo, Waterloo, ON, Canada, N2L 3G1
Email: lfu@uwaterloo.ca

ABSTRACT: This paper presents a simulation model that has been developed to model a variety of technology-oriented pickup and delivery distribution systems. The paper discusses the general concepts and models applied in the simulation system, focusing on how various components are modeled and how they interact with each other in the overall simulation framework. The simulation system is applied to model a specialized passenger pickup and delivery system - dial-a-ride paratransit with the objective of evaluating the potential operational improvement that may be attained from the application of automatic vehicle location system (AVL). A series of simulation experiments were performed on a set of hypothetical cases and a realistic example from the City of Edmonton, Alberta, and have resulted in valuable insights into the potential impact of AVL technology.

INTRODUCTION

Pickup and delivery systems operated either by private firms such as parcel carriers and trucking companies, or by public transit agencies rely on a fleet of vehicles and associated crews to distribute goods or provide service to customers. Due to escalating fuel costs, growing salaries of crews and increasing demand for timely delivery, it has become increasingly important for these distribution firms and transit

agencies to maximize the efficiency and reliability of their daily delivery operations. Latest advance in information technologies such as automated vehicle location (AVL), digital telecommunication and computers has afforded a unique opportunity to meet this need. However, many fundamental questions need to be addressed. How effectively will these technologies help increase the operational efficiency of a pickup and delivery system? How much improvement in service reliability can be expected from such technological enhancement? What operating policies and dispatching strategies can take advantage of the availability of real-time information?

In order to address these issues, it is required that performance of systems under alternative technological settings be predicted. Due to the dynamics of pickup and delivery operations, the uncertainty of system environments, and the complexity of the underlying routing and scheduling problem, such prediction is often a forbidding task, defying utilization of traditional analytical models and field test method. A computer simulation model may effectively overcome these hindrances because of its potential to represent the diverse operating environments and emulate the underlying complex process.

This paper presents a simulation system that can be used as an evaluation tool to address some of the aforementioned issues. The paper first presents an overview of technological components of Advanced Pickup and Delivery Operation Systems (APDOS). The principle components and structure of the simulation system are then introduced, focusing on how various components are modeled and how they interact with each other in the overall simulation framework. Finally, an example is used to demonstrate the application of the simulation model.

ADVANCED PICKUP AND DELIVERY OPERATION SYSTEMS (APDOS): TECHNOLOGY BACKGROUND

Pickup and delivery operations require a set of interrelated functions such as reservation, vehicle scheduling, real-time dispatching, billing and business reporting. With various information technologies such as microcomputers, AVL and digital communication, these functions

can be automated for potentially more cost-effective operations. This section presents an overview of a conceptualized system called Advanced Pickup and Delivery Operation Systems (APDOS) as it is the modeling target of the proposed simulation system.

In this hypothetical APDOS, as shown in Figure 1, the reservation system provides the link between the operation center and the customers. It takes responsibility for recording the customers' requests including pickup and delivery locations, desired time window, load to be transported and their special requirements, and for updating request information in the case of service cancellation and change of service time. This procedure can be performed through a reservation clerk, an automated telephone system or Internet.

The automated vehicle location (AVL) system is used to locate and track vehicles. The most popular system is the Global Positioning System (GPS) which relies on signals from satellites to locate the vehicles. The location information can then be used for real-time monitoring and vehicle dispatching.

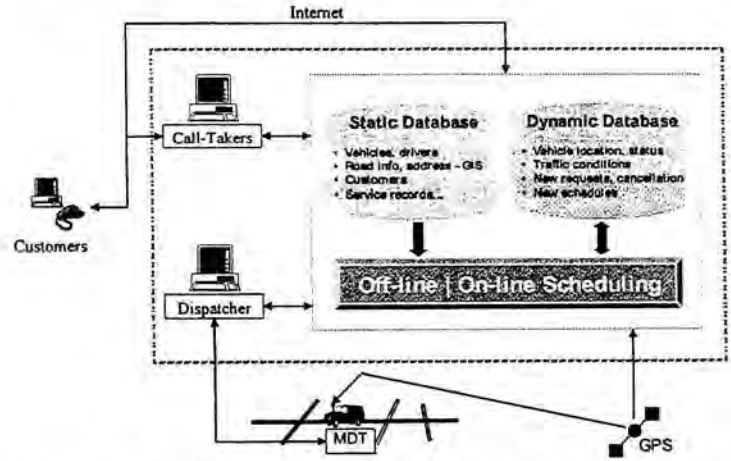


Figure 1. An Advanced Pickup and delivery Operation System (APDOS)

All related information is managed by a central database management system (DBMS) and a geographical information system (GIS) for effective data support to all associated functions.

The scheduling component provides both off-line and on-line scheduling capabilities. The off-line scheduling function is used to assign the loads that are requested in advance and known before the operation starts while the on-line scheduling component is responsible for assigning the loads that arrive in real time and need to be serviced immediately.

The dispatcher monitors continuously any operational changes in the system such as vehicle breakdowns, service cancellations and new requests. These changes may justify modification of vehicle schedules such as diverting a vehicle en-route to service a new request in vicinity or re-assigning loads from one vehicle to another. Once a change is verified, the modified schedules are sent to the drivers and displayed in an in-vehicle computer or mobile data terminal (MDT).

OVERVIEW OF THE SIMULATION MODEL

The simulation system SimPAD (Simulation of Pickup and Delivery Systems) has been developed primarily for evaluating APDOS under a variety of technology options and operating strategies. As a result, one of the main challenges is to model these technologies and associated system entities at an acceptable degree of realism. This section first describes how various physical components in APDOS are modeled, followed by an overview of the structure of the simulation system.

The simulation system consists of seven principle models as described as follows.

1). Service Area and Road Network Model

It is assumed that the pickup and delivery service of interest is located within an urban or suburban area covered by a road network. In order to realistically trace individual vehicles' movements in an urban traffic environment, the simulation system explicitly models the underlying road network as well as the temporal and stochastic variation of travel time in the network. This ability is important for modeling a service

system in which most demands have tight pickup and/or drop-off time windows and the total system cost is proportional to the service hours of individual vehicles. It is also important for the reason that a system with a technology option such as AVL may be more advantageous in a highly varied operating environment than in a stable environment. In current implementation, the road network is represented by a set of nodes (intersections) and links (road segments). Each link has two parameters: link length and a travel time vector. The travel time vector represents the mean and standard deviation of travel times on the link as a function of the time of day.

2). Trip Model

A trip involves a passenger or a certain volume of cargo to be picked up at a given location (pickup stop) and delivered to another location (delivery stop) in the service area. The simulation system considers two types of trips: advance reservation trips which are requested in advance, e.g. 24 hours before the service starts, and real-time trips which need to be serviced immediately. The common attributes of these two types of trips include: (a) seats or volumes required by up to three loading types, (b) desired pick-up and/or drop-off time, or request time for real-time trips, (c) pick-up and drop-off locations, (d) dwell time (loading and unloading).

Since the dwell time may involve substantial variation and is therefore modeled as a random variable. It should be noted that, by explicitly modeling the magnitude and variation of dwell time, potential effects induced by some technological options such as AVL might be modeled. For example, suppose that customers are able to check the real-time location of the vehicles that are scheduled to pick them up due to AVL, they could then get ready for their travel before the vehicles arrive. This means that the dwell time at pickup stops may be reduced for a system with AVL.

3). Vehicle Model

The fleet vehicles are the entities of the system that provide transportation service to customers. Vehicles are mainly distinguished by their loading capacities of up to three types, the period that each vehicle is available for service and their depot

locations as represented by coordinates. The unit of the loading capacity could be seats for passenger transportation, volumes or weight for freight transportation, depending on the underlying application to be modeled. During the simulation process, the system tracks and updates vehicles' status which could be one of the following: (a) at garage waiting to start a service (ATGARAGE), (b) idling and waiting to start next shift (IDLE), (c) at stop loading or unloading a passenger or cargo (ATSTOP), (d) on road moving toward the next stop on its schedule (ONROAD), (e) done with its scheduled service (DONE). For each vehicle, the simulation system maintains a set of information on its assigned schedule and travel path, including a list of stops to visit with the expected time to visit these stops, the number of stops visited, the street path for its assigned visits, the current link (road segment) the vehicle is traveling on, the current speed, the current coordinates, and the number of minutes that it is late behind its schedule.

4). AVL Model

The fundamental functionality of AVL is the ability to pinpoint the coordinates of service vehicles at specific or any points of time. The simulation system models the AVL as the facility for a dispatcher (or dispatch center) to access the coordinates - longitudes and latitudes of equipped vehicles at a fixed time interval. Note that the use of fixed updating time may not be ideal to model non GPS-based AVL systems such as sign post technology, however, it is possible, by properly selecting the time interval, to achieve a reasonable level of approximation. In order to model the accuracy of a given AVL system, the longitude and latitude is generated from a probability distribution that is assumed to be obtainable from the exact coordinates of a vehicle and the positioning error of the AVL. The actual location of a vehicle is traced during simulation based on the vehicle's schedule, travel path, and realization of travel speeds on the individual links along the travel path. The positioning error of an AVL is represented by a parameter R - the maximum possible distance between the location identified by the AVL and the actual location.

As discussed in the preceding section, in a dynamic system, a change in system states may prompt the need to re-optimize vehicle schedules for a more efficient operation. When schedules are to be re-optimized, knowledge on individual vehicles' locations could then make difference. The major operational difference between a system with AVL and one without AVL is considered in the scheduling model detailed in the section On-line Dynamic Scheduling System.

5). Dispatcher Model

The dispatcher model is the most critical component in the simulation system, responsible for undertaking dispatching actions under various real-time events. While the technology components such as AVL and communication systems made the real-time data available, it is this dispatcher model that actually makes use of the provided data to improve the system productivity, efficiency and responsiveness.

The simulation system includes two dispatcher models: virtual dispatcher and human dispatcher. The virtual dispatcher is merely a set of dispatching strategies that can automate all dispatching tasks without any human interventions during the simulation process. For example, when a new request comes in, the dispatcher model automatically invokes the real-time scheduling algorithm to search for a vehicle that can best service the new trip. If there is no vehicle available to provide the required service, it would then set the trip request as rejected.

The dispatching strategies define a set of rules that can be followed to respond to real-time operational events (see the section Real-time Operational Events). Based on the type of responses, dispatching strategies are classified into two categories: immediate responses and responses with a time lag. The time lag is the amount of time that the system must wait before a further dispatching action must be taken after it is triggered by a real-time event.

Dispatching strategies can be further classified by the type of actions such as re-scheduling, re-sequencing, re-assignment. Each dispatching strategy requires application of a scheduling algorithm to identify the best schedules under a given circumstance, as discussed in the section On-line Dynamic Scheduling System.

The system also allows interactive simulation in which a human dispatcher is in the loop of simulation and responsible for handling all real-time situations - events generated by the simulator. Under this mode, once a new event occurs, the simulation system would automatically 'slow down' by running under real-life clock and let the human dispatcher to make dispatch decisions in response to the event. After the modified schedules are updated, the system would then turn back into its original pace of simulation speed. This mode of simulation is expected to be useful for training purpose.

6). Real-time Operational Events

Real-time operational events that would trigger dispatching actions can be classified into three categories: customer-related events, vehicle-related events and dispatcher-related events. Customer-related events include trip request for immediate service (NEWREQUEST), and cancellation of trips after service starts (CANCELTRIP).

Vehicle-related events include breakdown of a vehicle during its service process (BREAKDOWN) and late behind schedule (LATE). The BREAKDOWN event can also be assumed to follow Poisson distribution for the same reason stated previously. The event LATE is an induced event that may be caused by excess travel times on some links (an indicator of traffic congestion) or long dwell time (unexpected long loading or unloading time), therefore would automatically appear whenever a vehicle is late for an amount of time exceeding a pre-specified threshold.

Dispatcher-related events involve periodical requests made by dispatcher to re-optimize schedules (REOPTIMIZE). The underlying assumption is that, as the time unfolds, vehicles' status may change and deviate substantially from the conditions that are assumed when schedules are prepared or dispatching actions are performed. By re-optimizing schedules periodically, the productivity and reliability of the service system may be improved.

7). On-line Dynamic Scheduling System

The dispatcher model discussed previously relies on an on-line algorithm to solve the dynamic (or real-time) version of the pickup

and delivery problems (1). The primary objective of a dynamic scheduling algorithm is to determine the assignment of real-time trips to vehicles that are already in service with a given set of schedules. Depending on what strategy is used, the algorithm may also be used to re-schedule trips that have been assigned to certain vehicles. In the current model, the dynamic scheduling algorithm is extended from the algorithm for the static dial-a-ride problems with a set of modified objective functions and constraints (2).

A system with AVL is modeled to have more flexibility in dynamic scheduling based on the following two operational assumptions, similar to Wilson et. al. (3):

- In a system with AVL, each vehicle that is currently traveling toward to the next stop according to its schedule may be diverted en-route by the dispatcher to a new stop if such diversion is efficient and at the same time is not expected to jeopardize the service to existing customers.
- Conversely, in a system without AVL, the location of each vehicle is not always known to the dispatching center. It is therefore assumed that a vehicle is not to be diverted from its immediate destination for a new customer. However, diversion is allowed after the first stop of a vehicle, as the location of that stop is known to the dispatching center.

The simulation system includes two essential program components: the main module and the event-processing module, as shown in Figure 2. The main module includes a loop over the event-processing module that is invoked whenever a new event occurs, and a sub-module that performs the tasks of updating system states at an interval of information updating time. This module follows time-based simulation logic and integrates the functionality needed for system animation.

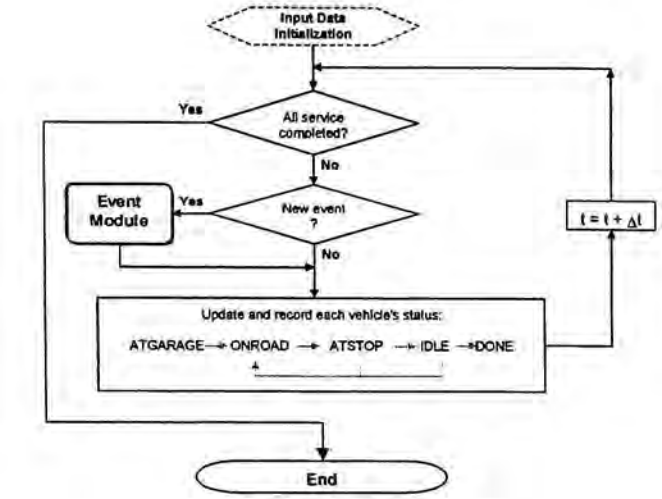
The event-processing module consists of a set of actions that are driven by various real-time operational events described previously. The module is invoked by the occurrence time of next event from the event queue. Once activated by an event, this module first updates the positions of individual vehicles if AVL is used. Otherwise, the

projected time that each vehicle will arrive at its immediate stop is updated. This information is subsequently used in the dynamic scheduling process. For each specific type of event, corresponding dispatching strategies are applied by the virtual dispatcher to find the optimal dispatching actions in response to the given event. Schedules are subsequently modified and updated. This modification has an immediate effect on the main module, which will simulate the system based on the modified schedules.

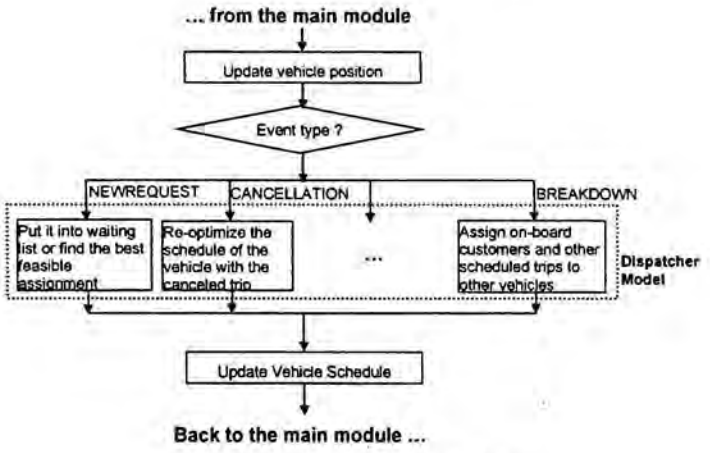
The simulation starts with loading all needed data from a database, including vehicle data, advance reservation trip data, road network data, and schedules for the advance reservation trips. After all data are prepared and parameters are set, the simulation can then be activated. During the simulation process, the system logs the detailed service records of each vehicle, including arrival time, dwell time and leave time, at each stop. This information, combined with trip data, is used to generate all simulation statistics. The simulation process continues until all vehicles complete their service and the event queue is exhausted.

SIMULATION EXPERIMENTS AND RESULTS

To demonstrate the application of the developed simulation system, the system is applied to simulate the operations of a passenger pickup and delivery system - dial-a-ride paratransit. Dial-a-ride paratransit is a public transportation service operated commonly by transit agencies to provide transportation service to the disabled and elderly. The objective of this simulation study is to investigate the differences in operational performance between a paratransit system using AVL and one without AVL under the assumption that a system with AVL has an increased flexibility in dynamic scheduling as described in the preceding section.



(a) The main module



(b) The event-processing module

Figure 2. SimPAD simulation logic

The experiments were first performed on a set of hypothetical cases generated within a geographic area of 10x10 km. The area is covered by a uniform grid road network with a link length of 500 meters and a link speed 30 km/h; Three levels of demand with trip densities of 0.5, 1.0 and 1.5 trips/hour/km^2 (corresponding to a total of 100, 200 and 300 trips respectively), were considered with percentage of demand trips varying from 10% to 50%. At each demand level, three random sets of trips were generated to represent the variation in trip distribution. Each trip was assumed to have a pickup/drop-off dwell time of 1 minute. A total of 27 cases were therefore included. Each case was simulated twice: one with AVL and the other without AVL, and the resulting statistics were collected for further analysis.

It was assumed that the routing and scheduling objective is to minimize the total travel time. A maximum ride time of 90 minutes and a maximum service time deviation of 30 minutes were used in scheduling the reservation trips. In real-time dynamic scheduling, the maximum waiting time was 30 minutes for demand trips and 10 minutes for reservation trips. These constraints define the minimum level of service that must be guaranteed in the test cases. The comparative analysis then focused on the difference in vehicle productivity between individual scenarios.

Figure 3 shows the relationship between the percentage of increase in productivity due to AVL and the percentage of demand trips. Several observations can be made from these results. First, systems with AVL have a clear advantage over ones without AVL in terms of vehicle productivity. The average increase in vehicle productivity due to AVL ranges from 1.7% to 3.5%, with the highest observed increase of 8.8%.

Second, the relative increase in productivity appears to be an increasing function of the proportion of demand trips, with an approximate 1% improvement in productivity in average for every 20% increase in demand trips. This relationship is somehow expected, as the higher is the real-time demand in a system, the more opportunities exists for en-route diversion and thus the more advantageous is it for a system with AVL.

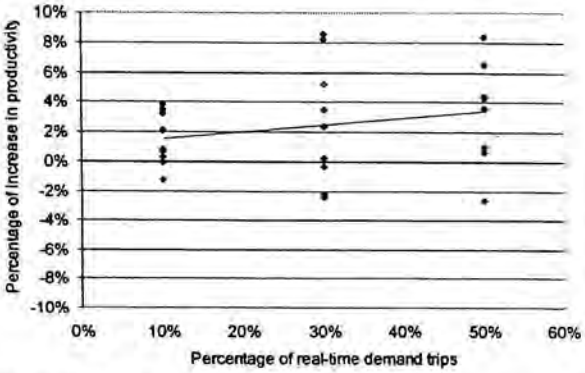


Figure 3. Relationship between productivity improvement and proportion of real-time trips (hypothetical cases with trip density = 0.5-1.5 trips/hour/km^2)

Third, the actual benefit is highly case-dependent with productivity improvement varying from negative gaining (-2.5%) to as high as 8.8%. For the cases with negative gaining (5 out of 27), it means that a decrease in productivity was observed, indicating that using AVL had in fact worsen the system performance in these cases. Such performance variation is however expected as the relative advantage of an AVL system depends on the formation and location of the active routes and the demand trips; some combinations present better potential than others in terms of travel time saving that can be obtained through en-route diversion. Furthermore, in a dynamic system, a decision made in the present affects the future state of the system. As a result, whereas a dynamic assignment solution is always advantageous to a system with AVL under the current system condition, it may turn out to be less desirable in the future when other demand trips arrive.

Experiments were then performed on a modified real-life example from the Disabled Adult Transportation System (DATS) in the City of Edmonton, Alberta. The problem instance consists of a weekday off-peak service (11:00am~1:00pm), including 460 advance reservation

trips. A fleet of vehicles with a capacity of 10 seats is assumed to provide the service. Travel times between stops are estimated based on Euclidean distance and an average travel speed of 30 km/h. The productivity improvement was also observed in the real-life problem from the City of Edmonton under three hypothetical proportions of real-time trips, as shown in Figure 4. The average increase in productivity was between 2% to 4%.

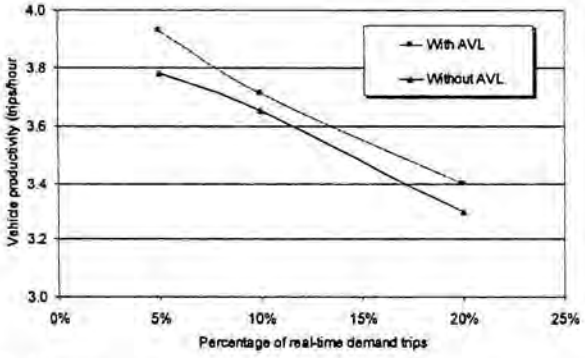


Figure 4. Relationship between productivity improvement and proportion of real-time demand trips (Edmonton case, trip density =0.45 trips/hour/km^2)

CONCLUSIONS

This paper presented an overview of the concepts, models and computational technologies applied in a new simulation system called SimPAD, which has been developed as a virtual test bed for evaluating advanced pickup and delivery operation systems (APDOS). The simulation system explicitly models the functionality of the important APDOS hardware components such as AVL, allows realistic representation of the underlying road network and explicit consideration of time-dependent, stochastic traffic patterns. It

represents various important dispatching strategies that may be applicable for responding to common real-time operational events such as new trip requests, trip cancellation and vehicle breakdown. The simulation system was applied to model a specialized passenger pickup and delivery system - dial-a-ride paratransit. The objective was to evaluate the potential operational improvement that may be attained from the application of AVL. A series of simulation experiments were performed on a set of hypothetical cases and a realistic example from the City of Edmonton, Alberta. The simulation results have shown that AVL benefit due to increased flexibility in dynamic scheduling is highly case-dependent. The observed productivity gain ranged from –2.5% (loss of productivity) to +8.8% with an average productivity increase of 4%. It should be stressed that the simulation study presented in this paper is still limited in representativeness. Further research is needed for a more complete sensitivity analysis with respect to area size, demand distribution, operating policies, dispatching strategies and variation in travel time.

ACKNOWLEDGEMENTS

This research was supported by the Natural Sciences and Engineering Research Council of Canada.

REFERENCES:

1. W. P. M. Savelsberch and M. Sol, "The General Pickup and Delivery Problem", *Transportation Science*, Vol. **29**, No. 1, 1995,17–29.
2. L. Fu and S. Teply, "A Program for Off- and On-line Routing and Scheduling of Paratransit Vehicles", *Computer-Aided Civil and Infrastructure Engineering* **14**, 1999, 309-319.
3. N. H. M. Wilson, J. M. Sussman, H. K. Wong and T. Higonnet, *Scheduling Algorithms for a Dial-a-ride System*, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1971.

"The Elusive Link between Transport Infrastructure and Economic Growth: Testing for Causality between Provincial Infrastructure Capital and Economic Activity"

by
W.G.Waters II
Centre for Transportation Studies
The University of British Columbia
bill.waters@commerce.ubc.ca

1. INTRODUCTION

The causal link between transport infrastructure capital and economic activity has been almost a tenant of faith among transportation professionals. Railways were vital for frontier development as well as for market and political integration in both Canada and the United States. In more recent decades, the development of national road systems and airport facilities are seen as vital to the state of the economy at both the local and national level.

In the last decade, a literature has grown up trying to develop precise quantitative links between public infrastructure, of various types, and economic growth. Aschauer (1989a, 1989b, 1989c) initiated these studies. He showed, *inter alia*, that the much-discussed decline in productivity growth in western nations was strongly correlated with a reduced share of public infrastructure capital in government spending. He investigated this using national time series data as well as data across countries. Munnell (1990a, 1990b) followed his approach using U.S. state data, i.e., using a combined cross-section of states' and time series of years' data. She

appeared to confirm Aschauer's results, i.e., that greater investment in public infrastructure capital is correlated with higher levels of economic activity both across states and over time.

Subsequently, many other authors have investigated this relationship, and different findings and opinions have emerged. Summarized concisely, many of the subsequent authors have found that the apparent strong empirical relationship between infrastructure and economic growth weakens and even disappears once various econometric problems are corrected. That is, there may be a spurious relationships among the variables leading to overestimates of the influence of infrastructure capital on economic growth. For example, over time economies grow and more is spent on infrastructure, but which comes first? Also, looking across different state or provincial economies, wealthier regions have larger stocks of private and public infrastructure capital, but did the infrastructure bring about the higher levels of wealth, or is it just that wealthier regions spend more on infrastructure? Although it cannot be definitive, there are statistical techniques to try to test for causality. This paper applies these Granger Causality Tests to provincial time series data on various measures of public infrastructure capital and provincial economic output. Data cover all 10 provinces and the years 1961-1997.

The paper first provides a capsule summary of the Aschauer-type approach to measuring the link between public infrastructure capital and economic activity, and the findings and controversies that have accompanied this literature. Part 3 of the paper presents the Granger Causality Test and applies it to data across Canadian provinces. The concluding Part 4 discusses the implications of these tests for measuring the links between public infrastructure capital and the level of economic activity.

2. THE ASCHAUER DEBATE: PUBLIC INFRASTRUCTURE CAPITAL AND ECONOMIC GROWTH

2.1 The Aschauer Hypothesis

The Aschauer hypothesis is a statistical investigation of the contribution, if any, of public infrastructure capital to overall economic growth of an economy or region. The most common formulation is to postulate an aggregate production function which relates total output to the quantities of inputs provided. A traditional form of this relationship relates total output (national or provincial GDP) to aggregate quantities of inputs of labour and capital, i.e.,

(1) $Y = f(K, N)$

where Y is GDP, K represents (private) capital inputs and N represents labour inputs. One could (and should) include additional inputs including energy, natural resources, and other inputs, but these data often are not available. By incorporating a time variable t into this formulation, $\partial Y/\partial t$ provides a proxy measure for neutral technological change or productivity growth.

(2) $Y = f(K, N, t)$

Aschauer's innovation was to argue that public infrastructure capital should also have an effect on aggregate output, both directly in terms of output of the government sector but more particularly in enhancing the productivity of labour and private capital. For example, a simple reformulation of (2) is (3):[1]

(3) $Y = Y(K, N, P, t)$

where P refers to the stock of public infrastructure capital and other variables are defined as before.

[1] Aschauer's approach was to divide by private capital first and thus test for the impact of public capital on output/private-capital productivity; Munnell (1990a) used a similar approach focusing on labour productivity.

2.2 Evolution of Recent Empirical Literature

The empirical investigations of the links between infrastructure and economic growth have given rise to a number of issues. One basic question is whether to employ the aggregate production function (3) portrayed above, or to treat public infrastructure capital as having an indirect effect on (1 or 2) via its affect on the productivity of other inputs. In working with equation (3), the issues are whether or not the marginal product of public capital P is significantly positive, and how does its size compare with that of the marginal product of private capital? An alternate approach is to test for an impact if any of public capital on the marginal products of private capital and/or labour in equation 1 (or 2) (further discussion in Oum, Waters and Yu, 1998; see also Fox, 1990). For this paper, we employ the second formulation of the aggregate production function, equation (3).

Lynch (1994) used provincial-level data for B.C. in his exploration of a linkage between road infrastructure and GDP (he used national data as well). Khanam (1996, 1999) used aggregate data for the goods-producing sector for the Canadian provinces to investigate a link between aggregate output and highway capital stocks. She found a significant relationship although she explored only a limited number of econometric specifications. This is an important issue.

Munnell (1990b) used cross-section and time series data of U.S. states and showed a significant link between state GDP and public infrastructure capital, including highway capital. However, several subsequent authors have found that more sophisticated econometric techniques tend to greatly reduce the apparent link between public infrastructure and economic activity (Eisner, 1991; Evans and Karras, 1994; Holtz-Eakin, 1994). There are sources of spurious correlation that may result in misleadingly-high estimates of the causal link between infrastructure and economic growth. One is a time-series problem: as economies grow, more public infrastructure is needed and supplied. But which is the direction of causality? Does

public infrastructure drive the level of economic activity? Or vice versa? Similarly, looking across countries, states or provinces, we observe different size stocks of public (and private) capital infrastructure accompanying different size economies. There is a positive correlation: larger GDP is associated with larger capital stocks, but which is the causal direction? The production function specification in (1-3) postulates a particular direction of causality. But is it correct?

This is the motivation for this paper: to investigate statistically the causal relationship between public infrastructure capital of different types with variations in provincial GDP over time.

3. TESTING FOR CAUSALITY

As noted above, the presumption in aggregate production functions is that economic output is "explained" by the quantities of inputs, viz., amounts of labour and capital employed, along with productivity improvements taking place over time. But there are other macroeconomic relationships that can be postulated. While it is true that inputs produce output, it is also possible that changes in the level of economic output may explain changes in inputs. That is, a rising economy may stimulate private investment hence increases in the private capital stock; similarly, increases in provincial GDP will stimulate employment. Of particular concern for assessing public capital is that while public capital is an input to the aggregate production function, it might also be true that levels of government investment might be "caused" by the growth in the economy. If so, there are "feed-back" linkages between capital stocks, employment and economic activity. The econometric models explored in the previous chapter need to be extended to incorporate these feedback effects (Lynch and DeBenedictis, 1995, explored this issue but were not able to implement it empirically).

3.1 The Data

The data consist of GDP for the 10 provinces, in constant 1992 dollars, for the years 1961-1997. These data are from the

Conference Board of Canada (CBOC). Statistics Canada (StatCan) compiles estimates of total public and private capital stocks, by industry sector and their aggregate for the provinces and territories. Total public capital is not compiled by province, but it can be approximated. We use three measures of public infrastructure capital. Total public infrastructure capital P is measured as the sum of capital stocks for "government service industries", "education service industries" and "health and social service industries". These are end-of-year net stocks, using geometric depreciation, in millions of constant 1992 dollars. These data may include some private capital stocks in these categories but these are thought to be minor.

A more specific measure of public infrastructure capital is to use "engineering construction capital" for "government service industries," labelled E below. Roads and highways are the largest component of this capital series, but it also includes dams and power transmission lines. A still more specific capital series is to use only the roads and highway portion of engineering construction capital. However, these figures normally are not available. Transport Canada worked with StatCan to develop this series (reported in Richardson, 1996, also Khanam, 1996). These data were made available to us, designated H below. These data are only available for the years 1981-1993.

Total private capital K for each province is estimated by subtracting our measure of total public capital P from StatCan's total capital figures for each province. This measure of private capital will include some public capital that StatCan allocated to specific industrial sectors, but this is not thought to be a major item. The measure of labour inputs by province is measured by total provincial employment for the various years; this is from CBOC data.

These data were used to estimate production functions to explore statistical links between the various measures of public infrastructure and provincial GDP (Waters, 1999). The present paper explores one aspect of that study, the question of causality.

3.2 The Granger Causality Test

The issue of causality between variables can be investigated using a Granger causality test (Granger, 1969; a textbook discussion is in Pindyck and Rubinfield, 1991, pp.216-7). Essentially, this uses regression analysis on lagged variables to see whether income is more likely explained by capital stocks, or vice versa. This is not a definitive proof of causality, but it is a recognized statistical test for this purpose.

> "The basic idea is quite simple: If *X* causes *Y*, then changes in X should *precede* changes in Y. In particular, to say that 'X causes Y,' two conditions should be met. First, X should help to predict Y, i.e., in a regression of Y against past values of Y, the addition of past values of X as independent variables should contribute significantly to the explanatory power of the regression. Second, Y should *not* help to predict X. The reason is that if X helps to predict Y *and* Y helps to predict X, it is likely that one or more other variables are in fact 'causing' both X and Y."
>
> (Pindyck and Rubinfield, 1969, p.216)

We first illustrate the Granger causality test for B.C.-only data. Subsequently we apply the causality tests to other provinces' data.

3.3 The Causality Test for B.C.

We explore the causality question for the variables sequentially. Consider employment first. The working hypothesis of the production function concept is that labour inputs result in economic output (GDP). But one can also postulate a macroeconomic relationship that "increases in income creates jobs," i.e., the reverse causality. To investigate this, we carry out and compare four regressions. First we the influence of labour on income via two regressions:

$$Y = a_0 + \sum_{i=1}^{m} a_i Y_{t-i} + \sum_{i=1}^{m} b_i N_{t-i} + e_t \quad (4)$$

and

$$Y = a_0 + \sum_{i=1}^{m} a_i Y_{t-i} + e_t \quad (5)$$

and test whether or not the first regression predicts significantly better than the second. Next we set out two more regressions to investigate the alternative causality:

$$N = a_0 + \sum_{i=1}^{m} a_i N_{t-i} + \sum_{i=1}^{m} b_i Y_{t-i} + e_t \quad (6)$$

$$N = a_0 + \sum_{i=1}^{m} a_i N_{t-i} + e_t \quad (7)$$

Equations (4) and (6) are "unrestricted" regressions, whereas equations (5) and (7) are "restricted." An F test is used to determine whether the lagged N variables (we choose 3 year lags, i.e. m=3) contribute significantly to the first regression, i.e., is regression (4) superior to (5)? The F-statistic is as follows:

$$F = (T-k)\frac{(ESS_R - ESS_{UR})}{q(ESS_{UR})}$$

Where ESS_R and ESS_{UR} are the sum of squared residuals in the restricted and unrestricted regressions, respectively; T is the number of observations, k is the number of estimated parameters in the unrestricted regression; and q is the number of parameter restrictions.

Similarly, we apply an F test to regressions (6) and (7) to see if we can reject the argument that Y explains N rather than vice versa.

In similar fashion, we apply the Granger causality test to each of our other explanatory variables: private capital K, and the various definitions of public capital P, E and H. For completeness we also include P-E and P-H, i.e., public infrastructure excluding highways and similar engineering construction capital. The F

statistics are reported in Table 1 for B.C. (Table 1 shows the working hypothesis of interest, i.e., the causality; actually Table 1 is conducted postulating the null hypothesis that causality is *not* present and see if we can reject the null hypothesis).

Table 1 indicates that only private capital "causes" GDP in a statistically significant way (5.7% significance probability), and public engineering construction capital has a causal effect on GDP but only at a lower level of significance (prob. = 12.%4). On the other hand, economic output "causes" employment and "other" public capital P-E and P-H, i.e., the causality is the reverse of what is postulated in the production function specification. There are no causal directions between highway capital and output, and there are no double-direction causation between the independent variables and GDP for British Columbia.

Table 1: F-statistics of Causality Tests: British Columbia

Hypothe-sis	N	K	P	E	P-E	H	P-H
X causes Y	0.587 (0.63)	2.92** (0.06)	0.823 (0.49)	2.10** (0.12)	0.068 (0.98)	0.217 (0.88)	1.350 (0.28)
Y causes X	3.226* (0.04)	0.762 (0.52)	1.865 (0.16)	0.570 (0.64)	7.224* (0.00)	0.541 (0.66	3.77* (0.02)

Probability values are in the parenthesis; *: 5% significant level; ** 10% level; ***: 15%
X represents all independent variables N,K,P,E,H and P-E and P-H;
k=7, q=3, T=30 for H and P-H and T=34 for the others.

3.4 Causality Tests for All Provinces and Variables

The Granger causality tests have been carried out for all provinces and variables. Table 2 presents the causality test results for the other provinces, going west to east (excluding PEI for data reasons).[2] For Alberta, all of the variables show causality

[2] PEI was eliminated from the data set for two reasons. First, we noticed that the Confederation Bridge was recorded as private sector investment rather than as public infrastructure. The financing arrangements do not change it

influencing income, although the statistical significance varies. Total public and "other" public capital (P-E, P-H) are the most significant variables, along with private capital K. Four variables show dual directional causality: private capital, "other" public capital and, especially, highway capital. The latter shows strong reverse causality, i.e., lagged values of income strongly correlated with subsequent values of highway capital stocks.

Saskatchewan shows a positive influence on provincial GDP of highway as well as total and "other" public capital. Past values of GDP show a significant influence on engineering capital E and its "other" public capital complement P-E, but curiously total public capital P is not significant. Past values of income influence total private capital K and highway capital H.

Manitoba data show only private capital influencing GDP significantly, and reverse causality for employment.

Ontario and Quebec data show no directional causality of the variables on their respective GDPs. Ontario shows reverse causality primarily on private capital K and less significance for employment and the two definitions of "other" public capital. Quebec shows reverse causality primarily for private capital and employment, but also for total public capital as well as that category less engineering capital.

Turning to the Eastern Provinces (excluding PEI), private capital is strongly significant influencing GDP in New Brunswick and to a lesser extent in Newfoundland. Other public capital excluding engineering construction capital also is moderately significant for New Brunswick. None of the input variables are significantly associated with GDP levels for Nova Scotia. Looking at the reverse causality, lagged values of GDP influence employment levels significantly for all three provinces, and influence private capital

---

from being infrastructure. Second, there were evident errors in PEI highway capital stock figures.

stocks in Newfoundland and Nova Scotia. Nova Scotia also shows lagged income levels significantly influence subsequent stocks of "other" public capital.

Table 2: F Statistics of Causality Tests for Other Eight Provinces (Excluding BC and PEI)
(Prob. Value in parenthesis; Bold are significant at 10% level)

ALBERTA

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	**3.80**	**5.92**	**7.37**	**3.41**	**6.23**	2.22	**7.21**
	(0.02)	(0.00)	(0.00)	(0.03)	(0.00)	(0.11)	(0.00)
Y causes X	1.51	**3.58**	1.28	1.96	**3.20**	**6.22**	**4.28**
	(0.23)	(0.03)	(0.30)	(0.14)	(0.04)	(0.00)	(0.02)

SASKATCHEWAN

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	1.45	0.92	**5.31**	0.94	**4.35**	**4.61**	**3.29**
	(0.25)	(0.44)	(0.01)	(0.43)	(0.01)	(0.01)	(0.04)
Y causes X	1.29	**9.48**	1.40	**11.87**	**6.85**	**2.65**	**8.13**
	(0.30)	(0.00)	(0.26)	(0.00)	(0.00)	(0.07)	(0.00)

MANITOBA

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	0.35	**2.78**	0.01	0.01	0.12	0.99	0.23
	(0.79)	(0.06)	(0.98)	(0.97)	(0.95)	(0.42)	(0.88)
Y causes X	**3.20**	0.55	0.34	1.20	0.23	0.56	0.32
	(0.04)	(0.65)	(0.80)	(0.33)	(0.87)	(0.65)	(0.81)

ONTARIO

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	0.37	1.10	0.25	1.21	0.00	0.89	0.15
	(0.77)	(0.37)	(0.86)	(0.33)	(1.00)	(0.47)	(0.93)
Y causes X	**2.23**	**5.54**	1.86	0.77	**2.74**	1.65	**2.49**
	(0.11)	(0.00)	(0.16)	(0.52)	(0.06)	(0.21)	(0.09)

QUEBEC

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	2.07	2.12	0.08	0.16	0.26	0.82	0.48
	(0.13)	(0.12)	(0.97)	(0.92)	(0.86)	(0.50)	(0.70)
Y causes X	**3.47**	**3.33**	2.62	1.50	**2.66**	0.18	1.83
	(0.03)	(0.03)	(0.07)	(0.24)	(0.07)	(0.91)	(0.17)

NEW BRUNSWICK

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	1.78	**7.98**	1.20	1.19	**2.67**	1.05	1.86
	(0.18)	(0.00)	(0.33)	(0.33)	(0.07)	(0.39)	(0.16)
Y causes X	**5.19**	1.15	1.18	0.68	0.44	0.38	0.54
	(0.01)	(0.35)	(0.34)	(0.57)	(0.73)	(0.77)	(0.66)

NOVA SCOTIA

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	0.52	2.05	1.81	1.27	1.63	0.65	1.68
	(0.67)	(0.13)	(0.17)	(0.30)	(0.21)	(0.59)	(0.20)
Y causes X	**4.74**	**2.30**	1.27	0.76	**2.58**	0.14	**2.97**
	(0.01)	(0.10)	(0.31)	(0.52)	(0.02)	(0.93)	(0.05)

NEWFOUNDLAND

Hypothesis	N	K	P	E	P-E	H	P-H
X causes Y	1.94	**2.34**	0.87	0.76	0.75	0.75	0.88
	(0.15)	(0.10)	(0.47)	(0.53)	(0.53)	(0.54)	(0.47)
Y causes X	**5.27**	**3.27**	0.81	1.73	0.23	1.73	0.30
	(0.01)	(0.04)	(0.50)	(0.18)	(0.87)	(0.19)	(0.82)

Table 3 summarises the results of the causality tests applied across the 9 provinces using a 10 percent significance level. Table 3 shows quite mixed results, but by and large the causality is contrary to the production function specification, most notably for labour. That is, the data suggest that variations in GDP explain variations in employment, rather than vice versa.

Table 3: Causality Tests: Summary

1. Do Labour and Capital affect GDP?

Variable	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	NFLD	# Yes
Labour (N)	No	Yes*	No	No	No	No	No	No	No	1
Private_K (K)	Yes**	Yes*	No	Yes**	No	No	Yes*	No	Yes**	5
Public_K (P)	No	Yes*	Yes*	No	No	No	No	No	No	2
OtherP_K(P-E)	No	Yes*	Yes*	No	No	No	Yes**	No	No	3
Engineering (E)	No	Yes*	No	No	No	No	No	No	No	1
OtherP_K(P-H)	No	Yes*	Yes*	No	No	No	No	No	No	2
Highway (H)	No	No	Yes*	No	No	No	No	No	No	1

2. Does GDP affect Labor and Capital?

Variable	BC	ALTA	SASK	MAN	ONT	QUE	NB	NS	NFLD	# Yes
Labour (N)	Yes*	No	No	Yes*	Yes**	Yes*	Yes*	Yes*	Yes*	7
Private_K (K)	No	Yes*	Yes*	No	Yes*	Yes*	No	Yes**	Yes*	6
Public_K (P)	No	No	No	No	No	Yes**	No	No	No	1
OtherP_K(P-E)	Yes*	Yes*	Yes*	No	Yes**	Yes**	No	Yes*	No	6
Engineering (E)	No	No	Yes*	No	No	No	No	No	No	1
OtherP_K(P-H)	Yes*	Yes*	Yes*	No	Yes**	No	No	Yes**	No	5
Highway (H)	No	Yes*	Yes**	No	No	No	No	No	No	2

*: prob. value below 0.05; **: prob. value below 0.10.

4. CONCLUSIONS AND IMPLICATIONS

This study has investigated the directional or statistical causality between provincial income (GDP) and various measures of

inputs including labour, private capital and various measures of public capital. The results suggest that the recent approaches to investigating the link between public infrastructure and economic growth are not specified adequately. The results of the directional causality tests suggest that short run cyclical macro economic relationships are what are being indicated by the data, rather than the relationships postulated in a production function. Rather than labour explaining output levels, the latter explain the former. Thinking about it, this is quite plausible. Regression analysis explains the variations in the data about the mean or about a trend line. Once spurious sources of correlation are eliminated, such as trends or serial correlation, it is likely that year-to-year values of macro variables will reflect short-term shocks and reactions in the economy. Attempting to establish a statistical link between infrastructure capital stocks and economic growth is difficult because the long term relationships may be obscured by short-term cyclical patterns.

The research direction is to find ways to model both the long term production relationships but also taking into account short run reverse or dual causality between output and input categories (Lynch and DeBenedictis, 1995, formulated one such model). The easiest to deal with might be labour. We should jointly estimate labour as a function of income at the same time we estimate the production function which postulates the opposite causality. A reverse or dual causality for capital stocks is more difficult to formulate. We tested for whether or not recent values of capital stocks (private and public) influence current income more than simply using lagged values of income, and conversely, whether or not recent values of provincial income help explain the current capital stock values more than only using lagged values of the capital stock. But it would be implausible to postulate the current capital stock solely as a function of current income levels, the nature of a capital stock is it has to be linked to previous values of that capital stock. An important research direction is to model capital accumulation along with a formulation of production functions in order to clarify and distinguish short term macroeconomic fluctuations from long term linkages between infrastructure and economic output.

ACKNOWLEDGEMENTS
The author wishes to thank Bangqiao Jiang for his excellent research assistance. Thanks to Bilkis Khanam for discussions prior to commencing this study, and for supplying some data. The B.C. Ministry of Transportation and Highways provided financial assistance. Helpful comments were received on an earlier draft from David Gillen, Tom Kearns, Mark Lynch and Chunyan Yu. The author remains responsible for the analysis and views expressed.

REFERENCES

Aschauer, D.A., (1989a), "Is Public Expenditure Productive?", *Journal of Monetary Economics*, 23, 177-200

Aschauer, D.A., (1989b), "Does Public Capital Crowd Out Private Capital?", *Journal of Monetary Economics*, 24, 171-188

Aschauer, D.A., (1989c), "Public Investment and Productivity Growth in the Group of Seven", *Economic Perspectives*, 13(5), 17-25

Eisner, R., (1991), "Infrastructure and Regional Economic Performance: Comment", *New England Economic Review*, 45-58

Evans, P., and Karras, G., (1994), "Are Government Activities Productive? Evidence From A Panel of U.S. States", *Review of Economics and Statistics*, 1-12

Fox, W.F., (1990), "The Contribution of Infrastructure Investments to Growth: A Review of the Literature", Faculty of Economics, the University of Tennessee, Memphis, United States

Granger, C.W.J. (1969) , "Investigating Causal Relations by Econometric Models and Cross-spectral Methods, *Econometrica* 37,424-38.

Holtz-Eakin, D., (1994), "Public Sector Capital and Productivity Puzzle", *Review of Economics and Statistics*, 574-582

Khanam, B., (1999), "Contributions of Highway Capital to Output, Cost, and Productivity Growth: Evidence from the Canadian Goods-producing Sector", Ph.D Dissertation, York University, Ontario, Canada

Khanam, B., (1996), "Highway Infrastructure Capital and Productivity: Evidence from the Canadian Goods-Producing Sector", *Logistics and Transportation Review*, No. 32, 251-268

Lynch, M., (1994), "Applied Economics: Linking Transportation Policy and Economic Growth", *Proceedings* Canadian Transportation Research Forum, (Saskatoon: Univ. of Saskatchewan Printing Services),

Lynch, M. and L. DeBenedictis, (1995,), "Linking Transportation Infrastructure Investments and Economic Growth: On the Causality Trail", *Proceedings* Canadian Transportation Research Forum (Saskatoon: Univ. of Saskatchewan Printing Services), 217-31.

Munnell, A.H., (1990a), " Why Has Productivity Growth Declined? Productivity and Public Investment", *New England Economic Review*, 3-22

Munnell, A.H., (1990b), " How Does Public Infrastructure Affect Regional Economic Performance", *New England Economic Review*, 11-33

Oum, T.H., W.G. Waters and Chunyan Yu, (1998), "Development of an Econometric Model Linking Public Transportation Investments to Economic Growth in British Columbia", The Centre for Transportation Studies, The University of British Columbia

Pindyck, R., and D. Rubinfeld, (1991), *Econometric Models and Economic Forecasts*, Third Edition, McGraw-Hill

Richardson, S. (1996) "Valuation of the Canadian Road and Highway System," Transport Canada Economic Analysis Branch Report, TP-12794E.

Waters, W.G., II (1999) "Empirical Analysis of Public Infrastructure Capital and Economic Growth – British Columbia and Cross-Provincial Estimates," Report by the UBC Centre for Transportation Studies, Vancouver, Dec. 31.

The Impact of the Fredericton Airport on the Knowledge Industry In Central and Western New Brunswick

J. David Innes
John R. G. Brander
Manivannan Rajendran

UNB Transportation Group
University of New Brunswick

EXECUTIVE SUMMARY

The importance of airports to the economy of communities has long been recognized. In recent years, the nature of commerce has been transformed by emerging technologies and greater levels of international trade. Fredericton, specifically has enjoyed significant growth in this environment. The knowledge industry has become a dominant industry in the Fredericton area.

In 1999, the UNB Transportation group undertook a study of the

importance of the Fredericton Airport to this sector of the economy. This paper reports the results of that study. The paper examines the nature of the industry and outlines its growth in recent years and its importance to the local economy. The paper then examines the economic importance of the airport to that industry. The economic importance is evaluated by measuring the impact of the loss of the airport. The analysis is based on a survey of those industries and an examination of the proportion of their work which is not local and which would be lost if convenient and good air transport was not available. It is concluded that air services are absolutely essential if this sector of the economy is to be maintained and nurtured.

INTRODUCTION

In recent years, the only constant has been change. Commerce has been profoundly affected by technology and a climate of more disperse trade patterns. The structure of the Canadian economy has undergone great changes in the past two decades. These have been caused by the increased use of knowledge and technology in all sectors of the economy. Services and high-technology manufacturing have gained larger market shares than the low-technology manufacturing, construction, natural resources, and medium-tech manufacturing industries (Industry Canada, 1997). The globalization of business has occurred.

These changes have been manifested not only in the larger centres, but have penetrated small businesses in remote and small centres. In the small towns of western New Brunswick, it would seem that successful contemporary businesses are those which appeal to a national or international marketplace. The majority of commercial enterprises a generation ago on the other hand concentrated on the needs of a local market.

Fredericton has been the site of growth and expansion of the knowledge industry. While the city has been home to universities and offshoot consulting industries for some time, in recent years the growth in this type of activity has been more pronounced with a growing number of knowledge-based business in the service sector. Fredericton is now a hub for knowledge-based services including engineering consultants and information technology firms. It supports a considerable number of engineers and technical professionals.

The overall objective of the study undertaken was to describe and estimate the economic impact of the Fredericton Airport on knowledge-based businesses. The businesses included in the study were the information technology and engineering consultant firms as the predominant knowledge-based industries in the Fredericton region The economic impact was estimated in terms of employment and salary benefits to the residents, revenue flows into the region and tax benefits to the government. The study also projects the benefits of the airport to the knowledge based-businesses over the next five years and estimates the losses to the economy if the airport was no longer available for use.

The study was based on the following data: air-travel, employment, salaries, revenues and markets of knowledge-based businesses. These data were collected through a mail survey of IT and engineering consultant firms. For those firms, with inadequate information on revenues and salaries, the respective provincial averages were derived from secondary sources.

Two scenarios were considered to estimate the economic impact of the airport: one with the airport as is, and the other with the airport closed. The first scenario with the airport as is provided direct and total impact of the airport on the knowledge-based community. Industry specific input-output multipliers provided by the province are employed to estimate the total impact of the airport. The economic benefits of the

airport on businesses over next five years were projected from the total impact and survey information on future business expansions.

The second scenario considered the airport being closed. This scenario developed an estimate of the resulting immediate losses to the region. This estimate was based on the survey information on businesses that would move out of the Fredericton region, if the airport was no longer available.

FREDERICTON'S ECONOMY

The Fredericton region has a population of 121,520 while the city of Fredericton has 46,155 (Census 1996). Fredericton has the second highest per-capita income in the Atlantic region and sixth highest of any Canadian city in the 30,000-100,000 population group (GFEDC,1998). The region has a highly educated work force with about 48% of the labour force having some level of post secondary education. (Source: Statistics Canada, 1996)

The major economic sectors of the Fredericton region are public sector employment, information technology, engineering, manufacturing, retail, forestry and education/training (City of Fredericton 1999). It is the province's largest employer in the public sector including government, education, health and social service jobs with the public sector employing about 39% of the work force.

Fredericton is also the province's largest employer in the Information Technology sector and accounts for more than 40% of the provinces IT work force. The distribution of labor force by industry type is shown in Figure 1.

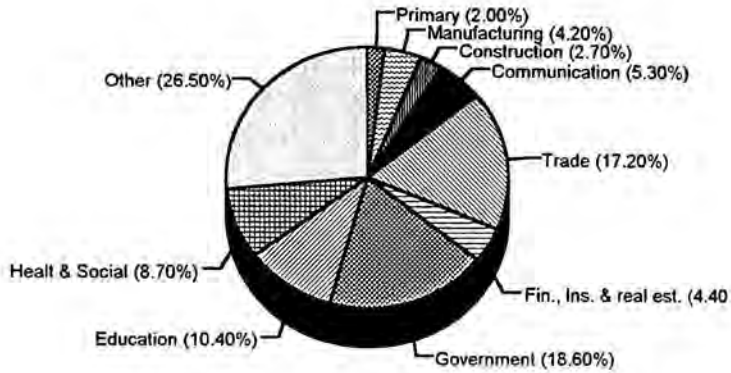


Figure 1
Greater Fredericton's Labor Force by Industry Type
(Source: Statistics Canada, 2B profile & 1996 Labour Force Survey)

It is noted that primary, manufacturing and construction industries together account for less than 9% of the total work force, while a wide range of service industries employ a major share of the work force. Fredericton has the largest service sector employment in the province.

THE KNOWLEDGE-BASED ECONOMY

Fredericton's knowledge-based industries are largely knowledge-using high-knowledge industries in the service sector. High-knowledge

industries employ high-knowledge/skilled work force and pay wages at rates higher than other sectors. The major knowledge-based businesses include the IT and engineering firms.

The Information Technology(IT) industry is the largest group of high-knowledge industry in the province. The number of IT firms grew 27% during 1997-98 in the province. A skilled local work force supported by an advanced telecommunication system has made Fredericton a leader in the IT sector. (Source: Information Highway Division, Department of Economic Development, Tourism and Culture, 1999).

IT companies in and around Fredericton employ about 1700 people which accounts for 63% of the total IT employment of the province. Within the local IT sector, computer system design and software development account for 50% of the employment.

Engineering consultant firms' are the other major group of knowledge-based businesses in the Fredericton region. Fredericton, for instance, has as many consulting engineers as does Winnipeg although it is only a fraction of that cities size. There are about 75 consulting and engineering firms in the Fredericton region employing a professional work force of approximately 750.

THE KNOWLEDGE ECONOMY AND THE AIRPORT

Knowledge-based businesses need good access to their markets. The distribution of markets by revenue for the knowledge-based businesses of the Fredericton region including the IT and engineering consultant firms are shown in the Figure 2.

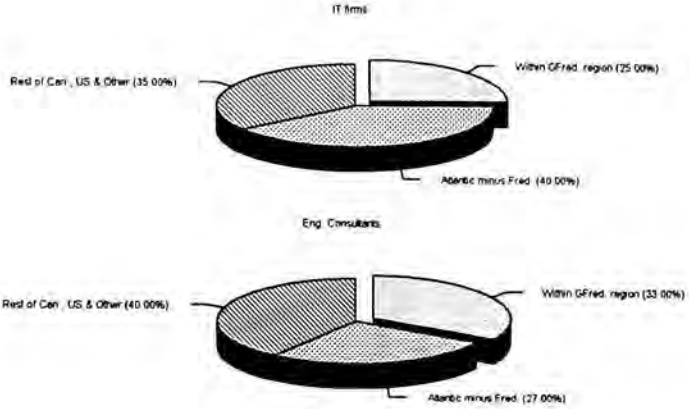


Figure 2.4
Distribution of Markets for Fredericton's Knowledge-Based Businesses

It can be seen that 70% of the total market for Fredericton's knowledge-based businesses including the IT and engineering firms, exists outside the Fredericton region and 50% of those external markets are distributed over the US, and central and west Canada (refer Appendix C). Thus, Fredericton's knowledge-based industries have a wide external market. Direct links to those markets are essential for their existence.

Fredericton air traffic constitutes largely of business traffic. A business survey carried out by the Greater Fredericton Airport Authority estimated that approximately two-third of the total air traffic destined to US is related to businesses.

MEASURING THE ECONOMIC IMPACTS

The benefits of an airport to an economy is the result of either direct and/or indirect consequence of the airport's activity within its influence region. This study assumed two different scenarios; one with the airport as is, and the other with the airport closed. The difference is then the benefit of the airport to the local economy.

Fredericton's knowledge-based businesses are high-knowledge service industries including the IT and engineering and consultant firms. These firms predominantly require high knowledge and/or high skilled human resources as the input for their production process. Unlike the manufacturing and primary industries, wherein a large amount is spent in purchasing material intermediaries from external markets, knowledge-based businesses do not expend money in purchasing material intermediaries from outside the local economy. Conversely, the produce of the knowledge-based business' find their final demand, either outside the province or country and hence the money predominantly flows into the region which would be spent and respent within the local economy.

The economic impact of Fredericton's airport on knowledge-based businesses were quantified in-terms of revenues earned, and employment and payroll benefits. The impacts were classified into two different levels depending on its level of penetration. These were the Direct impacts and the Total impacts.

DIRECT IMPACTS

The direct impact quantifies the total revenues earned, payroll and employment generated by knowledge-based businesses. The direct impacts of the airport on knowledge-based businesses included:

1.	Impact of Revenue =	Total revenue earned by knowledge-based businesses
2.	Impact of Employment =	Total work force (full time and part time) employed with knowledge-based businesses
3.	Impact of Payroll=	Total employment in knowledge-based businesses times the Annual average payroll in knowledge-based businesses.

TOTAL IMPACTS

The total impact quantifies the spinoffs generated by the knowledge-based businesses in addition to their direct impact on Fredericton's economy. The economic spinoffs are the additional economic activity generated by the spending and respending of the income of firms and employees of knowledge-based businesses, until all of the money is absorbed within the influence region. The economic spinoffs also known as the multiplier affects, takes into account the money that leaks out of the local economy.

The total impact of a sector on the economy were estimated using industry specific input-output multipliers. Statistics Canada provides multipliers by province at four different levels of aggregation. The Income multiplier, Employment multiplier and the Gross Domestic Product (GDP) multipliers by SIC industry may be employed to determine the total payroll, employment and revenue impacts of knowledge-based businesses of Greater Fredericton Region. The total impacts of the airport on knowledge-based businesses were estimated as follows:

1.	Total Payroll Impact	=	Total income x Income multiplier
2.	Total Employment Impact	=	Total employment x Employment multiplier
3.	Total Revenue Impact	=	Total revenues x GDP multiplier

DATA COLLECTION

The data required to estimate the economic benefits of the airport on knowledge-based businesses are primarily collected through a mail survey of the businesses including the IT and engineering consultant firms. The primary objective of the survey was to collect data to estimate the economic benefits of the Fredericton Airport to knowledge-based businesses and the losses to the economy if the airport was no longer available. The survey also identifies the travel needs and demands of the business sector from the airport. The questionnaire was broadly divided into four sections including sections on business travel, employment and payroll, future business growth, and revenues by markets.

ESTIMATE OF BENEFITS AND LOSSES

The benefits to Fredericton's knowledge-based economy if the airport were to exist and the loses to economy if the airport were to close can be represented as shown in Figure 3. The diagram represents the economy under different scenarios with and without the airport, over the base and horizon years.

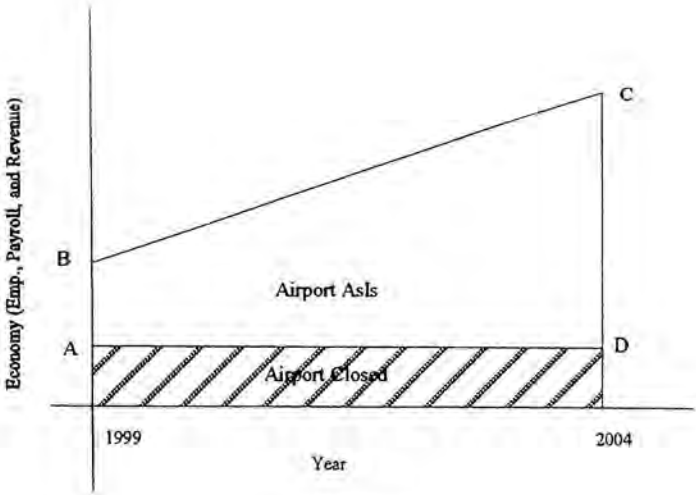


Figure 3

Economies under scenarios of with and without the airport

A basic assumption is made that if the airport was closed the economic activity would shrink and continue to remain the same over the next five years. In the diagram, B represents the total benefits to economy during the base year and C represents the total benefits during the horizon year if the airport exists. The difference between A and B represents the losses to Fredericton's economy for the base year and the differences between C and D represents the loses to economy for the horizon year if the airport is no more available for use. Thus from the values of A, B, C and D the benefits and loses to economy can be quantified.

Table 1 shows the value for A, B, C and D in terms of direct and total economy, under different scenarios for the base year 1999 and a horizon year 2004.

Table 1
Fredericton's knowledge-based economy for the base and horizon years

	Economy. with Airport As Is				Economy. with Airport Closed	
	Base Year (B)		Horizon Year (C)		Base & Horizon year (A or D)	
	Direct	Total	Direct	Total	Direct	Total
Emp.	2568	3505	3911	5338	2057	2808
Payroll (millions)	105	139	163	216	84	111
Revenue (millions)	323	460	430	625	260	370

Employing the values from the Table 1 in Figure 3, the direct and total benefits to economy are estimated in Table 2.

Table 2
Direct and Total Benefits to Fredericton's Economy

	Base year		Horizon year	
	Direct	Total	Direct	Total
Emp.	2568	3505	3911	5338
Payroll(millions)	105	139	163	216
Revenue (millions)	323	460	430	625

The total losses to Fredericton's economy may be estimated from the figure as:

Loses to Economy (Base year) = Total econ. with airport as is (B) -Total econ. with airport closed (A)

Loses to Economy (Horizon year) = Total econ. with airport as is (C) - Total econ. with airport closed (D or A)

Thus the direct and total losses to economy if the airport were closed were estimated and is summarized in the Table 3.

Table 3
Direct and Total Loses to Fredericton's Economy if Airport were Closed

	Base year		Horizon year	
	Direct	Total	Direct	Total
Emp.	511	697	1,854	2530
Payroll (millions)	21	28	79	105
Revenue (millions)	62	90	169	254

CONCLUSIONS

This study examined the major knowledge-based sector including the IT and engineering firms, that largely depends on the Airport for its businesses. It then estimated the size of their businesses that relies on the airport for commercial travel. Through a meticulously designed survey, the study identified the proportion of external businesses existing for the knowledge-based businesses and hence their dependence on the airport for the sustenance of their businesses now and in the future.

The study estimated that, on an average, about 70% of the total markets for Fredericton's knowledge-based businesses including the IT and engineering firms, exists outside the Greater Fredericton region and 50% of those external markets are distributed over the US, and Central and western Canada.

If the airport exists as is, the total benefit during the current year (1999) to knowledge-based economy of the Fredericton region is estimated at 3,500 in employment and $140 and $460 million in payroll and revenue respectively. The total benefit to the economy for the horizon year (2004) was estimated at 5,300 in employment and $215 and $625 millions in payroll and revenue respectively.

If the airport is closed, then the total economic loses to the Fredericton region for the current year is estimated at 700 in employment and $28 and $90 million in payroll and revenue respectively. If the trend continues into the future, without the airport facility, then the region is estimated to lose about 2,500 jobs and $105 and $255 million in payroll and revenue respectively.

The study clearly demonstrates that the present knowledge-based business of Greater Fredericton region has a wide external trade and the sustenance of those businesses and hence, the economy largely rests on the availability of a good airport facility.

REFERENCES

Census. 1996, *New Brunswick Population and Dwelling Counts,* New Brunswick Statistics Agency, Fredericton, New Brunswick.

City of Fredericton. 1999. *Economic Region Profile,* A Report by Planning and Development Division, Fredericton, NewBrunswick.

Industry Canada. 1997. *The Knowledge-Based Economy: Shifts in Industrial Output*, Working Paper Number 15, Ottawa, Ontario.

Information Highway. 1999. A report by Department of Economic Development, Tourism and Culture, Fredericton, NewBrunswick.

Isard, W. 1960. *Methods of Regional Analysis: An Introduction to Regional Science*, The MIT Press.

Jarvis, J., and Unger, V. E. 1976. *Analysis of Economic Impact Associated with Development of an Airport-Industrial Complex*, Transportation Research Record 588, Washington, D.C., p. 35.

Mazerolle, T.M. 1990. *An Airport Economic Impact Study Procedure for Atlantic Canada*, University of New Brunswick, Fredericton, NewBrunswick.

Miller, E. R. and Blair, D. P. 1985. *Input-Output Analysis: Foundations and Extensions*, Prentice-Hall, Inc., New Jersey.

Montalvo, G. J. 1998. *A Methodological Proposal to Analyze the Economic Impact of Airports*, International Journal of Transport Economics, Vol. XXV-No. 2, pp. 182-203.

Perera, H. M. 1987. *Framework for Classifying and Evaluating Economic Impacts caused by a Transportation Improvement*, Transportation Research Record 1274, Washington, D.C., pp. 41-52.

Stewart, E. B., and Laurence, J. K. 1987. *Measuring the Regional Transportation Benefits and Economic Impacts of Airports*, Transportation Research Board, Issue 1116, Washington, D.C., pp. 63-69.

Transportation Subsidies in Canada, 1987-1997

Wade W. Derkson
Research Associate
Transport Institute
University of Manitoba

1. Introduction

The 1980s and 1990s saw a new policy direction in Canada, one that sought to allow market forces to govern the evolution of Canada's transportation system. The *Canada Transportation Act* of 1996 effectively completes the process of devolution and commercialization toward the objective of full cost recovery.

The topic of transportation subsidies in Canada has always been an important one given the role which transportation has played in the development of the nation. On the one hand, the geography and economic history of the nation made the provision of east-west transportation links a matter of national necessity. On the other hand, regional heterogeneity and specific regional conditions have historically given rise to regional concerns with transport policy and to specific subsidies.

The purpose of this paper is to simply give a factual review of the federal government's withdrawal from subsidies and programs while documenting the revenues received from taxes and, now, user fees.

2. Data Sources and Issues

The collection and public dissemination of transportation data has changed significantly in the last few years. Prior to 1996 transportation information was not compiled in a single source. The

CTA changed that by directing Transport Canada to provide quantitative information to the public through its Annual Report, *Transportation in Canada* and through the "T-Facts" information system via the Internet. This has greatly improved the convenience of accessing transportation data in Canada, which was long a serious problem. However, other longstanding problems remain, principally the availability of transportation expenditures made by departments other than the Ministry of Transport and regional (provincial) distributions. For this reason, one must look to the Public Accounts.

Federal expenditure and revenue figures at the provincial level, while not necessarily secret are difficult to obtain and isolate. Transport Canada published a report entitled *Government Expenditures on Transportation by Province* in 1992 but the project was abandoned thereafter. This publication provides a provincial breakdown for net Transport Canada and NTA spending for the years 1987/88 – 1990/91. Data for subsequent years was obtained from Transport Canada but it does not include NTA/CTA expenditures at the provincial level. Consequently meaningful provincial comparisons could not be made for all modes or all programs.

Direct Versus Indirect Subsidies

Direct subsidies (i.e. grants and contributions) are payments to freight and passenger carriers intended to help cover operating deficits, to compensate for statutory rate reductions and to cover carrier expenditures on infrastructure (e.g. railway branchlines).

Indirect subsidies are normally defined as the difference between public expenditures on transportation-related infrastructure and services that can be attributed to a particular mode and revenues that can also be attributable to that mode. Expenditures include all operating and maintenance costs (e.g. road repairs), system

information and control services (e.g. air traffic control), administrative costs and the costs of infrastructure capital.[1]

3. Overview of Federal Government Transportation Revenues and Expenditures

Since 1992/93 federal government revenues have cumulatively exceeded gross expenditures by almost $10 billion (includes 1998/99).[2] In recent years one-time federal payments to accommodate the transition to a privatized air navigation system (ANS) ($1.2 billion to NAV Canada since 1996/97) and the end of Labrador ferry service ($350 million in 1997/98) obscured the general trend. For this reason they, along with revenues derived from their sale, have been removed from the following account.

Gross Federal Spending

Gross federal expenditures on transportation are projected to be only slightly higher than $2 billion in 1998/99 – a 65% decline from 1987/88 levels. **Figure 1** shows gross spending decline since 1987/88 against the background of increasing (tax) revenue in the 1990s. The forecast indicates a continuation of this trend into the next century.

Figure 2 and **Figure 3** show federal gross spending levels for Transport Canada and other agencies (e.g. Canadian Transportation Agency) and departments (e.g. Fisheries and Oceans). Total gross federal expenditures on transportation have declined at an average annual rate of 8.8%. As a percentage of total federal expenditures transportation expenditures have fallen from 2.9% in 1991/92 to 1.4% in 1998/99.

---

[1] Hickling Corporation, *Transportation Subsidies in Canada.* Prepared for the National Transportation Act Review Commission, 1992.

[2] Figures have been adjusted for inflation and are in current (1997/98) dollars. Forecasts are derived from planned spending published in Government of Canada Estimates and are indicated as such in the charts.

FIGURE 1: FEDERAL TRANSPORTATION SPENDING AND REVENUES, 1987/88-2002/03

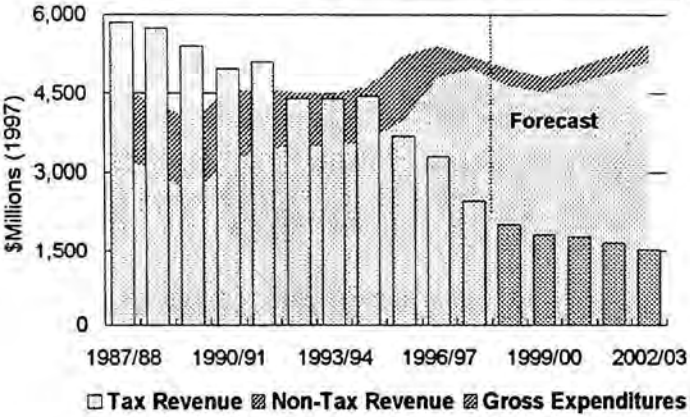


FIGURE 2: TRANSPORT CANADA AND OTHER SPENDING, 1987/88-2002/03

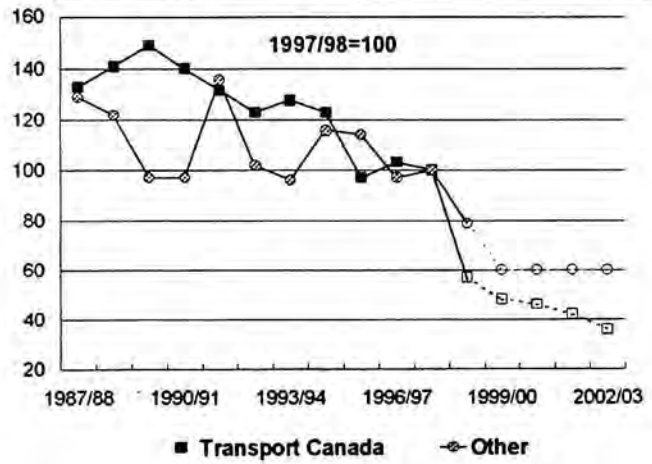
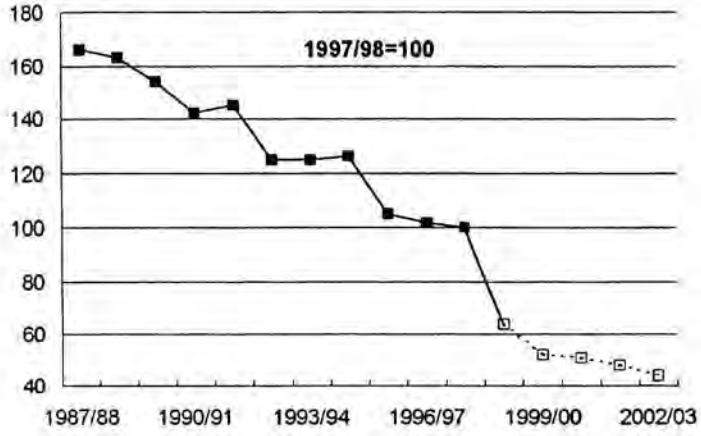


FIGURE 3: FEDERAL TRANSPORTATION SPENDING, 1987/88-2002/03



Commercialization and Divestiture

Transport Canada planned expenditures in 1998/99 are 66% less than 1987/88 levels as a result of privatization and divestiture of assets. The federal government has also benefited from the sale of public assets.

4. Direct Subsidies

Direct subsidies are payments intended to help cover carrier operating deficits and expenditures on infrastructure or to compensate for statutory rate reductions. Historically they have accounted for much of the federal spending on transportation (over $18 billion since 1987/88).

Decline of Rail Subsidies

Payments to Canadian railways accounted for over 90% of all subsidies; in 1987/88; by 1997/98 rail's share had fallen to less than 15%. Today subsidies to railways are 88% less than in 1987/88, declining at an average annual rate of 13.8%. There are two reasons:

1) Regional freight subsidies such as WGTA/ARFA ended in 1995/96;

2) VIA subsidies have declined from over $750 million in 1987/88 to $216 million in 1997/98.

Roads & Bridges

Historically the federal government has had limited involvement with highway funding, viewing them as provincial jurisdiction. The majority of federal subsidies to roads/bridges take the form of financial contributions to the provinces under cost-sharing programs.

Between 1987/88 and 1997/98 total subsidies to roads/bridges (including ARFA transition and Montreal bridges) was a cumulative $2.1 billion current (1997/98) dollars. The vast majority was Transport Canada highway agreements, most of which has occurred since 1993/94. Under these programs annual spending has averaged more than $200 million since 1993/94. Planned spending is approximately $200 million in 1998/99 and will average $115 million annually until 2002/03.

Other federal government departments also make road/road-related expenditures but these are not considered direct subsidies. Between 1987/88 and 1996/97 these totaled an estimated $2.1 billion (1997/98 dollars).

5. Federal Transportation Revenues

Total revenues from transportation activities have increased 13% since 1987/88 and have exceeded $5 billion in each of the years 1995/96 through 1997/98 (see **Figure 1**).

Taxes constitute over 95% of all transport-related revenues in 1997/98, up from 64% in 1987/88.

Fuel Taxes

Between 1987/88 and 1997/98 the federal government collected a cumulative total of over $38 billion (1997/98 dollars) in transportation fuel taxes.[3] In the 1990s transportation fuel tax revenues have grown at an average annual rate of over 4%. They form a growing percentage of both total transportation revenues and total federal government revenues. For example:

- In 1987/88 fuel taxes comprised 64% of all transportation revenues – in 1997/98 they comprised 81%;
- 1997/98 fuel tax revenues are 27% higher than 1987/88 levels; periodic raises to the tax rate on most fuels are partly the reason.

Air Transportation Tax (ATT)

Historically the ATT was a main source of Transport Canada revenue; in 1996 it was redirected to the Consolidated Revenue Fund (CRF). ATT revenues in 1996/97 and 1997/98 were the highest ever as the final stage of the transition. The estimate for 1998/99 - the final year of the ATT - is $285 million.

Airport Fees, Leases & Rents

---

[3] Includes some revenue from fuels used outside of transportation as data for *transportation only* fuel tax revenue was unavailable for the period 1987/88-1990/91. However, according to Transport Canada these other fuels constitute less than 5 percent of all fuel tax revenues.

The National Airports Policy (NAP) directed the financial burden of operating Canada's airports away from taxpayers toward users.[4] NAP provides for the transfer of NAS and non-NAS airports to local operation (as LAAs/CAAs[5]) under long-term lease agreements. Lease revenue has thus become the main revenue source for Transport Canada while local authorities now collect fees.

Transport Canada continues to collect fees at remaining Transport Canada airports; in 1998/99 they implemented the third of four planned increases in airport landing and general terminal fees.

Revenue from leases and fees in 1998/99, although 34% lower than 1987/88, are projected to exceed departmental airport/aviation expenditures by $134 million in 1998/99 because of the off-loading of costs of operations.

6. Federal Transportation Surplus

The difference between gross spending and revenues is calculated as the aggregate net in **Table 1** and illustrated in **Figure 4.** In 1989/90 the federal government still spent $1.4 billion more on transportation services and infrastructure than it received from taxes, rents and fees. However, by 1995/96 the government had a net surplus from

---

[4]Announced July13, 1994 the NAP outlines the government's divestiture plans for federally owned airports. By the end of 1999/2000 all NAS and other non-NAS airports excluding remote airports are to be commercialized. Further information can be found at Transport Canada www.tc.gc.ca/airports/nap/english/p17.htm and the Canadian Airports Council www.cacairports.ca

[5]The federal government began transferring responsibility for the operation, management and development of NAS airports to Local Airport Authorities (LAAs) and is now calling them Canadian Airport Authorities (CAAs). Agreements with the existing four LAAs - Vancouver, Calgary, Edmonton, Montreal - will be honoured, and the authorities will be invited to consider the latest revised/enhanced principles of transfer.

transportation of $1.5 billion. In 1998/99 the surplus is estimated to be almost $3 billion. This makes the cumulative surplus amassed since a surplus was first registered in 1992/93 to almost $10 billion. Once again, these figures do not include revenue generated from investments or sales of crown assets such as CN.

The trend toward greater annual surpluses is forecast to continue. The forecast surplus to the Government of Canada cumulatively over the years 1999/00 – 2002/03 is almost $14 billion.

FIGURE 4: FEDERAL TRANSPORTATION SURPLUS/(DEFICT), 1987/88-2002/03

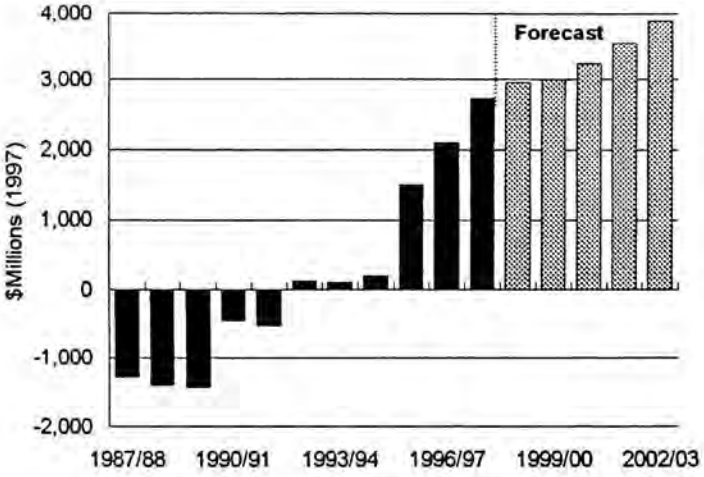


TABLE 1: FEDERAL GOVERNMENT TRANSPORTATION SURPLUS/(DEFICIT), 1987/88-2002/03 ($Millions(1997))

	Gross Spending	Tax Revenue	Non-Tax Revenue[1]	Total Revenue	Surplus/ (Deficit)
1987/88	5,851	3,294	1,274	4,568	-1,283
1988/89	5,724	2,969	1,353	4,322	-1,402
1989/90	5,398	2,642	1,332	3,974	-1,424
1990/91	4,984	3,180	1,358	4,538	-446
1991/92	5,099	3,431	1,142	4,573	-526
1992/93	4,400	3,460	1,057	4,517	117
1993/94	4,392	3,502	986	4,488	96
1994/95	4,441	3,580	1,050	4,630	189
1995/96	3,681[2]	3,971	1,228	5,199	1,518
1996/97	3,294	4,808[3]	592	5,400	2,106
1997/98	2,479	4,967[3]	230	5,197	2,718
1998/99f	2,031	4,640[3]	340	4,980	2,949
1999/00f	1,827	4,532	290	4,822	2,995
2000/01f	1,778	4,716	300	5,016	3,238
2001/02f	1,670	4,907	311	5,218	3,548
2002/03f	1,535	5,106	326	5,432	3,897

[1]User fees, leases, rents; does not include returns on investments or income from sales of assets
[2] Excludes $1 billion for lowering of CN assets (not a cash expense) but includes $1.1 billion in debt forgiveness
[3]Includes Air Transportation Tax - $737 million, $782 million and $285 million respectively; prior to 1996/97 ATT is in Non-Tax Revenue
Sources: Estimates of the Government of Canada; Transport Canada – Finance Directorate; Public Accounts

A CONSUMER BEHAVIOR APPROACH TO A COMMUTER TRAIN RESEARCH PROGRAM

The mission of the Montreal Transportation Agency (Agence métropolitaine de transport (AMT)) is to promote public transit with the goal of ensuring that people can travel within the Greater Montreal area more efficiently. The Agency, which is responsible for planning, coordinating and promoting mass transit services, has asked the Centre de recherche en gestion of the Université du Québec à Montréal (UQAM) to develop and implement a market research program in order to provide a better understanding of current and potential users' attitudes, behavioral intentions and behaviors with a view to increasing commuter train ridership. Another important objective of this research program was to estimate the market potential for existing and new commuter train lines.

General Background

The traffic situation for suburban residents of the Greater Montreal area has deteriorated dramatically over the last decade to the point of alarm (Cardinal, François, 2000). From 1988 to 1999, in the territory covered by the Agency, total population has increased by 10%, employment by 7%, and the number of automobiles by 30%; meanwhile, public transportation usage has decreased by 13% (Duddin, Jean-Maurice, 2000). As well the market share of public transit usage, in comparison with automobile usage decreased from 28% to 21% during the 1988-1998 period (INFO-AMT, 1999).

However, the situation is not hopeless. A major turn-around has been effected by the Agency, which has succeeded in stopping the decrease

1 Pierre Filiatrault, UQAM
Jacques Roy, UQAM
Paul Dorval, AMT

in public transit ridership. Between 1996 and 1997, the decade-long downward trend has been reversed, the number of trips having increased from 397.6 millions to 402.3 millions, that is an increase of 1.18%; and between 1997 and 1998, and the number of trips having increased to 410.5 millions, for a growth of 2.04% (AMT, 1999). Although commuter trains represent only a small percentage of the total number of trips made in the Montreal public transit system, the AMT foresaw in 1996 the relative growth potential of this type of transportation mode for suburban commuters. This is why the Agency decided to go ahead with a market research program designed to provide a better understanding of commuter behavior.

Research Program Objectives

The primary objective of this research program was to better understand the attitudes and behaviors of current and potential users of commuter trains in the Greater Montreal area in order to increase the ridership for this mode of transportation.

There were four secondary objectives for this research program: 1) to gain a better knowledge of the perceptions, attitudes and behavioral intentions of current users with respect to various modes of transportation; 2) to measure the satisfaction (or dissatisfaction) of current users; 3) to better understand the perceptions, attitudes and behavioral intentions of potential users with respect to various modes of transportation; and 4) to define the potential clientele for the proposed new lines and to estimate market demand to support the orientation of transit system planning toward targeted performance projects based on these studies.

Consumer Behavior Model

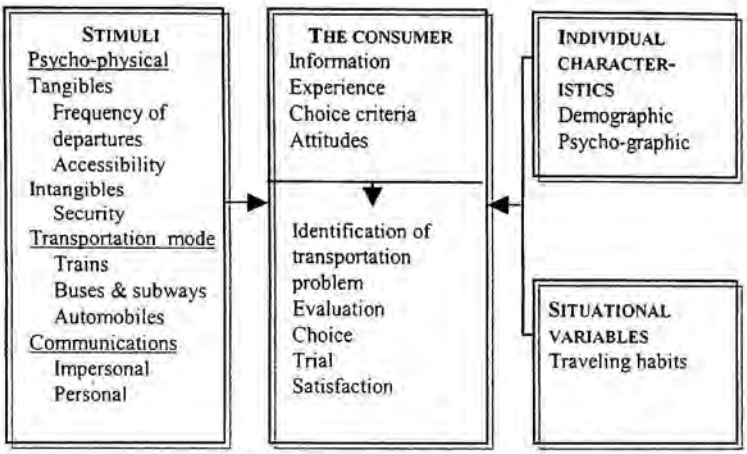
To define strategic orientations, a good understanding of the consumer decision-making process is particularly important for transportation planners and managers of the Agency concerned with offering services that respond better to changing rider needs, and

encouraging a shift in the choice of transportation mode from automobiles to trains. Who knows better than current and potential users what they think, expect or do (de Quatrebarbes, 1998)? Consumer research can provide substantial information to help link processes of design and delivery of transit services to the requirements of current and potential customers (Glascock, 1977). Transportation systems must respond to the needs and wants of potential customers, and these systems have to be recognized by potential customers as a real alternative to their current behavior (Brög, Werner, 1998). The key to ridership growth is understanding the travelers' choice of transportation mode, which implies understanding the choice set, and the criteria used and how they are evaluated (Schaller, 1999). How do suburban commuters decide on their transportation mode? How do they use this mode? Are they satisfied or dissatisfied? Why? For people who use their car to get to their workplace, or school, or to shop, train usage may require changes in established behavior patterns, attitudes and even lifestyles (Lovelock, Lewin, Day and Bateson, 1987).

It is to address these issues that a transportation consumer model was developed (Figure 1), based on well-known consumer behavior models (Engel, Blackwell and Miniard, 1990; Assael, 1992; and Paul and Olson, 1996). The present model (Filiatrault and Roy, 1997) shows the stages of the information-gathering and decision-making processes undertaken by users and potential users of a commuter train as influenced by stimuli of various kinds and by environmental variables. Current and potential customers are exposed to psycho-physical stimuli, to various transportation modes and to personal and impersonal messages which attract their attention, and which they learn to recognize and absorb. Their behavior is influenced to varying degrees by all this information, by their demographic and psycho-graphic profiles, by situational variables and by the resulting attitudes. The attitudes of current and potential users of a commuter train toward a transportation mode reflect the evaluation made by suburbanites of the capacity of a given transportation mode to satisfy their needs with regards to certain attributes or decision criteria.

Knowledge of the affective and cognitive structures of attitudes towards a transportation mode is essential to understanding the decision-making process of commuters in their choice, trial and usage of a given transportation mode and the satisfaction or dissatisfaction that results. This model is useful in that it provides an understanding of the transportation behavior of both users and non-users.

Figure 1
A simplified consumer behavior model



Changing the attitudes and behaviors of a non-user is difficult and may take a long time. The potential user must first recognize that he or she has a transportation problem and that his or her needs are not all satisfied. The user will become aware of various possibilities, including commuter trains, and will try to gather information like departure times, fares, intermodal transfer possibilities, etc. He or she may then decide to try the train for a couple of days. If the experience is satisfactory, positive reinforcement will occur, which will increase the probability that the usage will increase; that is why it is important to offer services of excellent quality at all times. Otherwise, negative

reinforcement will occur, and the user might reject this alternative for a long time to come.

This model makes it possible to understand the behavior of current and potential train users better. It stresses the important role of information, perceptions and attitudes in the choice of a transportation mode and permits the development of strategies designed to increase the loyalty of current users and to attract new users.

Research Methodology

A total of eleven studies were completed in this market research program, and both qualitative and quantitative research methods were used. Three studies were carried out on existing commuter train lines (Deux-Montagnes, Vaudreuil/Rigaud and Blainville) with both users and non-users, and five studies were conducted on possible new train lines (St-Bruno/St-Hilaire, St-Jérôme, Mascouche/Terrebonne, Delson and St-Jean-sur-Richelieu) with potential users only, of course. First, internal and external secondary data (from the transportation and the consumer behavior fields) were gathered and analyzed. The preliminary train transportation behavior model presented earlier was developed.

Qualitative research

Qualitative research was then conducted to gather information on commuters' transportation habits and their perceptions of various transportation modes. This took three forms: observation, individual interviews and focus groups. First, the researchers visited a few train stations, purchased tickets, observed employee behaviors and rode on the trains. Then, individual interviews were carried out with key executives of the Agency and with experienced public transportation managers. Finally, focus groups were organized. Data collection was subcontracted to marketing research firms. The researchers prepared focus group interview guides in collaboration with the personnel of the firm.

The first research project carried out on the Deux-Montagnes and Vaudreuil/Rigaud lines was the most extensive one. Six focus groups were held: one in French for each of the two lines and one in English for the Vaudreuil/Rigaud line, French-speaking users being predominant on the Deux-Montagnes line and English-speaking users being relatively more numerous, on the Vaudreuil/Rigaud line; three other focus groups were held with potential users in the same proportion as for users. All other focus groups were conducted in French only, the population of the areas being 90% francophone and above. For the Blainville train line, there was both a user and a non-user focus group. For the last five studies, there were two focus groups for each study, with subjects from different areas.

Quantitative research

Two types of data collection were employed for the quantitative research: questionnaires were distributed to users aboard the trains,

Table 1
Sample size and response rate

Train line	Sample Size	Response Rate (%)
Deux-Montagnes		
Users	224	58.4
Non-users	338	67.8
Vaudreuil/Rigaud		
Users	232	62.8
Non-users	403	67.8
Blainville		
Users	401	63.5
Non-users	402	67.2
St-Jérôme	200	67.2
St-Bruno/St-Hilaire	804	77.6
Delson	801	70.3
St-Jean-sur-Richelieu	799	70.9
Mascouche/Terrebonne	804	72.9

and telephone interviews were carried out with non-users. Sample sizes and response rates are presented in Table 1 for the eleven studies.

Results

The research results are presented in two parts: the results of the qualitative research and the results of the quantitative research. In both cases, we only present results which are common to all studies. In the case of the quantitative research, we present the general descriptive results first, followed by the psycho-graphic and attitudinal results, which were more extensive in the original Deux-Montagnes and Vaudreuil/Rigaud studies, and, finally we briefly present the methodology used to estimate demand.

Qualitative Research Results

The first part of each focus group interview was aimed at obtaining a general overview of the daily traveling experience of the participants. These individuals were then invited to give their overall perceptions of public transit services as a means for getting to work or school, to shops, and for visiting relatives and friends, etc. They were asked to give their spontaneous opinions and perceptions on commuter trains. The participants were further probed as to the perceived strengths and weaknesses of commuter trains. They were also asked to share their perceptions of the strengths and weaknesses of buses and the subway, and of automobiles as a comparative transportation mode. The comparative analysis of the strengths and weaknesses of the various transportation modes is presented in Table 2.

Results of the qualitative research show that : 1) perceived strengths and weaknesses of transportation modes (trains, buses and automobiles) reflect both utilitarian and emotional needs; 2) criteria users consider to make their choice of transportation mode vary according to these needs; 3) evaluations of various transportation

modes are based on perceptions which do not always reflect reality; and 4) often the lack of information required by current and potential users to make good choices.

Table 2

Perceived strengths and weaknesses of three transportation modes for suburban commuters

Commuter trains

Strengths	Weaknesses
Positive image	Lack of information
Reliability	Off-peak infrequency
Rapidity	Inadequate parking capacity
Punctuality	Potential vandalism in parking area
Economy	Too many stops
Security	Too few stations
Prestige	Transfers to other modes
Productivity gain	Cost
Access to subway	Lack of flexibility during the day
Reduced pollution	Fear of missing the train
Relaxing atmosphere	
Efficiency	
Cost	

Buses and subway

Strengths	Weaknesses
High frequency	Lack of comfort
Availability of information	Promiscuity
Large number of stops	Level of stress
Rapidity of travel	Lack of reliability
No need for parking	Transfers to other modes
Less pollution	

Automobiles

Strengths	Weaknesses
Flexibility	Traffic
Non-stop travel	Cost
Possibility to make stops	Parking problems
Listening to radio	Parking cost
Comfort	Possibility of accident
Freedom	Pollution

A focus group is a useful preliminary research technique which is well suited for an exploratory evaluation of perceptions and tendencies. However, because of the nature of this qualitative research tool, results cannot be generalized statistically to the total population. Nevertheless, the convergence of opinions on given subjects makes it possible to arrive at a consensus. In this case, it allowed to learn about the perceived advantages and disadvantages of three transportation modes and to investigate the motivations and deterrents that influence the choice of a given mode. These results were useful in developing the proper methodology for the quantitative research phase which followed, particularly in the development of the questionnaire.

Quantitative Research Results

General Descriptive Results

The demographic results of questioning current and potential users of commuter trains in the suburban belt around Montreal show a social profile which is higher than the provincial average: 25% have a university degree or diploma, which is twice the provincial average; the average household income varies between $57,000 and $71,000, depending on the suburb, in comparison with the provincial average of $40,826; and their average age is 36. In total, 54% of users are female. Current and potential customers are mainly francophone on most lines (up to 95%), and almost three quarters of them, on average, own their house.

Current riders use the train mainly to get to work (84%), on average 9.5 times per week, and 38% of them use the train more often now than previously; on average, it takes them 11 minutes to get from their home to the train station, and, in total, 55 minutes from their home to their destination. The most common activities engaged in during the trip are: reading (newspapers, magazines, reports, books), relaxing and talking with other passengers. The majority of riders (88%) own a car, and almost half the households (45%) own two cars; two-thirds of riders could use their car instead of taking the train.

Attitudinal and Psycho-graphic Research Results

The most important criteria that riders use to evaluate train services quality are, in order of importance: frequency of departures, punctuality, accessibility, security, neatness, understanding of needs, courtesy, trust in company, response to requests and availability of information. The degree of satisfaction among users is high (8.2 on a 10-point scale where 10 is very satisfied), and 78% of customers gave a rating of 8 and above. There are no statistical differences in degree of satisfaction with regard to demographic variables, except that francophones are more satisfied (.01). The higher the perceived quality/price ratio, the higher the degree of satisfaction (.001) and the higher the probability of continuing to use the train in the future (.001); and the lower the perceived relative cost of commuting by train compared with a car, the higher the degree of satisfaction (.001).

Analysis of the psycho-graphic data reveals that suburbanites believe it is necessary to work hard to succeed; they feel well when they are at home, their family is important to them and they are gregarious. However, there are certain statistically significant differences between users and those non-users who are unlikely to use a train: the latter feel more strongly that one must work hard to succeed nowadays (.01) and that, at this time their career, this is very important to them; they also find peace when they are driving their car (.001) and they are of the opinion that a car is an absolute necessity (.05).

The image of the train as a means of public transportation is positive for both users and non-users, and a train is a valid alternative to a car as a means of transportation to and from work for suburbanites. For non-users, the most important advantages of this mode of transportation are: rapidity, relaxation, avoidance of traffic, comfort, punctuality and lower costs; the main disadvantages are insufficient off-peak departures, lack of flexibility and inconvenient location of stations. This confirms some of the results of the qualitative research. The degree of satisfaction of non-users with their current mode of transportation, on a 10-point scale, is 5.9 for public transit (buses and

subway) and 7.6 for automobiles. The perceived cost for commuters of using a train is much lower than that of using a car: by 30% for those who use their car, in comparison with 60% for those who use the train.

Demand Estimation Results

A random sampling procedure provided the information required to estimate demand. The total population of people 15 years old and older was obtained from the Statistics Canada Census. Potential total demand was defined as all people living in a given suburb who make 6 trips (three return trips) per week to get to work or school in Montreal. From the survey, the percentage of this population relative to the total population was obtained (the margin of error varying between 3.5% (the most frequent margin of error with a sample size of 800) and 7.1%, 19 times out of 20 depending on the sample size of each study). Potential users were asked, on a scale of 0 to 100% (where 0 means a 0% probability and 100 means a 100% probability), how likely it is that they would take the commuter train on a regular basis, given two different scenarios (boarding stations, length of trip and fare were kept constant, but the number of departures varied (2, 3 or 4 departures either way)). The number of probable customers was estimated using a probability of 75% and higher of using the train. This figure was used to estimate the number of rides per day taking into consideration the actual number of rides per week provided by respondents. To be conservative, this estimate was judged to be the long-term market potential for a five-year period, and the probable demand estimate for the first year was defined as 20% of the long-term potential. The different scenarios made it possible to measure a degree of elasticity of demand with regard to the number of departures: increasing the number of departures from 2 to 4 increased, for instance, the estimated potential demand for non-users by 30% and that of users by 50%. The St-Bruno/St-Hilaire study has shown a net increase in behavioral intentions when subjects were presented with a scenario of 5-departures instead of 3; this has resulted in a 5 departure proposal for this new line. Finally, interestingly enough, the

total number of rides on the Blainville train actually increased from 3 150 rides daily in January 1997 to 5 320 rides daily in January 1999, when the number of departures in the morning increased from 4 to 6.

Managerial Implications

A knowledge of consumer behavior is only one of the decision-making tools available to the Agency to manage the commuter train network in the Montreal area, and it has been used for three purposes: first, it permitted the Agency to gain a better understanding of current users' attitudes, behaviors and level of satisfaction; secondly, it was useful to learn more about potential users' attitudes toward public transportation in comparison with automobiles and about their behavioral intentions; thirdly, it made it possible to estimate the market potential on new proposed train lines.

Based on the perceived advantages of trains as a means to commute, various marketing retention strategies were developed to increase the loyalty of the riders on the Deux-Montagnes and Vaudreuil/Rigaud lines. Marketing strategies were also developed to attract new users on these two lines. The market was divided into five segments: users and non-users, the latter group consisting of four types: the "probables", the "possibles", the "resistors" and the "intransigents". At this stage of the diffusion process, it was decided that the efforts would be concentrated on the segment that had expressed the greatest probability of becoming users, that is, the "probables". Results were impressive, with ridership increasing dramatically (Table 3).

Table 3
Number of rides per day

Deux-Montagnes		
1997	1999	2001
19,100	27,000	30,000 (est.)
Vaudreuil/Rigaud		
11,600	13,300	15,000 (est.)

During the same time, a new line was launched between Blainville and Montreal. Many marketing strategies and tactics were employed: advertisement (targeting specific markets), free train rides, and others. The results are convincing: during the first year (1997), the number of daily rides reached 3,000, and it has now more than doubled, reaching 7,000 daily on busy days. Since the Agency has taken a more aggressive marketing approach, supported by a market research program, the total number of rides in the Greater Montreal commuter train network has increased by 39 % (Table 4).

Table 4
Number of rides per year on the Greater Montreal commuter train network

Year	Number of rides per year (millions)
1996	6.93
1997	8.36
1998	10.02
1999	11.36

The third use of these studies was to estimate the demand on five proposed new lines. This information was used for planning purposes and to prepare the reports required to obtain the necessary budgets and authorizations from the Quebec Department of Transport, various municipalities, the public transit organizations, and other intervening parties. In fact, these studies have proven to be an excellent tool for convincing politicians and other public decision-makers of the opportunities for various projects, as they represent the opinions of citizens with regard to projects already proposed.

Conclusion

This paper reports on a market research program developed by the Centre de recherche en gestion of the Université du Québec à

Montréal at the request of the Montreal Transportation Agency with the aim of gaining a better understanding of current and potential customers' attitudes and behaviors with a view to increasing commuter train ridership. It is strongly believed that greater usage of trains in the Greater Montreal area can contribute to providing a more pleasant and efficient way for commuters to get to work or school, and help to decrease traffic jams and air pollution. This research method is not a substitute for other transportation research methods, but rather a complementary tool which focuses on the most important element of a public transit system: the customer. This approach has, in fact, contributed to an increase in the usage of commuter train in this area.

References

AMT, Rapport annuel 1998, April 1999, p. 11.

Brög, Werner, Individualized Marketing, Implications for Transportation Demand Management, Transportation Research Record No.1618, Transit Planning, Management, Marketing, New Technology, Capacity, and Quality of Service, National Academy Press, Washington, D.C., 1998, pp. 116-121.

Cardinal, François, Construire un monorail et prolonger la 30 pour désengorger Montréal, Le Devoir, January 13, 2000, p. A1, p. A8.

de Quatrebarbes, Usagers ou clients? Écoute, marketing et qualité dans les services publics, Éditions d'Organisation, 2nd ed., Paris 1998.

Duddin, Jean-Maurice , Le transport en commun souffre d'un manque d'information, Le Journal de Montréal, January 13, 2000. p. 9.

Engel, James F., Roger D. Blackwell and Paul W. Miniard, Consumer Behavior, 6th ed, The Dryden Press, Hindsdale, Ill., 1990; Assael, Henry, Consumer Behavior & Marketing Action, 4th ed., PWS-Kent Pub. Co.,Boston, Mass., 1992; and Peter, J.Paul and Jerry C. Olson,

Consumer Behavior and Marketing Strategy, Richard D. Irwin, Chicago, Ill., 1996.

Filiatrault, Pierre and Jacques Roy, Étude sur l'utilisation de trains de banlieue, Centre de recherche en gestion, UQAM, 1997, p. 57.

Glascock, Jane, Research on Customer Requirements for Transit Service Design and Delivery, Transportation Research Record No.1604, Public Transit 1997 Planning, Management, Marketing and New Technology, National Academy Press, Washington, D.C., 1997, pp. 121-127.

INFO-AMT, Les résultats de l'enquête Origine-Destination, 1998, vol. 3, no. 7, December 1999, p. 8.

Lovelock, Christofer H., Gordon Lewin, George S. Day, and John E.G. Bateson, Marketing Public Transit, A Strategic Approach, Preager Publishers, New York,1987.

Schaller, Bruce, Enhancing Transit's Competitiveness, A Survey Methodology, Transportation Research Record No. 1669, Public Transit Planning, Management and Performance, and Marketing and Fare Policy, National Academy Press, Washington, D.C., 1999, pp. 143-149 .

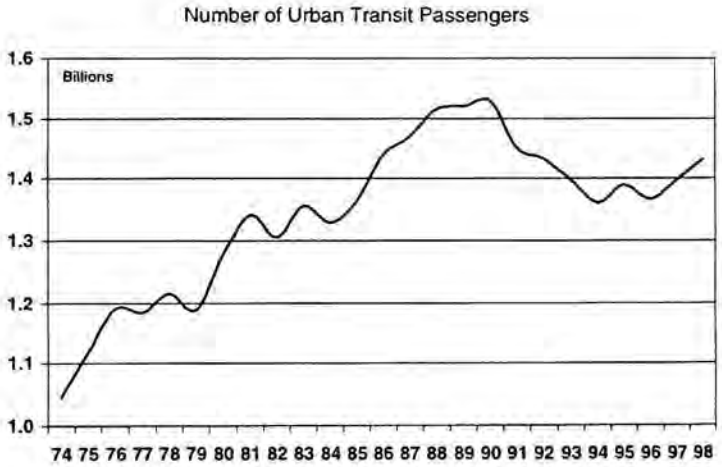
Pierre Filiatrault, UQAM
Jacques Roy, UQAM
Paul Dorval, AMT

Factors Affecting Urban Transit Ridership

Harold M. Kohn[1]

Introduction

The use of urban transit services (buses, urban rail, subways and streetcars) in Canada grew steadily in the seventies and eighties, reaching a peak of 1.53 billion passengers in 1990. Ridership then declined to 1.37 billion in 1996, but in 1997 and 1998, the trend began to reverse, reaching 1.43 billion in 1998[2]. The longer term trend is uncertain.



Source: *Passenger Bus and Urban Transit Statistics*, Statistics Canada, Catalogue 53-215-XIB

Many have postulated reasons for the decline in the early nineties: increased suburbanization leading to an increase in automobile usage; lower perceived operating costs of the automobile; a preference for the convenience of the automobile[3]; increasing fares, decreasing subsidies, an aging population with a preference for the comfort and security of personal transportation; and varying levels of public support for urban transit across jurisdictions[4].

Within the urban environment, the automobile is by far urban transit's greatest competitor. The 1996 Census revealed that only 10 percent of urban workers utilized public transit. About 81 percent of urban workers travelled to work by personal vehicle. The remainder walked or used bicycles.

Around the world, constituencies that have implemented policies that support urban transit have, in some cases, encouraged people to switch from the automobile to forms of public transportation such as buses, streetcars and subways. For example, in Austria, which has one of the world's highest urban transit ridership rates[5], government has implemented policies that encourage public transit (for example, by providing supporting infrastructure such as bicycle park and ride). Other constituencies, such as Singapore, require automobile drivers to purchase special permits at high fees that allow the driver access to the downtown core. Thus, public transit is encouraged.

Prohibitive taxing and pricing policies (e.g. fuel taxes) have the potential to force drivers out of their cars into urban transit vehicles[6]. Nevertheless, with the exception of a handful of major population centres, most communities in Canada are sparsely populated, which makes the provision of urban transit services relatively expensive and difficult to offer on a comprehensive basis (that is, providing all parts of the community with frequent service). Changes in work patterns such as "work-at-home", shift work outside the traditional 9 to 5 time frame, the location of work sites away from downtown areas and other similar factors have given urban transit planners a multitude of challenges.

The cost of providing comprehensive services, especially for communities that are characterized by urban sprawl, has meant a requirement for subsidization. In 1998, governments in Canada paid

approximately $2.4 billion in capital and operating subsidies to urban transit companies[7]. Nevertheless, transit companies have sought out new sources of revenue such as fees from parking lots and advertising. Revenues from these sources grew from $82.4 million in 1995 to $110.4 million in 1998.

Demand and Supply

Most would agree that there are many factors that affect both the demand for and supply of urban transit. These include:

- family size – Families with children may choose to use personal vehicles rather than urban transit because the monthly cost of transit passes may be (or is perceived to be) more expensive;
- economic changes (e.g. employment opportunities, taxes, fuel costs, parking fees, automobile insurance costs, vehicle operating costs, subsidies, investment, etc.);
- demographic impacts such as population growth, immigration rates and fertility rates;
- ridership loyalty (that may be affected by events such as bus strikes);
- parking rates and distance to work;
- other factors such as convenience, a change in work schedules and the "work-at-home" phenomenon; and
- community size – Large cities with long commutes, expensive downtown parking and relatively greater distances to destination points may positively influence the use of public transit because of the level and frequency of service as well as time and cost savings. Travel times in smaller communities may not be as lengthy, although in smaller communities, the availability of urban transit may not be as comprehensive as in larger cities. For example, the Toronto metropolitan area has an extensive commuter and urban transit system compared to many other Canadian cities. According to the 1996 Census of Canada, 22 percent of the employed population in the Toronto Census Metropolitan Area used public transit to travel to work, and the median one-way travel distance to work was 9.3 kilometres (implying that half commuted further and that half had a shorter commute). On average in Canada, 10 percent of urban workers use public transit.

Factors that affect supply and demand are complex, constantly changing and difficult to identify and discern. For example, in the 1990s, in Toronto, Canada's most populated city, subsidies fell 39 percent, fares increased 50 percent, service levels decreased 12 percent and ridership fell 20 percent[8]. These data imply that fare increases, and subsidy and service reductions combined to produce a drop in ridership. At the same time, however, there was *"a major economic downturn in the Toronto region resulting in a substantial reduction in work trips...demographic factors related to age, female workforce participation and a flow of population and employment to the suburbs (that) reduced ridership...and...two work stoppages/work-to-rule actions"*[9]. This evidence suggests that there may be many factors that influence transit ridership.

Price Elasticity

Economic theory states that, in general, as the price of a good or service increases, the demand decreases. In the real world, differences in the way that consumers react to price changes depend on several factors, including the ability to substitute goods and services, the degree to which consumers react to price changes and wealth and income effects. These factors may be defined in terms of price elasticity. If a product or service has an inelastic demand, consumers will still have a tendency to purchase the product or service when the price increases. This may be true for commuters who must, for various reasons, utilize urban transit services. Conversely, a company that offers a product or service that has an elastic demand will find that demand (and revenue) will change noticeably with a change in price. Commuters who may have alternative methods of urban travel may have demand curves that are more elastic than those dependent upon urban transit.

With regards to urban transit, it is generally believed that demand is inelastic[10]. Thus, there could be a tendency to increase fares on the assumption that revenues will increase. In the Toronto study[11], the assumed fare elasticity was 0.3[12]. (A price elasticity of demand of less than 1.0 is considered to be inelastic). However, in Toronto, ridership and revenues fell as fares increased, indicating that demand was more elastic than expected.

Objective of the Study

In view of the complexity of factors that may impact urban transit ridership, a quantitative study was undertaken in an attempt to identify those factors that may affect supply and demand. The research utilized an extensive database gathered by the Canadian Urban Transit Association directly from member transit companies. These data are collected on an annual basis, and provided in raw form to Statistics Canada. Specifically, data from approximately 85 urban transit companies were used. These companies carry about 97 percent of all urban transit passengers in Canada. Data elements included demographics, hours of service, fare structure, vehicle statistics, energy consumption, employment, passenger statistics, revenues and expenditures. Seven years of data were used, from 1992 to 1998. Because the data represent many of the same cities over a period of seven years, the database was in the form of cross section - time series data.

Average Fares, Revenues and Ridership

Although the database consisted of fares and the number of passengers broken down by adult, child, student, senior citizen and other, it was not possible to obtain revenues for each of these categories. Therefore, an average fare was developed by dividing passenger revenue by the total number of passengers.

Using this measure, it was found that average fares have increased, on an aggregate basis across Canada, from a low of $0.93 in 1992 to $1.14 in 1998 (in current dollars)[13]. During the same time period, the number of passengers using urban transit remained almost constant, but revenues increased from $1.2 billion to $1.5 billion. On the

surface, it might appear that there was a positive correlation between fares and revenue but almost no relationship between fares and the number of passengers.

The data were segregated by year, by population distribution and by province. Little variation was observed in terms of the statistical relationship noted in the previous paragraph.

Regression analysis was then used to test the various data elements provided by the transit companies themselves, to determine if one or more variables could be used to explain the variation in ridership.

Result of Multiple Regression Analyses[14]

As a first step, average fares were regressed against the number of urban transit passengers using the entire database. The result produced an R square value not significantly different from zero (i.e. the independent variables explained almost none of the variation in the number of passenger trips). Variations of this model were tested, such as using only cities where the number of transit passengers was greater than 100,000, 500,000, 1 million, etc. There was little improvement in the model's statistical tests (e.g. R square, t statistics, F ratio, etc.)[15].

In the next stage of analysis, the population of the service area (as defined and provided by each urban transit company) was added as an independent variable to try to explain the variation in the number of urban transit passengers. The R square value obtained was 0.39, which was lower than expected. However, this was a significant improvement over the use of average fares in the single equation single variable model described in the previous paragraph.

These two variables were then combined into one model, producing an R square value of 0.51, again an improvement but still not sufficiently strong. A number of variations were tested, such as clustering the data by population, average fare, province or region, urban size, etc. The R square, t statistics and F ratios were statistically insignificant for the most part, indicating little statistical relationship between the explanatory variables and passenger trips.

Other independent variables were then added for testing purposes. They were included mostly in the form of dummy variables[16]:

- for each year of data (to account for any differences on an annual basis);
- for cities that have populations in excess of one million; this dummy variable assumed that larger cities have more comprehensive transit systems, more traffic, a greater dispersion of people geographically, longer commute times, and, perhaps, a greater tendency towards transit ridership;
- for cities with more than one million urban transit passengers; this dummy variable was similar to the preceding variable for cities with populations in excess of one million; despite the apparent similarity, the correlation between the 2 variables was only 0.19; and
- for cities with populations less than 100,000; this dummy variable assumed that cities with populations less than 100,000 people have less comprehensive transit systems, less population dispersion, shorter commute times and, perhaps, a lower tendency to use public transit than cities with greater populations.

By using all these variables, the R square value improved to 0.7 and the F ratio was 111, statistically significant at the 99 percent level of confidence. Most of the t statistics were statistically significant and none of the independent variables were correlated.

Despite the fact that an acceptable R square value was obtained, the residual analysis did not provide strong results at a micro basis (i.e. on a city by city basis). (In the residual analysis, the estimate of the number of passengers was compared to the actual number of passengers). In most cases, the individual data points exhibited large residual errors[17]. Further refinement of the model was undertaken.

Ridership rates (to compare cities) were introduced through the use of a dummy variable. The dummy was applied to communities where the ridership rate was greater than 100 (that is, 100 trips per person per year).

The results of one of the earlier models are shown in Table 1. Although this iteration demonstrated some positive qualities, it lacked other desirable characteristics.

- All signs on the coefficients were as hypothesized. The average fare coefficient was negative, indicating that as fares increased ridership decreased. The negative coefficient on the dummy variable for communities with less than 100,000 passengers was also as expected, indicating that people in smaller communities rely more on other modes of transport rather than buses (smaller communities are more likely to have lower levels of urban transit service than larger communities).
- Although the R square, t statistics and F ratio were acceptable, the model produced high residual errors, except in a few cases.
- Sensitivity analysis was restricted because of the large number of dummy variables compared to variables with observable and useful data. As a result, it was difficult to conduct meaningful sensitivity analysis since estimations would be similar if the dummy variables were consistent.

TABLE 1 – Statistical Results of an Early Model

Independent Variable	Coefficient	Standard Error	t Stat
Intercept	28,249,639	3,422,054	8.3
Average Fare	-27,257,012	2,971,573	-9.2
1 Million Passenger Dummy	8,231,286	2,023,896	4.1
1 Million Population Dummy	144,450,347	5,376,838	26.9
Dummy - cities with less than 100,000 passengers	-1,515,797	3,136,120	-0.5
Ridership Rate Dummy	160,505,085	5,908,999	27.1
R square = 0.88	F Ratio = 755.7 (99% significant)		

Service and Other Variables

At this point, other independent variables from the urban transit database were introduced: revenue vehicle hours, revenue vehicle kilometres and a series of population variables.

In general, all population variables (such as the population of the primary city, the population of its service area, the population of the metropolitan area and the population of the metro service area) all produced coefficients with negative signs. This was deemed to be unacceptable since intuitively, the larger the population, the greater the urban transit ridership. The population variable was dropped at this point.

The one million passenger dummy variable was highly correlated with both service variables, as might be expected, since larger population centres (with higher ridership levels) would be characterized by longer travelling times and distances travelled. The sign on the dummy variable was also negative, which is counterintuitive. This dummy variable was dropped.

The ridership rate dummy variable was also highly correlated with both service variables, and was deleted from any further analysis.

Further, the two service variables were correlated. It was necessary to choose one. Since the kilometres driven consistently produced a negative coefficient, it was dropped in favour of revenue hours.

The introduction of revenue vehicle hours was desirable since it provided an indication of service levels (a point of discussion and importance in the Toronto study mentioned earlier) and it provided a proxy for population, level of service, complexity and comprehensiveness of the urban transit system in any community.

The model then consisted of four independent variables:

1. revenue vehicle hours;
2. average fare;
3. the one million population dummy variable; and
4. the dummy variable for communities with less than 100,000 passengers.

Although the model produced strong statistical results, the sign on the 100,000 passenger dummy variable was positive (which was counterintuitive) and was, therefore, removed. The one million population dummy variable was also dropped because it was not statistically significant.

Final Model[18]

Several other combinations of variables were tried, both to produce signs and statistical characteristics that were intuitively correct and statistically significant, and to improve the residual error rates. Subsequently, a final model was developed that included 2 independent variables: revenue vehicle hours and average fares, as shown in Table 2.

TABLE 2 – Statistical Results of Research Model			
Independent Variable	**Coefficient**	**Standard Error**	**t Statistic**
Intercept	5,099,953	2,232,952	2.28
Average Fare	-7,976,442	2,024,021	-3.94
Revenue Vehicle Hours	49.58	0.41	119.85
R square = 0.97	F Ratio = 7190 (99% significant)		

This model displayed several positive characteristics as follows:

1. The model is relatively easy to use since it consists of only 2 independent variables. One of these measures the level of service and acts as a proxy for complexity of the urban transit system, population, ridership levels, etc.
2. Statistically, the model is strong.
3. The sign on the average fare is negative, indicating that as fares increase, ridership levels decrease. The positive sign on service hours indicates that as service hours increase, more passengers utilize buses. Both are intuitively correct.
4. The residuals were better than earlier models.
5. It is possible to conduct sensitivity analyses because the 2 independent variables can be established for any community.

6. There are no dummy variables needed.
7. The model was first developed using 1992 to 1997 data. The introduction of 1998 data produced little variation in coefficients and statistical results, indicating relative stability in the model.

The Model's Estimation Abilities

Table 3 shows results for 8 of Canada's busiest urban transit centres. These cities account for approximately 84 percent of all urban transit in the nation. The table shows:

- the changes that occurred between 1992 and 1998 in vehicle service hours, average fares, ridership and revenue; and
- the estimate of the number of passengers in 1998 using the model compared to the actual number of passengers.

TABLE 3 – Eight Canadian Cities

	% Change 1992-98				Difference Between Estimate & Actual Number of Passengers 1998
City[19]	Vehicle Revenue Hours	Average Fare	Number of Passengers	Revenues	
1	2.0	-5.2	30.0	23.2	5.1
2	-9.7	7.3	3.4	10.9	-58.1 *
3	-4.2	35.2	-20.7	7.2	-27.2
4	-19.8	11.8	1.2	13.1	31.0
5	-14.0	12.3	-10.5	0.5	1.8
6	-3.6	32.9	-3.8	27.7	-0.2
7	18.5	45.8	-3.2	41.1	-50.3
8	-5.6	39.8	-17.5	15.3	-53.2
* - negative sign = the model overpredicts					

Observations:

1. The model predicts well for cities 1, 5 and 6.

2. The model overpredicts the number of passengers for cities 2, 3, 7 and 8. The reason for this may be that people in these cities do not use urban transit to the same extent as the national average, or, at the same level as some of Canada's larger cities. On a national basis, per capita ridership fell from 92 trips per person in 1992 to 84 in 1998.

   In 1998, for cities 2, 3, 7 and 8, per capita ridership rates were 65, 76, 63 and 37 respectively. Other cities, more dependent on urban transit, have exhibited per capita rates between 160 and 190. In cities 2, 3, 7 and 8, per capita ridership rates have also been falling. Per capita ridership in city 7 fell from 92 in 1992 to 76 in 1998, and in city 8, the rate fell from 77 to 63. In the case of city 3, per capita ridership in 1992 was 53 whereas in 1998, the rate had fallen to 37.

3. The model underpredicts for city 4. This city's per capita ridership is the highest in Canada at 192 trips per year in 1998, an increase from the 189 trips in 1992.

4. The table also shows the impact on ridership after the transit companies in these communities changed the level of service and fares. Between 1992 and 1998, in city 1, average fares declined and at the same time, the number of service hours increased (that is, revenue earning hours that buses are on the road). Passenger growth was 30 percent and revenues increased just over 23 percent. City 7 showed an increase in service hours but fares grew just over 45 percent. The impact was a 3 percent drop in passengers and a 41 percent increase in revenues. In the other 6 cities, service hours decreased and average fares increased. Impacts, however, varied. In city 2, both the number of passengers and revenues increased. A 35 percent fare increase in city 3 coupled with a 4 percent service decrease resulted in a 21

percent drop in ridership and a 7 percent increase in revenues. Average fares increased by almost 12 percent in city 4 and service hours decreased by 20 percent, but the result was an increase in both the number of passengers and revenues, 1.2 and 13.1 percent respectively. City 5's increase of 12 percent in fares along with a 14 percent drop in service hours produced a 10 percent drop in ridership and a small increase in revenues. City 6 increased fares by 33 percent and decreased service by just under 4 percent. The result was a 28 percent increase in revenues and a 4 percent drop in ridership. Finally, in city 8, a 6 percent decrease in service and a 40 percent increase in fares resulted in an 18 percent drop in ridership and a 15 percent increase in revenues.

5. These results indicate that both service declines and fare increases will generally have a negative impact on ridership but a positive impact on revenues. Thus, it appears that urban transit ridership is, indeed, inelastic.

6. It may be that revenue or ridership declines prompted transit companies to raise fares and/or decrease service levels on marginal routes. Despite the fact that most bus companies raised fares, reduced levels of service and suffered declines in ridership, they did realize greater revenues. This indicates that if the objective of the bus companies was to increase revenues, they were successful in achieving this goal, even though ridership may have declined.

Conclusions

In the 1990s, most Canadian urban transit operators implemented both service and fare changes. Generally, service hours have decreased whereas fares have increased. The general impact has been a decrease in ridership coupled with an increase in revenues. Results vary on a city by city basis.

The fact that revenues have generally increased along with the average fare indicates that the demand for urban transit services is, in general, inelastic, that it, commuters continue to use urban transit

services even though fares have increased. The fare increases may be seen as marginal, when compared to the costs of operating automobiles and downtown parking.

The results also show the diversity in urban transit ridership across the country and how different policies affect cities in varying ways.

---

[1] The views expressed in this paper are those of the author and do not necessarily represent the policies of Statistics Canada or the Government of Canada.

[2] Source: *Passenger Bus and Urban Transit Statistics*, Catalogue 53-215-XIB, Statistics Canada

[3] Based in part on notes from a speech by Mr. M.A. Charlebois, of the Canadian Urban Transit Association, Ottawa, June, 1997.

[4] Some may interpret subsidy decreases as an example of a reduced commitment to urban transit.

[5] Source: From information contained in a speech by Mr. David Bayliss, Director of Planning, London Regional Transport, London, Great Britain, to the delegates attending the International Union of Public Transport conference held in Toronto in May, 1999.

[6] Mr. Ken Ogilvie, one of the co-chairs of the Transportation Climate Change Table (a discussion table established by the Government of Canada to study the Kyoto Protocol), in speeches made at the Canadian Transportation Research Forum (CTRF) held in Montreal in May, 1999, as well as at the International Union of Public Transport/Canadian Urban Transit Association Conference held in Toronto in May, 1999, indicated that significant gasoline fuel tax increases, as well as other policy options, have the potential to divert people from private to public transport. A senior Transport Canada analyst made the same comments at the CTRF conference and published an article in the 1998 CTRF Proceedings which made a similar reference to the impact of fuel taxes: *Canada's Commitment on Greenhouse Gas Emissions under the Kyoto Protocol and the Potential for Reductions in Transport* by John Lawson, Economic Analysis, Transport Canada 1998 CTRF Proceedings, May, 1998, p 465.

[7] Source: *Passenger Bus and Urban Transit Statistics*, Statistics Canada, Catalogue no. 53-215-XIB.

[8] *Optimising Transit Service Decision Based on Ridership: Good for Passengers and the Community*, Bill Dawson, Superintendent, Service Planning and Monitoring, Toronto Transit Commission, Toronto, presented at Workshop #5 Service Planning at the UITP International Congress 1999 Toronto, May, 1999.

[9] ibid p2

[10] Based on informal discussions with planning officials of OC Transpo (the provider of urban transit services for the Regional Municipality of Ottawa-Carleton).
[11] ibid p 6
[12] For those not familiar with elasticities, the following is provided as an example. In the Dawson paper, a 10 percent fare increase was multiplied by the elasticity of 0.3 and the product multiplied by the number of passengers to produce an estimate of the number of passengers lost as a result of the fare increase: 372 million passengers times 0.3 times 0.1 = 11.16 million passengers lost.
[13] An examination of constant dollars may be warranted in future research. However, for purposes of regression analysis, current dollars were used to ensure maximum variability for this independent variable.
[14] Not all results are described in this paper because of space constraints. Only highlights and major steps are outlined.
[15] Although it may appear that the emphasis is on the R square, this is, in fact, not the case. For each model that was tested, a full range of statistical tests were run. These tests included the F ratio, t statistics and a residual analysis. For brevity, not all the statistical results are presented for every regression model tested.
[16] For those readers who are unfamiliar with the use of dummy variables: Dummy variables are structural indicators, that is, variables that attempt to define the structure of the economy. A common example is a model attempting to explain changes in GDP over time. Dummy variables may be used for years in which nations are involved in major wars (such as World War II) because the nature, or structure, of the war economy is different than the same economy in peacetime. Dummy variables are normally binary (that is either 0 or 1 – off or on). Care must be taken not to use dummy variables that are linear (e.g. 0, 1 and 2) since linear forms will impart a bias in the data results.
[17] Large residual errors can occur even if a model's statistical tests are positive. A model of this type may be relatively strong on an aggregate basis but on a micro basis the model may be weak, at least for some of the observations. In other words, the model may be able to predict well on an aggregate basis (such as for a nation's Gross Domestic Product) but for individual sectors (e.g. banking, aviation, agriculture, etc.), the same model may not have the reliability or accuracy to estimate each sector well. On balance, the errors may cancel out producing a relatively good model on an aggregate basis. This may be the best a researcher can expect to achieve in some cases.
[18] Although called the "Final Model" the research is continuing.
[19] Cities are coded for purposes of confidentiality.

Impact of Cultural Trends on Urban Transportation

By Javier Caceres and Darrell Richards, AgriTrade and Transport

This paper analyzes urban transportation policy and planning against the background of changing societal values. It is an attempt to explain and understand why planning from different decades produces different results. Making the value judgements explicit should lead to more informed debate and better decisions.

Trends in urban planning influence transportation patterns. This paper examines trends in urban planning from the compact city to the suburban model and then back to the neo-traditional compact form. It concludes by describing the current conflict between suburban and compact land use approaches.

There have been few financial, resource or political constraints to urban sprawl. The growth in individualistic attitudes shifted us from the common space of cities to the private space of suburbs. Today, however, the cost of providing sewer, water and road infrastructure in new suburbs is driving some planners and politicians to promote intensification. However, the lifestyle appeal of low-density developments remains a very powerful market influence. Globalization, specialization, big box stores and high technology are transferring wealth from cities to suburbs and edge cities. It is not yet clear how the clash between the differing values of "city" and "suburb" will be resolved, if they can be resolved.

There is also an economic struggle as implicit cross-subsidies support suburban development and the economic activity there tries to maintain its advantage through the political system. Governments have cut social programs such as housing and welfare that are more important to cities, but are reluctant to confront implicit subsidies that support mobility, lifestyle and economic activity in the outer suburbs and edge cities.

Introduction

This paper analyzes urban transportation policy and planning against the background of changing societal values. It is an attempt to explain and understand why planning from different decades produces different results. Making the underlying value judgements explicit should lead to more informed debate and better decisions.

It would be inhuman to believe that transportation and urban planning professionals could be completely immune to prevailing social and cultural attitudes. These professionals are not the only ones who appear to influence and be influenced by the society in which they live. For example, trends in medical treatment change, resulting in different types of intervention over time. Economic prescriptions also change over time, for example from Keynes to Friedman.

Trends in urban planning influence transportation patterns. This paper examines trends in urban planning from the compact city to the suburban back to the neo-traditional compact form. It concludes by describing current political stalemates on the conflict between suburban and compact land use approaches.

Urban Planning – The Trend To Suburbanization

Cities have been shaped by changes in the modes of urban transportation which allow social and economic exchanges. The walking city prior to motorization was very efficient in its use of space. Circulation patterns assured access for daily functions by people travelling the least distance. When more than about 30,000 massed in an area, they congregated around another focal point. With industrialisation, specialisation, and increased scale of production, the walking city could no longer house enough people close to work places.[1]

In the tracked city, streetcars and rapid rail systems allowed people to live in suburbs away from the noise and pollution of the city and its factories. Many of the radial rail systems were built to increase the value of outlying land owned by speculators and developers. But, these suburbs were anchored to the rails and could not spread out in the gaps between the lines radiating out from the centre of the city.[2]

The rubber city of trucks and cars was no longer tied to the rail lines and spread out in all directions beyond the city. Transit ridership declined both in absolute numbers and in rides per person.[3]

One might be tempted to conclude that technology drove this transformation. Although technology made the entropy of urban planning possible, it was not the only factor. Health and safety concerns, lifestyles and cultural identity also played an important role.

---

[1] K.H. Schaeffer and Elliot Sclar, Access for All, Transportation and Urban Growth. Pelican: undated, probably mid 1970's. Chapter 2
[2] ibid, Chapter 3
[3] ibid, Chapter 4

The automobile suburbs were marketed as a clean, quiet lifestyle, free of the pollution, crime and noise of the city. After World War II, there was growing demand for housing the families of baby boomers. Converting farmland to housing and shopping centres accommodated growing urbanisation.[4] After 15 years of economic depression and war, the population was ready to let the good times roll.

There were few constraints on planners and developers from the 1950's to the early 1970's, and this influenced the philosophy of urban development. There was lots of land available for new developments and highways in the outer areas, and technicians could obtain political support for expropriation in the cities. Governments provided the funds for land and construction of roads.

Urban planners segregated different types of land use from a well-intentioned desire to improve health and safety. Transportation efficiency was no longer required because fuel was cheap and the automobile was flexible enough to go anywhere you decided to locate people or activities. Residential housing was segregated from the dirty and noisy industrial areas. Whereas people in the tracked city shopped on main streets, shopping in the rubber city was segregated away from housing in shopping malls surrounded by free parking. Schools were no longer the centre of the neighbourhood, but were bigger and located in one part of town.[5] Whether people in these communities liked cars or not became irrelevant. They needed them to function. As one writer put it, with the automobile it is hard to untangle the shot gun marriage from the love affair.

---

[4] Active Living,Go For Green, Retrofitting Communities for Sustainable and Healthy Active Transportation, 1997, p.5

[5] ibid

The suburban dream was a complete cultural package including the car, the house, the neat lawns, and neighbours similar to you. Young adults with children moved away from the city. As a result, residential areas increasingly became stratified by age, income, and social status. While the population of the inner city declined, the portion made up by the old, sick, and poor increased.

Suburban homes built in the 1950's and 1960's had a one car lane and one car garage. In the 1970's, these homes were retrofitted with a lane for two cars. In the 1990's, homes were built as a large two car garage with an attached house at the back. In California, new suburban homes may have a three car garage, sometimes a four car garage with bays of larger dimension to accommodate 4,000 pound sport utility vehicles.

Perceptions of safety have driven many consumer choices and planning decisions. The suburb offered a reprieve from the crime and off-beat people in the city. Family activity moved away from the front porch and veranda to the backyard protected by a high stockade. Some communities have been gated and protected by private police. Families moved out of the city to where they perceived the schools to be free of drugs, gangs and the influence of non-English speaking immigrants.

The private car increased the personal sense of security compared to fear of crime waiting for or riding a bus. Ironically, the chance of being killed in a vehicle crash is five times greater than being killed by homicide[6]. Because suburban dwellers drive more often and longer distances, they may have traded psychological comfort for greater real risk to their life.[7]

---

[6] In 1997, there were 586 homicides (murder plus manslaughter) and 3,064 persons killed in vehicle collisions in Canada

[7] Alan Thein Durning, The Car and the City. Seattle: Northwest Environment Watch, 1996, p.24

Planners reduced the peril of traffic in residential areas by preventing through traffic on dead end streets and crescents. Even the Canadian sport of street shinny hockey has been banned in some suburbs. Every residential street used to be an informal playground, but now streets are dedicated to vehicles and traffic. While the suburban model reduced traffic in a particular neighbourhood, it increased auto usage overall and focused it on the arterials which became barriers and safety risks for pedestrians.

Planners in the suburbs regimented neat and orderly development, even though the anti-tax and anti-government sentiment is strongest there. Planners mandated larger lot sizes and homes set back from the street line. Zoning bylaws segregated housing, that is ranch houses here, town houses there. Corner stores were not allowed within the neighbourhood, which required residents to use the car just to buy a carton of milk. Social housing or apartments were discouraged or segregated to a different area. One suburb even banned clotheslines.

Government planning intervention peaked in the 1950's and 1960's with the expropriation and assembly of land for freeways, built at significant cost to local and provincial taxpayers. Functional working class neighbourhoods were razed to make way for parks, freeways or redevelopment. For example, in the 1960's the National Capital Commission expropriated and bulldozed the Le Breton flats community in Ottawa which was home to 2,800 people, two-thirds of them working class French Canadian. Thirty-five years later, the vast area close to downtown Ottawa remains vacant. In 1961, Halifax used the expropriate and demolish routine to level Africville, home since the 1840's to blacks who fled north after the War of 1812.[8]

There was a populist backlash against freeway development and urban demolitions, for example with a watershed political decision to kill the Spadina Expressway which would have cut a swath through downtown Toronto.

---

[8] Phil Jenkins, An Acre of Time. Toronto: Macfarlane Walter & Ross, 1996, Chapter 18

New Urbanism and Neo-Traditional Development

The excess of the post World War II planning model came into question in 1961 with the publication of Jane Jacob's book The Death and Life of Great American Cities. [9] Both conservatives and urban reformers embraced her attack on the prevailing orthodoxy of planning. Her book acquired a following and orthodoxy of its own.

Newman and Kenworthy's 1989 work Cities and Automobile Dependence [10] argued that excess mobility was inefficient. This statistical correlation of indicators in major cities world wide started to quantify the problems of urban sprawl where it had been criticized mostly from a conceptual framework before. It also made the counter-intuitive argument that cities with the slowest and most congested traffic were more efficient and less costly. People in congested cities spent less time travelling to work than people in free-wheeling cities who used higher traffic speeds to live farther from work. The book proposed that congestion is a good management tool.

Developers and planners began to design alternatives to the conventional low-density suburb. This planning school, called neo-traditional or new urbanism, embraces a community design that has a diversity of land uses mixed together, a grid street network (as opposed to crescents), and is scaled to the pedestrian.[11]

---

[9] Jane Jacobs, The Death and Life of Great American Cities. Toronto: Random House, 1961

[10] P. Newman and J. Kenworthy, Cities and Automobile Dependence. Aldershot, England: Gower, 1989

[11] Active Living,Go For Green, Glossary

The late John Hartman of the Transportation Association of Canada (TAC) bridged the gap between professions by integrating this new urban planning ideology into the mainstream engineering community. He wrote the watershed 1993 TAC document A New Vision for Urban Transportation. Point one of 13 recommended principles was to plan for increased densities and more mixed land use.

In 1995, Newsweek Magazine featured articles on how to fix the suburbs, with a focus on neo-traditional development (give up the big lawn, bring back corner stores, make the streets skinny, drop the cul-de-sac, put the garage at the back, mix housing styles, plant trees, build malls out to the street, plan for transit, link work to home, make a town centre, shrink parking lots, turn down the street lights, think green.)

In 1995, the Blais report Economics of Urban Form estimated that urban sprawl in the Greater Toronto Area would cost an additional $13.5 billion in capital investment for roads, sewer pipes, parks and schools to 2021 compared to a more compact form of development. Additional operating and maintenance costs in the period would be $7 billion.

On January 12, 1996 the Globe and Mail responded with an editorial titled "A sprawling mess on government largesse." It went on to say that: "The biggest red-ink bleeding, cash-gobbling, robbing-empty-pocketed-Peter-to-pay-comfortable-Paul government program is the low-density urban form known as the suburb." A few days later on January 20, the Globe said in an editorial that: "Congested cities work best." The Newman and Kenworthy theory that congestion was an efficient growth management and development tool was now in the mainstream press.

In 1996, Atlantic Monthly published an 18 page feature titled "Home from Nowhere," which argued that America's land zoning regulations, intended to protect people from industry, had contributed to urban sprawl and many other problems.

In 1996, transportation engineers John Braaksma and Ian Lockwood presented a paper that suggested engineers needed to watch out for implicit value judgements that had a pro-automobile bias and discriminate against pedestrians. For example, "improving" a road may mean making it safer or more efficient for a vehicle, but make it more dangerous for a pedestrian to cross traffic flowing at higher speed. Thus, to the pedestrian it is not an improvement.

Some developers such as Peter Calthorpe have been able to retrofit existing suburbs to increase human activity and encourage walking. Other attempts have been less successful. Even though citizens strongly express a desire to have a traditional town centre or main street shopping environment, efforts by Kanata, Ontario, to create one have failed so far. The existing town centre and transit hub languished as big box stores created a power retail centre on the other side of the highway. The Mayor and Council are making new efforts to create a town centre in another location to give consumers an alternative to big box stores and conventional strip malls.

There are still powerful macro forces that are shifting market share in growth of human and business activity into the suburbs and edge cities. These include wealth and power transfers caused by globalization, specialization, high technology development and big box retail stores. The marketing and promotion of new cars, the declining (until this year) real cost of gasoline, and the trend toward incentive low-interest rate financing, propelled auto sales and usage in the 1990's. And the cultural icon of the 1990's depicted in television advertising and popular movies was the minivan or sport utility vehicle in a suburban driveway.

Fear of personal safety on city streets and in city schools continues to drive exurban development, even though the resulting auto dependence increases overall traffic risks. Residents of existing suburban neighbourhoods resist retrofitting to mixed land use. They are opposed to allowing corner stores or more compact housing due to fears about impacts on property values and traffic. Moreover, marginal political power, i.e. the swing vote, has followed the shift of wealth from the city to the suburb.

While the interventionist policies of governments expropriated the land and built the freeways that drove urban sprawl, they also tended to shore up investment and income in cities. This provided some counter-balance to the centrifugal forces shifting economic activity to suburbs. Provinces invested in and subsidized urban transit. Even the Federal Government provided some urban transportation funds. Federal and provincial governments invested in Coop and public housing.

So far, downsizing of government has hurt cities more than suburbs. The Federal Government got out of urban affairs and urban transportation assistance. Federal and provincial governments stopped investing in affordable housing. Provinces cut urban transit funds, and in some cases social assistance payments which affected cities disproportionately. In larger cities, government job cuts tended to affect downtown more than suburban office space.

Political Stalemate?

A previous section of this paper described how urban planning philosophy had come full circle from the traditional compact city of the streetcar 100 years ago to the edge suburban city of the post World War II era, to the neo-traditional compact model at the turn of the millenium. While there are new town centre developments, in-fill projects, and more compact residential developments, there are also many new low-density developments in exurban areas such as the 905 belt around Toronto. At this point, there is no clear triumph of one ideology over another.

A case study of Ottawa-Carleton's new Official Plan illustrates some of the ideological struggles occurring in metropolitan areas across the country. This is not just about the allocation of wealth, but also the allocation of access, mobility and the negative impacts of traffic.

In 1993, IBI Group prepared a background environmental analysis in preparation for the 1997 Official Plan. It found that a resident in an outlying suburb required twice as much road infrastructure as a person in central Ottawa, drove cars twice as much, and generated twice as much air pollution. The central Ottawa residents used transit more often, and walked and cycled about four times more often than the suburb.[12]

[12] IBI Group, Environmental Review of Ottawa-Carleton's Official Plan, Feb. 1993

After undertaking a number of other background studies, in July, 1997, the Regional Municipality of Ottawa-Carleton adopted a new Official Plan, embracing many of the principles and recommendations of the 1993 TAC New Vision for Urban Transportation. A summary of principles follows:

- Plan land use to take advantage of existing water, wastewater and transportation systems
- Encourage denser, more compact and more balanced development on lands designated for urban purposes
- Encourage an increase in the proportion of new dwelling units built inside the Greenbelt (outer suburbs are beyond it)
- Support a long-term balance of 1.1 jobs per household in each urban area outside of the Central Area
- Improve the balance of jobs and housing inside and outside the Greenbelt
- Implement a walking-, cycling-, and transit-first policy as part of a balanced transportation system that minimizes environmental, social and financial impacts
- Minimize the life cycle-costs of services required for growth
- Ensure that servicing responds to areas of employment demand
- Encourage residential development in areas that are the most cost-effective to service and discourage residential growth in other areas, while supporting choice in the market.

Following are some of the detailed policies in the Official Plan to support development in areas already serviced by infrastructure:

- 53 per cent of new residential dwellings are to occur inside the Greenbelt, up from 40 per cent currently
- Designated 33 kilometres of surplus rail line identified as transit corridors in the Regional Development Strategy to be developed into a rail rapid transit system, depending on success of a pilot project

- Target for the pedestrian mode is to comprise 10 per cent of peak-hour trips by 2021, region wide. Cycling to comprise three per cent. Transit to comprise 20 per cent, which requires a 75 per cent increase in riders.

The most controversial element in the plan was the Regional Development Strategy to have 53 per cent of new dwellings built inside rather than outside the Greenbelt. The intensification strategy carried.

In 1999, RMOC staff recommended that development charges in new suburban areas be increased to reflect the actual cost of servicing new areas. Council agreed to an increase one-tenth of the amount recommended on a cost recovery basis.

On one hand, the city versus suburban political split is a conflict of different visions for the urban area: new urbanism versus conventional suburban lifestyle. On the other hand, this is an economic struggle. If development charges in the outlying areas do not cover the life-cycle cost, the outlying area benefits from the short-term boost in economic activity from construction and tax revenues, while the city residents have to share the new infrastructure cost not covered by development charges.

Provincial policies will have a two-fold impact on the ability of Ottawa-Carleton to implement its Official Plan objectives for intensification.

- The Province has cancelled its 75 per cent funding of transit infrastructure and 50 per cent funding of road infrastructure. Thus, the Region may be unable to finance the infrastructure that would be required to support too much exurban development.

- Changes in Provincial education policy and the formula for school funding will close a number of city schools in order to fund new school capacity in growing suburban areas. In a perverse twist, a recent proposal for Ottawa would see the closure of existing schools and the addition of 600 student spaces in portable classrooms in the city in order to replace some portable classrooms in the suburbs with new school buildings. As one parent put it, the solution of closing city schools perpetuates the problem of school crowding in the suburbs because it will encourage young families to move to the suburbs.

The following table illustrates and compares the two competing visions for urban living.

The Two Solitudes

City Vision	**Suburban Vision**
Cities are more efficient because they reduce transportation	Traffic is more efficient in the suburbs
City residents subsidize new infrastructure developments in the suburbs	Suburban residents pay taxes for social programs that benefit City residents disproportionately
Suburbs are bad for the environment because they are too auto dependant	Cities are dirty, noisy and unsafe
The Central Business District is the heart of the overall regional economy	Suburban high tech parks are the engines of wealth generation

Conclusions

Urban and transportation planners are influenced by overall cultural and societal trends and preferences. We have come full circle in planning preference. Cities 100 years ago were built on a grid system of transportation with retail, housing and jobs in close proximity. After World War II, planners segregated retail, housing and jobs, thereby creating urban form that created sprawl and automobile dependency. The new urbanism or neo-traditional planning embraces the compact mixed land use pattern and grid transportation system of the last century.

The economic cost of providing sewer, water and road infrastructure in sprawling suburbs is driving some planners and politicians to promote intensification. However, the lifestyle appeal of low density developments remains a very powerful market influence. It is not yet clear how the clash between the differing values of "city" and "suburb" will be resolved, if they can be resolved.

There is also an economic struggle as implicit cross-subsidies support suburban development and the economic activity there tries to maintain its advantage through the political system. Governments have reduced funding for many social programs, but are reluctant to confront implicit subsidies to mobility and lifestyle in the exurban areas such as the 905 belt in the Greater Toronto Area.

The Transport for Persons with Disabilities: An Economic Evaluation

Michel Boucher*
École nationale d'administration publique, Université du Québec

1. Introduction

Since the beginning of the 80's, many provincial governments have passed laws imposing large municipalities or regional transit commissions to supply comparable transportation services to persons with disabilities. To induce local authorities to develop it, provincial governments gave them subsidies varying from 50% of the total operating costs like Ontario to 75% for Québec. Local taxpayers and users shared the remaining costs.

However, the Canadian published evidence obtained from a wide search on the working of this specialised transportation market is very sparse. There is a good deal of material describing programmes and information on costs and usage of such services, but the analytical content is partial and sometimes deficient. The purpose of this paper is to throw some light on this particular market where consumers are subsidised and the output is produced under the supervision of municipal officials. It is done by comparing two regional authorities producing this specialised service, the Ottawa-Carleton Regional Transit Commission (OC Transpo), through its Para Transpo service, and the Société de transport de l'Outaouais (STO). Their respective production function is similar, but there is a fundamental difference in the way each manages the respective demand for their service.

Section 2 contains the main cost indicators and a brief description of how services are supplied by both regional organisations. The other component of the market, the demand, is presented in Section 3.

Section 4 describes the dynamics of this market where the price mechanism is replaced not only by a trip reservation procedure, but also in some circumstances by a rationing system of which side effects are perverse. Finally, comments are set forth and some conclusions deduced from the analysis are briefly presented.

2. Considerations on costs

The transportation for disabled persons in different regional jurisdictions is generally done by outsourcing it to local transportation entrepreneurs. The monitoring of the remaining activities like reservation, scheduling and dispatching is in house. On a periodical basis, regional political authorities ask potential suppliers to bid on a transportation contract and the winner is the firm that generally has the lowest price tag for a given quality of service. However, accessible transit officials have evolved their management practices by adopting a learning-by-doing process. At the beginning, all the activities, booking, scheduling, dispatching and transportation, are contracted out. Public managers discover that the contractor's interests, to maximise his profits, are different from what they are searching for, a given number of on-time trips at the lowest possible cost. The ultimate outcome of this inefficient arrangement is a high price of transporting clients, a lower number of trips carried over a year and a reduction in quality such as less just-in-time services, delays in the schedule and inefficient matches between minibus and taxis. So they realise that there are monitoring economies in managing all operations within the organisation, but transportation per se. As a consequence of this discovery experiment, they produce more trips for a given level of quality with the same amount of money. In short, they increase their productivity as they move along their learning curve.

They learn too as time goes on that the best way to minimise costs when transporting disabled persons is to develop a portfolio of carriers and to enter in to different contracts with each of them. Their customers are not homogenous and therefore their needs are different. Individuals with physical handicaps use wheelchair or motorised

scooter while ambulatory disabled customers do not generally need a fully accessible vehicle. A typical organisation transports its clients by using a fleet of buses and minibuses, accessible sedans and standard taxis. The on-street service provided by a private contractor is paid on an hourly basis and the sedan/accessible taxi provider receives the fare on the meter plus a fixed fee.

Table 1 shows the values of the cost indicators for the STO paratransit service along with some other variables on usage for the years 1990 to 1998. The first column shows the total costs of the output (TC) which are equal to the overall revenue, the fare revenue collected from all passengers (FR), the average cost per trip (TC/T), the average contribution from user for a ride (FR/T), the real contribution to the cost borne per each rider in percentage (RATIO), the population of eligible registrants (ER) and the annual quantity of trips (TRIP) produced in a year.

The operating budget (TC) is relatively constant since 1995 because the Québec government and regional politicians have decided not to increase their subsidies to the accessible transit service. The fare collected from users (FR) is lightly increasing since its percentage of the overall revenue is 9,3% in 1997 comparatively to 6,5% in 1990. The average cost of a trip by user (TC/T) is decreasing since 1994, while the average contribution obtained from passengers (FR/T) is relatively stable since 1995. On the other hand, eligible registrants (ER) are growing at an annual rate of 6,2% whereas the output, measured by the number of trips, tends to go up and down in successive oscillations. Finally, it must be noted that the inverse relationship observed in 1997 between the decrease in the average cost of a ride (TC/T), namely $14.80, relatively to $16.64 in the previous year, and the important growth in the quantity of trips 94,200 compared to 83,179 in 1996.

Table 1
STO Costs, Registrants, Users and Trips, 1990-1998

Years	$TC million	$FR thousand	$TC/T	$FR/T	RATIO (%)	ER	TRIPS
1990	1,336	87,0	16.40	1.05	6,5	841	81,515
1991	1,417	89,6	18.77	1.14	6,1	736	78,325
1992	1,474	99,6	21.17	1.49	7,0	835	66, 40
1993	1,538	95,6	21.25	1.29	6,1	876	74,081
1994	1,379	97,4	18.67	1.32	7,1	1,017	73,896
1995	1,375	116,2	16.61	1.40	8,4	1,080	82,756
1996	1,384	113,4	16.64	1.36	8,2	1,175	83,179
1997	1,395	128,8	14.80	1.37	9,3	1,255	94,244
1998	1,438	122,0	15.95	1.35	8,5	1,371	90,200

Source: Data from the STO and the Répertoire statistique, Transport adapté, Ministère des Transports 1990-1997.

Table 2 describes the same variables for the Para Transpo service. The paratransit service had to adjust twice to imposed fiscal restrictions, first in 1993, when the provincial government put an end to its subsidies programme and again in 1998, when the OC regional government froze its subsidies to the 1997 level. After the first event, the total budget (TC) does not change a lot for some years. It starts a light decrease in 1997. Fare revenue (FR) from riders is increasing, the average cost per rider (TC/T) is decreasing and the average contribution borne by users is on the rise since 1993, although it tends to oscillate around 8%. Data on the number of persons registered for the service is incomplete. Para Transpo officials estimate it is too expensive to do it on an annual basis, so the register is checked every three years. Only the most recent data are reproduced, being more accurate. The output of trips is oscillating since 1994 between a lower bound of 733,504 and an upper bound of 757,731.

Table 2
Para Transpo Costs, Registrants, Users and Trips, 1990-1998

Years	$TC million	$FR million	$TC/T	$FR/T	RATIO (%)	ER	TRIPS
1990	9,104	0,557	19.29	1.18	6.1	-	472,130
1991	11,939	0,709	22.11	1.31	5.9	-	539,753
1992	14,104	0,920	22.49	1.47	6.5	-	626,620
1993	15,668	1,132	22.19	1.60	7.2	-	706,067
1994	15,513	1,195	21.13	1.63	7.7	-	733,564
1995	15,707	1,281	20.69	1.69	8.2	11,543	758,906
1996	15,892	1,381	21.42	1.88	8.8	10,299	735,263
1997	14,702	1,290	21.10	1.70	8.1	11,846	757,731
1998	14,697	1.259	21.71	1.71	7.9	8,893	734,571

Source : The Para Transpo service from Ottawa-Carleton Transpo, 1990-1998.

Some general considerations are deduced from these two tables: the Para Transpo average cost per rider is higher than that of the STO, although its permanent registered customers are higher, and that the OC Transpo territory is denser than that of the STO. However, both have the same percentage of the cost borne by riders. So the explanation for the apparent lower performance observed in the Para Transpo service must come from the demand side.

3. The demand for disabled transportation service

Main financial facts on the demand side are condensed in the following sentences: this specialised mode of transportation is highly subsidised, users paying less than 10% of the real cost of production. The demand will be always higher than the resources put in its production by the public sector. There is no real substitute for it, the private sector asking between $25 to $50 for the same service. Finally, Statistics Canada estimates that 68% of disabled adults had in 1991 incomes below the median income of the general population.

Customers for this accessible transit service can be divided in two groups. The first one is composed of persons who use the regular booking, mainly for work, post secondary education and those who

use the advance booking for non recurrent physical therapy or medical services. The opportunity cost is high for most of them because the absence of this particular service would deprive them, either from their actual salaries or completion of their higher education or enjoyment of curative services that improve their health and their well being. In the second group, we find all those working in protected shops for mentally ill patients, the most intensive users of regular booking reservation, and those customers who reserve by advance booking for shopping, cultural and social events. In short, the value of time for the first class is important whereas for the second, it is low. The demand for disabled transportation service from the members of the second class will be always higher than the actual capacity, the fare structure being constant.

On the other hand, provincial governments did not help by changing liberally the definition of disability over the years so that the number of registrants is steadily increasing. Moreover, the gradual ageing of the population and changes in social service and health care practices and policies are other factors augmenting the volume of clients for a specialised service for which provincial and regional politicians do not want to give more funds.

Finally, the procedure for trip reservation is briefly discussed because it will help a lot in our explanation of the market operations. An applicant becomes eligible if an appointed committee certifies that the functional disability information disclosed in his application is well founded and accurate. A permanent registered customer can reserve transportation using three different methods. The regular booking is a trip reservation arranged for customers who require transportation to a specific destination on a regular basis each week. Regularity always means a trip from the same origin-destination and on the same day-the same time each week. The number of regular bookings is opened for a customer, once a week to seven days a week. Trip purpose is usually work, post secondary education and non-repetitive heath care. The necessary recurrence is a minimum of four consecutive weeks with 75% of completed trips. If the latter clause is not respected, the

booking is subject to cancellation. Only one call is needed to book it and it becomes permanent.

The second, advance booking, is a trip reservation arranged by customers some days before the service is required. If customers require a fully accessible vehicle, they can call the reservation line before ambulatory customers who do not need this type of equipment. The Para Transpo gives this priority to customers using wheelchair and scooters over ambulatory customers, but not by the STO specialised service. Trip purpose is shopping, recreation, cultural and social activities. Each time that a given registrant needs this service, he must phone one day before, if the Para Transpo is his producer or three days before the service is required if he is registered at the STO service.

Daily booking is a trip reservation arranged for registrants on the same day that they require the service. As expected, available seats are very limited, but it is worth trying when the value of time is low.

The real difference in the way the Para Transpo and the STO manage their respective specialised service is the following: the former does not ask the trip purpose and does the scheduling and the assignment to vehicles as the reservation is done. The latter compels each registrant to reveal his preferences by expressing the real motives for the trip. Incentives to do it right are high because regular bookings are the first on the list when the schedule and the assignment to vehicles are done. If he declares his true intentions and that he requires a regular booking, he is sure to have it. If not, his booking will be solely determined by the normal procedure of seat assignment and vehicles. The marginal benefit is far higher than the marginal cost of not revealing his preferences

4. Market forces at work?

How efficiently doe a market operate where customers receive heavy subsidies to consume a specialised transportation service and where public managers learn being efficient without incentives and through

a learning-by-doing process? Of course, trips are produced, but some by-products or side effects are generated that both customers and production managers do not like and enjoy for different reasons. As the price mechanism does not clear the market, additional tools are introduced such as unaccommodated trips and a rationing by a waiting line. Together, they raise the level of frustration of some users who do believe that they, as a sub-group, are openly discriminated against.

Table 3 shows the extent of the problems faced by local transportation managers when scheduling and assigning persons to vehicles and the behaviours adopted by customers to counter their strategies. For each paratransit service, respective columns present unaccommodated requests (UR) because resources are lacking, late cancellations and no shows (NS), synonym for the absence of customers at the designated entrance, and preventive cancellations done by clients (PCT) in conformity with the normal procedure contained in the customer information booklet.

The first respective column (UR) expresses reactions by managers when the demand exceeds the capacity of production. Their only choice is to reduce the level of transportation services. The next two elements reflect the customers'behaviour. We focus on the variable preventive cancellations (PCT). Data show that this particular situation is very recent for the STO service whereas the Para Transpo service has faced in for a long time. The main reason explaining this discrepancy in behaviour is that Para Transpo customers request many trips, that they pick up the best one for satisfying their needs and that they cancel the others after. They are called pseudo regular users. The same situation appears at the STO in 1996 and 1998, but on a smaller scale. This high number of cancellations is one components of the explicit price borne by the Para Transpo for not asking the purpose of trip. But the STO has to face it too.

Table 3
Evolution of Unaccommodated Requests (UR), No Shows (NS) and Preventive Cancelled Trips (PCT) for Para Transpo and STO, 1990-1998

	Para Transpo			STO		
Year	UR	NS	PCT	UR	NS	PCT
1990	-	22,297	48,614	0	-	-
1991	845	28,057	56,359	66	-	-
1992	1,930	32,488	67,574	0	0	0
1993	5,025	33,890	81,495	254	0	0
1994	16,861	31,538	86,458	219	0	0
1995	30,130	30,746	101,516	190	700	0
1996	39,810	29,751	105,665	1,025	1,601	10,310
1997	39,588	30,157	122,819	207	2,107	7,797
1998	39,714	33,306	131,381	4,817	1,076	9,545

Source : Data obtained from Para Transpo and STO and Canadian Urban Transit Association, Annual Report, various years.

Table 4 shows the same information as in Table 3, but in percentage. As a quick reading reveals, Para Transpo percentages are always higher than those from the STO. The rate of increase for normal cancellations (PCT), namely a day before the delivery of service, grows steadily and it is the highest among these three perverse effects created by subsidies. Unacommodated requests (UR) are also a recent problem for the Para Transpo managers. It became important the year after the provincial government abolished its financial contribution for the transportation for disabled persons. The percentage of no shows (NS) is decreasing, maybe because the population asking for specialised transportation service is changing. As a matter of fact, the percentage of trips for individuals having physical handicaps and using wheelchairs and scooters is far less than those having only ambulatory deficiencies, among them more and more aged people. As this particular phenomenon appears only in 1996 and 1998 in the STO case, we must assess how those unanticipated consequences have emerged in a context far different from that prevailing at the Para Transpo.

Table 4
Evolution in percentage of Unaccommodated Requests (UR), No Shows (NS) and Preventive Cancelled Trips (PCT) for Para Transpo and STO, 1990-1998

	Para Transit (%)			STO (%)		
Year	UR	NS	PCT	UR	NS	PCT
1990		4,7	10,3	-	-	-
1991	0,2	5,2	10,4	-	-	-
1992	0,3	4,8	10,8	-	-	-
1993	0,7	4,8	11,5	0,3	-	-
1994	2,3	4,3	11,8	0,3	-	-
1995	4,0	4,1	13,4	0,2	0,8	-
1996	5,4	4,0	14,4	1,2	1,9	12,4
1997	4,2	4,0	16,2	0,2	2,2	8,3
1998	5,4	4,5	17,9	5,3	1,2	10,6

Source: Computed from Tables 1, 2 and 3.

4.1 The emergence of the first STO bubble

The explosion of the demand occurs on a regular basis for Canadian urban transit organisations that produce a transportation service for disabled persons. This periodic situation comes from the basic fact that customers do not pay the full price of producing the service they consume and that they expect a lot from it, being considered as «a social equaliser» in terms of opportunities. A first bubble emerged in 1996. Bubble means in economics a sudden growth in the demand that exceeds the actual capacity of production. The data from Table 1 show the thread of the events and help to bring out the underlying forces. In 1993, the average cost for a trip is $21.25 and it decreases to $16.64 in 1996. As expected, the output moves in the opposite direction since its goes up to 83,179 in 1996 from 66,940 in 1993. The reduction in the average cost per trip allows the STO paratransit service to increase its volume of trips. Users reacted naturally to this additional capacity by increasing their demand. They see new opportunities for transportation. They bear only 6.1% of the total cost incurred by the STO in 1993 and 8.2% in 1996. For whatever are the motives, either they have required more trips than necessary or they have changed their mind in the meantime and they cancel more trips

than before. From 1990 to 1995, normal cancellations (PCT), as described in the STO customer's booklet, were nearly zero, but in 1996, they skyrocketed to a peak, 10,310. The explosion of the demand for trips, induced by an efficient performance from the STO, that monitors in house two activities previously done by a private contractor, the scheduling and the dispatching, leads the STO to act by implementing a rationing process. The final outcome is an increase in unaccommodated requests (UR) from 190 in the previous year to 1,025 in 1996.

Table 5 shows the necessary information to understand the internal dynamics created by the customers'expectations when noting an increase in the STO capacity. It contains three sections and the first refers to the attributes of the registrants. The latter is subdivided then in three different groups: the first is composed of persons who need wheelchairs or scooters to move or non-ambulatory customers (NA). The second represents persons with ambulatory deficiencies (AD) and the third includes persons with intellectual, psychic and visual deficiencies (Others). The central section of table shows the number of trips for three groups, those considered as non ambulatory customers (NA), those who are classified as ambulatory disabled persons (AD) and the third, the companions (COM). The last section, located on the right hand side of the table, presents the number of trips according to their methods of reservation, regular booking and advance booking. In general, the classification also reflects the purpose of trip expressed by users.

The presentation of the facts and the analysis of the bubble start with the changes occurred in the central part of the table. The demand for trips rises by 3,114 for registrants who are ambulatory disabled (AD) since their trips grow from 56,122 in 1995 to 59,236 in 1996. This increase is conjugated to a reduction in the demand for trips by 1,747 from non ambulatory customers (NA), their demand decreasing from 22,632 in 1995 to 20,885 in 1996. These changes are then transposed in type of trips as they are booked, the third part of the table, in the following way: regular booking trips increase by 5,172 to 58,703 in 1996 from 53,5531 in 1995 whereas advance booking trips regress

from 29,225 trips in 1995 to 24,476 in 1996, a loss of 4,794. In short, the rise in the demand for trips coming from ambulatory disabled customers is translated subsequently by an increase in regular booking trips that must be balanced by a decrease in the number of advance booking trips.

Table 5
Evolution of the Registrants Attributes, Trips by Group and Riders by Trip Purpose for the STO, 1990-1998

	Attributes of Eligible Customers			Trips for Each Class of Eligible Customers			Trip Purpose Choices	
Year	NA	AD	Others	NA	AD	COM	Regul.	Adv.
1990	338	504		20,502	58,221	2,792	64,244	17,271
1991	414	343		21,163	53,756	3,406	61,038	17,287
1992	-	-		19,180	44,967	2,793	52,400	14,540
1993	455	421		22,473	48,718	2,890	55,562	18,519
1994	542	216	259	21,205	49,386	3,305	52,845	21,051
1995	547	262	271	22,632	56,122	4,002	53,531	29,225
1996	576	300	299	20,885	59,236	3,088	58,703	24,476
1997	594	331	330	25,068	65,410	3,766	62,885	31,359
1998	674	531	270	24,362	64,492	2,604	64,747	24,107

Source : Répertoire statistique, Transport adapté, Ministère des Transports 1990-1997; data obtained from STO and Canadian Urban Transit Association, Annual Report, various years.

The most plausible explanation of this conclusion is based on the experience observed in the Para Transpo organisation. This situation is similar in a way to the behaviour of pseudo regular customers: they book many trips and they cancel those that are judged no longer interesting. The STO accessible transit service is forced to be involved in an activity that the Para Transpo is in for a long time, a policy of overbooking as in the airline industry for instance, to minimise its operating costs.

There is another approach to measure the consequences of a bubble among various classes of registrants. Although the point of view is different, it is in fact a complementary angle to the preceding analysis. It concentrates on the relative importance of each group of

eligible registrants, the non-ambulatory disabled persons (NA) and the ambulatory disables persons (AD), relatively to their intensive use of the paratransit service. A ratio superior to one reveals that a particular group uses it more intensively than its relative importance in the population of eligible registered persons and a ratio inferior to one implies that the group is a lesser user of transportation service than its percentage in the population of registrants. Those weights are converted in an absolute number to acknowledge the disproportional use of the transportation for disabled persons by a particular group.

Here are the results obtained by this approach for the first bubble. In 1995, ambulatory disabled customers (AD) used 2.79 times more the transportation for disabled persons than their relative importance in the population of eligible registrants whereas non-ambulatory customers (NA) used it in a proportion inferior to their percentage in the population of registered persons, let 0.539.

In absolute terms, the 1995 intensity factor is strictly the product of two ratios:
$(AD_p/AD_c)/(NA_p/NA_c)$=(67.8%/24.3%)/(27.3%)/50.6%)=(2.79/0.539) =5.18
where small subscripts p and c are respectively for the relative importance of trips completed by each group and for the relative percentage of eligible customers in the population. In 1996, the relative respective weights are 2.79 for the ambulatory disabled (AD) and 0.512 for non-ambulatory disabled persons (NA).
The absolute measure obtained, 5.45, is the product of two intensity ratios:
$(AD_p/AD_c)/(NA_p/NA_c)$ =(71.2%/25.5%)/(25.1%/49,0%)=(2.79/.512).
In other words, the relative position of non-ambulatory persons (NA) is worse in 1996 than in 1995. A part of the 1996 bubble comes from an increase in the intensive use of the paratransit service by the ambulatory disabled persons (AD), although they represent a lower percentage of the population of eligible persons than the non-ambulatory disabled persons do.

4.2 The 1998 bubble: recurrence of an unstable situation

The second bubble occurs in 1998 and again the relevant information is taken from Tables 1, 3 and 5. This time, the principal cause is an increase in the average cost of a trip production from $14.80 in 1997 to $15.95 in 1998. As the cost reduction realised in 1997 by internalising the scheduling and the dispatching was not recurrent, the rise decreases the capacity of production by 4,044 trips, from a 94,244 peak in 1997 to a lower level, 90,200 in 1998. On the demand side, users'expectations are always high mainly for the same reasons as mentioned before; they contribute a small part in the production costs and many of them have a low opportunity cost because of their general physical and psychological condition. Preventive cancellations (PCT) increased to 9,545 in 1998 from 7,797 in 1997 as shown in Table 3. As the STO production capacity is restricted by this rise in its average cost of production, local officials introduced a rationing system. The effect is to increase unaccommodated trips from 207 in 1997 to 4,817 in 1998, a factor of 22 times. However, the relative share borne by the two user classes differ, non ambulatory persons (NA) reporting a decrease of 2,8% or 706 trips and ambulatory disabled persons (AD) a decrease of 918 trips or 1,4%. If these trips reduction are converted up to the method of reservation, it implies a 23.1% decrease in advance booking reservation or 7,252 less trips consumed in 1997 than in 1998, the difference between 31,359 trips in 1997 and 24,107 in 1998. For the regular booking component, trips increase by 3,5% or 2,189 more trips consumed in 1998 than in 1997. In real numbers, regular booking trips grow from 62,885 in 1997 to 64,747 in 1998.

By using the second approach based on the intensity factor of each group, it is shown that in 1997, ambulatory disabled persons (AD) used 2.63 more times more the accessible transit service than their relative importance in the population of registered disabled individuals. The other group, non-ambulatory disabled persons (NA), used it less intensively than their respective percentage of the population by a factor of 0.560. The intensity factor for 1997 is therefore:

$(AD_p/AD_c)/(NA_p/NA_c)$=(69.4%/26.4%)/(26.6%/47.3%)=(2.63/0,560) =4.70.

In 1998, their relative weights are respectively 2.59 for ambulatory disabled persons (AD) and 0.511 for non-ambulatory disabled persons (NA). The 1998 intensity factor, the product of the two ratios, is equal to 5.07 and it is obtained by $(AD_p/AD_c)/(NA_p/NA_c)$=(70.5%/27.2)/(26.6%/52.0%)=(2.59/0.511)= 5.07.
The conclusion deduced for the first bubble holds that the intensive use of the accessible transit service by the ambulatory disabled persons partly causes the emergence of a bubble.

The STO, in concert with its accessible transit advisory committee, reacts to this second bubble by changing some internal practices. Here is a list of the most important changes implemented. Some demands for transportation are refused and a waiting list as screening device is introduced. Moreover, regular booking is restricted to registrants who need it for work, post secondary education and on non-repetitive health care. Restrictions are also applied on trips for those who receive medical care in Ottawa hospitals. All trips whose motives are other than those mentioned for a regular booking are now considered as advance booking trips and they must be booked three days before the service is required. As the first call first serve principle is no longer valid, eligible customers can call during hours of service. Finally, the STO establishes some fixed routes/fixed schedules for ambulatory disabled persons who work. All is done to attenuate the side effects created by the bubble.

Our last comment refers to the enforcement by the STO of its rules when some users do not comply with its regulation. As shown in the analysis, no-shows and late cancellations, although endogenous to the system, are the most important problem. The User Guide is specific about it. If a registered customer does not respect the policy, a first letter warns him. If he is a repeat offender, a second letter is sent. If the same behaviour goes on, he can be suspended for a given period

of time. But STO acknowledges that nobody has been suspended yet. The STO policy is less severe than that set up by Para Transpo.

5. Concluding remarks

The analysis reveals that the bubble is a periodic phenomenon and that Canadian accessible transit services solve it in the same way, by generating inefficient behaviours on both sides of the equation. Even paratransit services that require from each registered person to reveal the trip purpose face the same inefficient consequences, although at a smaller scale. Pouring additional money in the paratransit service will lead to a spiral, an upward shift in the demand, an increase in expectations for registrants and more bubbles. An accessible transit service can only provide individuals with disabilities the same public transportation service opportunities as everyone else.

The analysis of these two bubbles leads to the following four conclusions. First, ambulatory disabled persons seem to be favoured when a bubble emerges because they use more intensively the accessible transit service than their relative importance in the population of registrants. Secondly, the reservation procedure per se gives a priority to registrants who reserve trips through the regular booking method over those who must reserve them by advance booking. Thirdly, users with intellectual deficiencies who now live in residence and no longer in psychiatric hospitals obtain a high percentage of those regular trips. Fourthly, non-ambulatory disabled individuals are the most affected by bubbles when reserving through the advance booking method.

References

*This paper is technical by-product of a more intensive research funded by the National Transportation Agency. It reflects the views of the author and not necessarily those of the National Transportation Agency.

Berechman, Joseph (1993). *Public Transit Economics and Deregulation Policy*. North Holland. New York.

Canadian Urban Transit Association, *Répertoire statistique du transport adapté au Canada*, Annual Report, various years Toronto.

Finn, Linda et John J. Lawson (1996). *Cost-Effectiveness of Equipment Subsidies under Transport Canada's National Strategy for the Transportation of Person with Disabilities (1996)*.Working Paper TP12732E. Policy, Economic Analysis, Transport Canada, Ottawa.

Gazette officielle du Québec (1979). Loi du ministère des transports, *Subventions au transport des personnes handicapées, A.C. 2071-79*, 11 juillet.

Gomez-Ibanez, Jose A. et John R. Meyer (1992). *The Political Economy of Transport Privatization : Successes. Failures and Lessons From Developed and Developing Countries*. John F. Kennedy School of Government, Harvard University.

Ministère des Transports. *Répertoire statistique, Transport adapté, 1990-1997*. Québec.

Ministère des Transports (1983). *Politique d'admissibilité au transport adapté pour les personnes handicapées*. Québec.

Mnistère des Transports (1993). *Politique d'admissibilité au transport adapté, Édition révisée*. Québec.

Ministère des Transports (1998). *Politique d'admissibilité au transport adapté, Édition révisée*. Québec.

OC Transpo, various documents, Ottawa.

OC Transpo, www.octranspo.com, *The Way Ahead Becoming the Best of the Best*

Société de transport de l'Outaouais, various documents, Hull.

Aeropolitics, Global Alliances, and the Battle for Air Canada

Michael W. Pustay and Raymon J. Kaduck

For the past several months, newspapers around the world have carried stories about the struggle for control of the Canadian airline industry. The proposal by Onex Corporation to acquire Air Canada and Canadian Airlines triggered a competing offer by Air Canada to buy up Canadian Airlines. On the surface, this struggle would appear to be a purely domestic matter, in as much as the principals are all Canadian corporations. However, American Airlines, a member of the Oneworld alliance, served as a silent partner in the Onex offer. Similarly, Air Canada's offer was backed by two of its Star Alliance partners, United Airlines and Lufthansa.

The goal of this paper is to examine the growing impact of global aeropolitics and global alliances in shaping competition in the Canadian airline industry. The paper examines the interaction between Canadian domestic, international, and transborder aviation policies and their impact on the viability of Canadian-flag carriers. It then discusses the role of global alliances in triggering this takeover battle. The paper concludes by examining how the growth of global alliances is constraining the policy options available to domestic policy makers using the battle for Air Canada as a case study.

CANADIAN AVIATION POLICY

Commercial air service in Canada began in 1919, although for many years service was confined to short-haul routes. Canadian travelers wishing to fly across the North American continent were often forced to route their trip through the United States. To remedy this problem, the Trans-Canadian Airlines Act of 1937 called for the establishment of a federally-owned, transcontinental airline. Trans-Canada Airline, the corporate predecessor to Air Canada, began serving the Montreal-Vancouver market a year later. During the same decade, the Canadian Pacific Railway was creating Canadian Pacific Airlines (the corporate predecessor to CP Air and Canadian Airlines). Although over the years numerous regional carriers were established to service local or provincial needs, the Canadian domestic market has essentially been a duopoly since the 1930s.[1]

Regulation of the Canadian domestic airline industry commenced with the passage of the Transport Act of 1938. The initial focus of federal regulators was to create a national network of routes. Canadian policy was predicated on a belief that air service to many smaller city-pair markets was unprofitable and on a desire to minimize the demands on the federal treasury of providing such service. Accordingly, Canadian regulators granted carriers monopolies in larger, profitable markets with the understanding that they would then use these profits to cross-subsidize their services in smaller, unprofitable markets. Air Canada benefited substantially from this policy, for it was granted monopolies in many of the larger and denser markets in Central and Eastern Canada.

These policy decisions have had a pervasive and durable impact on all aspects of the Canadian airline industry despite subsequent changes in Canadian regulations. For example, domestic regulatory policy underwent dramatic changes in 1984 when many economic regulations governing air service in the southern half of the country were eliminated. Yet concentration in the domestic market remained little changed. Most city-pairs continued to be served by only one or two carriers. Moreover, the balance of power between Air Canada

and Canadian Airlines was not affected. The former continued to be the pre-eminent carrier in Central and Eastern Canada, while Canadian Airlines' strength lay in Western Canada.

The philosophy underlying Canada's domestic airline policies was also reflected in its international and transborder aviation policies. For many years Canada was unwilling to promote intra-flag competition on international routes. Because of Air Canada's then existing status as a Crown Corporation, Canadian regulators systematically granted all of Canada's international operating rights to Air Canada. Its monopoly on international routes was broken only in 1948, when CP Air was designated as Canada's flag carrier in the Pacific. Although the boundaries of Canada's "division of the world" policy changed from time to time, the impact of Canada's policy was to grant Canadian Airlines Canadian-flag dominance on transpacific routes and Air Canada on transatlantic routes.

Canada's transborder policies were far less balanced. Until the signing of a new agreement in 1995, the Air Service Agreement (ASA) between Canada and the United States severely restricted entry. As was the case in international markets, initially Canadian regulators reserved Canada's transborder operating rights for Air Canada. Indeed, it was only in 1967 when CP Air received its first U.S.-Canada route, between San Francisco and Vancouver. Time did not improve the hand dealt the carrier. When the new ASA was signed, CP Air served but a handful of transborder markets, and these were restricted to West Coast markets ex-Vancouver. As a result, Air Canada's ability to integrate transborder traffic into its Canadian route network was far superior to that of Canadian Airlines prior to 1995. Moreover, Air Canada was in a far stronger position to exploit the new ASA than Canadian Airlines. Air Canada had more physical presence (i.e., gates, check-in counters, etc.) and brand name recognition in most U.S. cities than Canadian Airlines. And unfortunately Canadian Airlines' ability to respond to the new transborder ASA when it was signed in 1995 was limited by its now precarious financial situation.

THE 1999 TAKE-OVER BATTLE

The two Canadian main line carriers struggled through the 1990s. Air Canada was occasionally profitable and a generous "sweetheart balance sheet", with which it had been endowed when it was privatized, allowed it to acquire one of the youngest fleets in North America. Under Hollis Harris, it began to show signs of moving away from its bureaucratic roots, but it was a perennial disappointment, and lost favour with investors. Perhaps only a provision limiting shareholders to no more than ten percent ownership, also a political insertion at the time of its privatization, prevented it from being taken over.

By the late 1990s, Air Canada's revenue growth was substantial, but so was that of its costs. A 13-day strike by its pilots in 1998 and an expensive settlement with its flight attendants in 1999 typified its labor problems. The low value of the Canadian dollar boosted its costs for fuel oil and other imported goods, as did rising airport and air navigation charges.

Canadian's problem was the reverse. Because of its long-term financial difficulties, it had managed to negotiate a series of wage concessions from its employees. However, its revenues were hurt by the decline in traffic attributable to the Asian currency crisis and by competition from WestJet, the country's most successful post-deregulation discount start-up carrier, whose operations were concentrated in Western Canada.[2]

To resolve its growing financial crisis, Canadian Airlines proposed a merger with Air Canada in January 1999. It offered to exchange 2.5 shares of Canadian stock for each share of Air Canada, yielding an estimated 33 percent premium over the existing market value of Canadian's shares. AMR (the parent corporation of American Airlines) would receive about C$65-70 million for its preferred shares in Canadian, which had a face value of C$330 million. (AMR had earlier written off its entire investment in Canadian). The proposed offer also protected AMR's economic interest in its on-going service

agreement with Canadian. The newly merged carrier would continue to purchase reservation services from AMR-owned Sabre and would become a member of the Oneworld alliance. Should the new carrier abrogate the service agreement, it would owe AMR a cancellation fee of 50 percent of the revenues otherwise due.

In April, Air Canada made a counteroffer. It proposed to pay C$3 for each Canadian share (about a 50 percent premium over market value) but offered AMR nothing for its preferred stock and no buy-out payment for termination of the services contract. Canadian's creditors were also asked to pay Air Canada C$1 billion to compensate it for "balance sheet erosion."[3] Air Canada did make one major concession; it agreed that the new carrier would be a member of the Oneworld alliance.

Neither the original offer nor the counteroffer was accepted. After the talks failed, in June 1999 Air Canada offered C$2 billion to acquire Canadian's international routes and a minority stake in Canadian. The offer was rejected, allegedly at the behest of American Airlines, which owned one-third of that carrier's equity and one-quarter of its voting stock.[4] It also had a veto over any restructuring of Canadian.

In early August 1999 Canadian Airlines informed Transport Canada that it might have to abandon some of its routes for financial reasons unless it received some relief. Analysts following the industry believed that Canadian might exhaust its cash reserves by the end of the winter if nothing were done. Recognizing the implications of Canadian's dire financial straits, on August 13, 1999 the Transport Minister, David Collenette, announced that he would invoke section 47 of *The Transportation Act*, which allowed the Minister to suspend competition laws if necessary to avoid disruption of the country's transportation system.

The Minister explained publicly that he had invoked section 47 after being asked to do so by the carriers, since it allowed the two carriers to discuss a variety of issues, such as reducing excess capacity on

routes served by both of them, in order to restore the industry's economic health.[5]

Some months later, the House of Commons Standing Committee on Transportation (SCOT) itself questioned this explanation. It had heard testimony from both of the carriers in which they denied having asked the Minister to use the provision.[6] In its report, the Senate Committee on Transport and Communications concluded that the action was not necessary because the carriers had had previous discussions on the same issues without the invocation of section 47.[7]

It may be, however, that section 47 was invoked in order to preempt criticism about anti-competitive behaviour. In July, the Competition Bureau had released a report in which it found that the previous discussions were more limited in scope.[8] In the light of subsequent testimony, the carriers may have been less than candid about the extent of their discussions, although it may be a fine legal point that the merger discussions were not the sort of collusion that would have specifically worried the bureau.

Media commentators questioned the use of section 47, pointing to the serendipitous fashion in which the Onex bid appeared so soon after it was invoked. For many, the tie between Collenette and Gerry Schwartz, a long-time Liberal Party fundraiser seemed too much of a coincidence. Schwartz was an astute businessman, who had multiplied the share value of Toronto-based investment company Onex Corporation many fold through the 1990s. Onex specialized in taking over underperforming companies and turning them around. Onex had considered taking over Canadian in 1996, but had determined that it was not attractive unless large-scale rationalization of the industry was possible.[9] Schwartz's solution solved both the rationalization issue, and the issue of Air Canada's aggressive stance toward the "blue team". He proposed to take over both airlines.

On August 25, 1999, Onex announced a C$1.8 billion plan to acquire Air Canada and Canadian Airlines and merge them into a new company, AirCo, which would operate under the Air Canada name.

Onex's complex offer was made in conjunction with American Airlines, which pledged to invest $184 million in AirCo and loan it an additional $151 million in return for a 15 percent stake in the company. Onex would put up $670 million for its 31 percent stake in AirCo's stock. AMR and Onex also agreed to purchase $168 million in AirCo debentures which carried warrants to purchase another 12.5 percent of AirCo's equity.[10]

This approach offered American Airlines several advantages. Air Canada would rely on AMR for scheduling and reservations services.[11] The new carrier would also become part of the Oneworld alliance, whose leading partners are American Airlines and British Airways. This would significantly raise American Airlines' passenger traffic; Canadian Airlines alone flows an estimated 750,000 passengers onto American flights, traffic worth an estimated U.S.$140 million annually.[12]

Onex expected to save C$600 million in annual operating costs, much of which was attributable to a planned 5,000-person cutback in staffing levels. However, as a result of political pressures, it soon announced it would not layoff any employees. Instead, it would utilize voluntary buy-outs to reduce the combined carrier's work force by 5,000. Onex agreed to freeze prices to reduce consumer fears. To woo politicians, Onex also said it would preserve service to small communities and maintain existing corporate headquarters in Montreal and Calgary. Many analysts were concerned however, that these concessions might make it harder to trim operating costs after the merger.[13]

Air Canada's board of directors quickly rejected Onex's C$8.25 a share offer in September 1999, claiming that the deal was "structured to rescue Canadian Airlines at Air Canada's expense."[14] The board adopted a poison pill to deter Onex's bid, which would be triggered if any party acquired more than 10 percent of Air Canada's common stock without the permission of its board of directors.[15]

Air Canada's 2,200 pilots also opposed Onex's plan for fear that their junior pilots would bear the brunt of any merger-induced layoffs. To preserve their interests, the union announced it would consider sponsoring an employee buy-out of the carrier.[16] The intensity of the pilots' opposition grew out of a fear that if the seniority lists of the two unions were merged on an equal basis, as was suggested by Schwartz's statements, that Air Canada pilots would be made worse off. Seniority lists determine which pilots have the right to bid on positions in larger aircraft and more sought-after routes. Canadian Airlines had done little hiring through the 1990s, while Air Canada had expanded. On average, the Air Canada pilots were a younger group, and if the seniority lists were merged with pilots from both airlines treated equally, many would find themselves with significantly diminished prospects for flying the high wage aircraft and the most sought-after routes. Pure self-interest led many to conclude that only if Canadian were taken over by Air Canada, or forced into bankruptcy, could they protect their own place on the seniority list. Overblown rhetoric was the order of the day. ACPA president Jean-Mark Belanger referred to CAIL as having a "virus" that would infect Air Canada.[17]

At least publically, Air Canada's Star Alliance partners stood solidly against Onex. They unanimously agreed to support any plan that would keep the carrier from transferring its allegiance to the OneWorld group. Noted SAS CEO Jan Stenberg:

> We stand together in full support of the actions taken by our partner, and will take whatever steps necessary, including making a financial commitment, to protect the interests of our partnership and its customers.[18]

In October 1999 two of Air Canada's Star Alliance partners, Lufthansa and United Airlines, announced two approaches to thwart Onex's bid. First, they negotiated a commercial agreement with Air Canada that served as a poison pill to any other alliance-oriented takeover. Under the terms of the agreement, Air Canada agreed for ten years not to join any other alliance, form a joint venture, or

engage in code-sharing with any carrier that was not a member of the Star Alliance. Both United and Lufthansa were granted the right to seek an injunction should Air Canada try to withdraw from the Star Alliance. If Air Canada were to breach the agreement, it agreed to pay Lufthansa and United C$250 million in damages. Such a breach might also force Air Canada to redeem C$250 million of preferred shares owned by the two Star partners. As a defensive measure, Air Canada announced it would spend C$1.1 billion buying back 36 percent of shares. It would use C$480 billion of its own cash, supplemented with C$620 million from Lufthansa and United.[19] In return, the two foreign carriers would receive 10 million preferred shares convertible into non-voting common shares, which would give them about 7 percent of Air Canada's equity.[20]

Onex responded to these initiatives by raising its offer for Air Canada to C$13 per share. To allay political concerns about its role, American Airlines said it would sell all of its shares in a merged carrier at C$8.25 through a rights offering and forego exercising any of its voting rights.[21] In early November, Onex raised its cash offer for Air Canada once again to C$1.2 billion, or C$17.50 per share. The new cash came from American Airlines, raising its share of the total package to C$626 million.[22]

Air Canada broadened its counteroffensive. It announced a C$92 million offer to buy Canadian Airlines at C$2 per share.[23] It agreed to operate Canadian as a separate subsidiary that would code-share with Star Alliance members as well as with Delta Airlines. By so doing, Air Canada could control Canadian without having to consolidate its rival's C$2.2 billion in debt on its own balance sheet. Air Canada also pledged to use the excess capacity created by the merger to establish a new discount fare carrier within Canada.[24]

The battle effectively ended when a Quebec court ruled that Canadian law forbade any shareholder from owning more than 10 percent of Air Canada.[25] This judicial roadblock cleared the path for Air Canada's C$2 per share offer for Canadian Airlines. To reduce its financial exposure, the actual purchase was made through a company

controlled by a debt-restructuring firm. Air Canada would take over ownership only after Canadian's debt load was reduced substantially.[26]

However, Air Canada was forced to make several concessions to American Airlines because its agreement with Canadian Airlines entitled American to hundreds of millions of dollars in break-up and other fees.[27] Air Canada agreed to operate Canadian as a subsidiary and to allow American Airlines and Canadian to continue to feed traffic onto each other's flights. American could continue its code-sharing arrangements and complementary frequent flyer programs with Canadian for ten years. Should Air Canada decide to dissolve Canadian as an independent subsidiary, American would retain some marketing rights. Air Canada also agreed to allow Canadian to continue to purchase certain services – primarily reservations through AMR's Sabre affiliate – and to pay American as much as C$83 million if it terminated the service purchase agreement. As a final teaser, Air Canada also agreed to pay American C$55-60 million for its convertible preferred shares in Canadian Airlines.[28]

Policy Options

The fundamental policy question of why Canada would permit the monopolization of the business market remains unanswered. Certainly there were short-term political gains by avoiding job loss that would have accompanied the failure of Canadian. Other options existed, however, and the Competition Bureau outlined a number of liberalizations that could have increased competition in the market after the creation of a "dominant carrier". In the same period, for example, Australia opened competition and liberalized ownership restrictions unilaterally.

Canada did not do so, largely for domestic political reasons. Quebec nationalists and Canadian economic nationalists, unions and other left-wing voters would have opposed the sale of this "jewel" to purportedly U.S. interests. This motive, as absurd as it may seem in a country that is heavily trade-dependent, remains a domestic policy

issue. So pervasive is the idea, that even Jennifer Hillard, of the Consumers' Association of Canada, applauded Air Canada for a "made-in-Canada solution", as though potential exploitation by a domestic monopolist were somehow an improvement over other options.[29]

Robert Milton used overblown chauvinistic rhetoric to great effect; a delicious irony since he is the third U.S. citizen in a row to head Air Canada, while Donald Carty, the American Airlines president he painted as the villain of the piece, and Gerry Schwartz, the Onex president, are both Canadians.

Transport Canada may also have felt that unilateral liberalization would reduce bargaining power when it eventually had to further liberalize the North American market. No credit would be given by the U.S. for any liberalization Canada had undertaken on its own.

Alliance behaviour

The value of a Canadian feeder into the alliance structure was tested, and several observations can be made. The Oneworld partnership valued Canadian Airlines largely for the connections it could provide American Airlines in the Asia-Pacific market. However, Oneworld did not view the loss of Canadian as critical to its future. The Air Canada April offer would have had the dual effect of depriving the Star Alliance of Air Canada's presence and providing Oneworld with Canadian's and Air Canada's combined route authorities and slots. AMR clearly did not value this offer highly enough to meet Air Canada's demands that it be compensated for "balance sheet erosion".

Some analysts conclude that this was never really a good faith offer, but rather a continuation of a decade-long Air Canada strategy to force Canadian into increasingly weakened condition. In any case, Oneworld had substitute arrangements available, such as strengthening the AMR-Cathay Pacific relationship. In fact, this is what transpired following the merger.

The value of Air Canada to the Star Alliance is similarly a matter of preference, rather than strategic necessity. The loss of Air Canada's route authorities would have hurt United and Lufthansa, but not substantially. Rono Dutta, President of United Airlines, estimated Air Canada contributed $30 million a year to his airline, but it would recover approximately 8 years equivalent in liquidated damages if Air Canada left the alliance.[30]

While the alliance was portrayed as some form of white knight, it did not pay a high price for assisting Air Canada. United and Lufthansa purchased only a seven percent share between them. Since the Quebec court ruling, rather than the counterbid, ended the issue, it is unclear to what lengths the alliance might have been prepared to go in Air Canada's defence.

To defend its own control of the airline, however, Air Canada's management accepted a lock-in agreement with the Star alliance of unprecedented severity and length. Only time will tell whether this is a substantial benefit or penalty. International liberalization or evidence of increasing stability of alliances might might render this moot.

While the alliance structure certainly limited the potential suitors for the airlines, the value of the Canadian carrier, even with near-monopoly in the domestic market, was significant enough to fight for, and both expended some effort to keep it. Clearly, however, AMR's valuation of the airline fell below Air Canada's asking price.

The most significant constraints on Canadian policy were domestic politics and the existing Chicago regime. The latter could have been significantly altered by unilateral action if the Canadian government had favoured consumer interests over those of other interest groups.

Bibliography

Airline Industry Restructuring in Canada, Senate Committee on Transport and Communications, 36th Parliament, 2nd Session, Second Report, December 1999.

The Competition Bureau's letter to The Honourable David M. Collenette, P.C., M.P., Minister of Transport, October 22, 1999.

Competition Bureau. 1999. **No Evidence Found of Collusion Between Canada's Major Airlines**. Information bulletin dated July 12, 1999.

Restructuring Canada's Airline Industry: Fostering Competition and Protecting the Public Interest, Report of the Standing Committee on Transport, December 1999.

Speaking Notes for an address by Konrad von Finckenstein, Q.C. Commissioner of Competition, (Competition Bureau) to the Standing Committee on Transport, Ottawa, October 27, 1999.

Standing Committee On Transport/Le Comité Permanent des Transports, Evidence.

Stevenson, Garth. 1987. **The Politics of Canada's Airlines from Diefenbaker to Mulroney**. University of Toronto Press.

---

[1] The history of the two airlines prior to deregulation is covered admirably in Stevenson, The Politics of Canada's Airlines.
[2] "Canadian airline offers to divide domestic spoils," *Financial Times*, July 9, 1999, p. 18.
[3] "Canadian air rivals 'held merger talks'," *Financial Times*, September 27, 1999, p. 18.
[4] "Reject Onex bid, says Air Canada," *Financial Times*, September 22, 1999, p. 19.
[5] "Canadian Airlines' Difficulties Prompt Ottawa to Allow Talks With Air Canada," *Wall Street Journal*, August 16, 1999, p. C13.

[6] Air Canada's Robert Milton testified, "We asked the Ministry of Transport about the applicability of section 47; we did not ask for section 47. We were told by the minister's office that section 47 was not applicable in the case of an airline merger." SCOT Evidence Wednesday, October 27, 1999. CAIL's Kevin Benson testified that: "In our discussions with the Department of Transport, we asked if there was any way to expedite what we anticipated would be a very long process. We raised and suggested a number of different alternatives. Section 47 clearly was one of them. We did not lay out in any detail exactly why we felt our request met section 47. We felt Transport would obviously decide whether or not it did or didn't." SCOT Evidence Thursday, October 28, 1999.

[7] Airline Industry Restructuring in Canada, Senate Committee on Transport and Communications, 36th Parliament, 2nd Session, Second Report, December 1999. The Committee stated it was "not convinced that the use of section 47 was appropriate in this situation. It has not heard what the full range of provisions which the Act mentions might have been, nor is it convinced that a disruption was imminent."

[8] The Competition Bureau was "advised in writing by counsel for both Canadian and Air Canada that there have been no discussions or arrangements between the carriers which would lessen competition on domestic routes. All that took place were limited discussions on subjects, other than domestic routes, at the request of Transport Canada." No Evidence Found of Collusion Between Canada's Major Airlines. Competition Bureau information bulletin July 12, 1999.

[9] "Onex Tornado tears through airlines", *The Globe and Mail*, September 18, 1999, pp. B1/B10.

[10] "American Airlines to Help Fund Canadian Alliance," *Dallas Morning News*, August 25, 1999.

[11] "Onex Offers to Buy Canada's Big Airlines," *Wall Street Journal*, August 25, 1999, p. A3.

[12] "Canadian carriers pawns in global game," *Financial Times*, September 3, 1999, p. 16.

[13] "Air battle that may leave even the victor damaged," *Financial Times*, November 6/7, 1999, p. 8.

[14] "Air Canada Board Rejects Onex's Bid To Merge Airlines," *Wall Street Journal*, September 22, 1999, p. A14.
[15] "Air Canada hopes poison pill will fend off Onex bid," *Financial Times*, September 1, 1999, p. 15.
[16] "Air Canada pilots resist merger," *Financial Times*, September 10, 1999, p. 13.
[17] *Ottawa Citizen*, September 30, 1999, pp. C1/C2.
[18] "Europe extends probe on Onex bid," *Financial Times*, October 16/17, 1999, p. 8.
[19] "Conditions are Met in Bid To Buy Back Tendered Shares," *Wall Street Journal*, December 1, 1999, p. A16.
[20] "Air Canada deal could foil Onex," *Financial Times*, October 28, 1999, p. 19.
[21] "Onex Sweetens Offer to Buy Air Canada, Says AMR Will Cut Back on Role in Deal," *Wall Street Journal*, October 29, 1999, p. A6.
[22] "Onex lifts cash offer for Air Canada," *Financial Times*, November 6/7, 1999, p. 8.
[23] "Air Canada bid may provoke fight with AMR," *Houston Chronicle*, November 9, 1999, p. 6C.
[24] "Air Canada reveals move to foil Onex bid," *Financial Times*, October 20, 1999, p. 22.
[25] "Onex Ends Bid for 2 Canadian Airlines After Part of Its Plan Is Ruled Illegal," *Wall Street Journal*, November 8, 1999, p. B14.
[26] "Canadian Air Board Backs Bid by Air Canada," *Wall Street Journal*, December 6, 1999, p. B14.
[27] "Onex Ends Bid for 2 Canadian Airlines After Part of Its Plan Is Ruled Illegal," *Wall Street Journal*, November 8, 1999, p. B14.
[28] "AMR Reaches Pact With Air Canada, Removing Hurdle to Canadian Air Deal," Wall Street Journal, December 9, 1999, p. A4.
[29] *The Globe and Mail*, October 20, 1999, p. B12.
[30] SCOT Evidence, Thursday, November 4, 1999.

Consumer Attitudes Towards Aviation Regulation: A Comparison of Canadian, U.S., and Mexican Air Travellers

Edward R. Bruning, Transport Institute, University of Manitoba
Barry E. Prentice, Transport Institute, University of Manitoba
Victor Rueda, Transport Institute, University of Manitoba

Introduction

Recent policy initiatives between the governments of Canada and the United States have significantly liberalized the two country's cross border aviation policies. Mexico, on the other hand, has been slower to change, although significant changes have been instituted since the early 1990s (Bruning 1994). Between Canada and the U.S., the 'Open Skies' agreement has allowed a greater number of cities to be serviced by air carriers from these two countries. The effect of this change, some argue, is to create greater international competition between carriers--Canadian and American--which will benefit travellers and, indirectly, create greater stimulus for innovation and market responsiveness for the airlines. Extending the liberalized aviation regulatory environment to Mexico is expected to lead to greater competition, and by extension, economic benefits, among the North American partners (Labrie, Propeck, and Arellano 1994).

Not everyone agrees with the competitive policy model (Bruning and Oberdick 1982). It is countered that a pro-competitive policy will usher in the demise of local air carriers and the incursion of large, U.S.-based providers. Also, others argue that intense competition between local carriers, particularly in countries such as Canada and Mexico where the competitive arena is plagued with small numbers to begin with, will result in the monopolization of the local market. It is feared that international carriers will fill the void in local competition.

Our research addressed several issues related to regulatory policy in North America. We sought to determine public attitudes with respect to airline competition, monopolization, and foreign ownership and operations within domestic markets.

In the next section we present our sample used in profiling responses to the regulatory questions posed in our questionnaire. The third section presents the survey results and provides comment on the interpretation of the findings for the air traveling public. In the final section of the paper we discuss the implications of our findings with respect to government policy makers.

Methodology

The present paper represents initial reporting of a much larger study undertaken by the research team (e.g., Bruning and Prentice 2000). The scope of the study includes travellers from seven cities in Canada, seven in the U.S., and over 600 travellers from Mexico. In total, over five thousand travellers are interviewed between the three countries. The present study represents our initial review of the data collected over the past several years. The overriding objective of the research is to profile Canadian, Mexican, and U.S. air travellers in terms of their attitudes towards transportation economic regulation and loyalty to national carriers.

A questionnaire is employed to solicit usage, attitudinal, and demographic information from respondents in order to capture attitudes towards regulation. The questionnaire comprises three sections. Section one captures information relative to the respondents frequency of travel, self-reported knowledge of air travel, assessments of air travel attributes, and future travel usage levels. The second section of the questionnaire includes eight questions related to national affiliation, sixteen questions concerning consumer ethnocentrism, and eight questions related to attitudes towards regulation. All scales exhibit acceptable levels of internal consistency (Green and Wind 1975). The final section includes items on respondents' age, income, gender, and air mileage programs.

Data were collected at Canadian international airports in Halifax, Quebec City, Montreal, Winnipeg, Calgary, and Vancouver. Airports in the U.S. where interviews were conducted were Seattle, Denver, Phoenix, Birmingham, Columbus, Corpus Christi, and Syracuse. Due to administrative restrictions we were not given access to Mexican airports and relied, instead, on interviewing departing Mexican air passengers from Houston. A convenience sample design was employed to identify and collect information from the sample units at the aforementioned airports during calendar year 1998. A total of 2200 Canadian, 2800 American, and 600 Mexican air travellers took part in the survey.

Results and Discussion

Characteristics of the sample units and key variables employed in the analysis are reported in Table 1. Average age of the respondent falls in the 39-45 range with 15% of respondents comprising the youngest age group and 19% in the 61 and over categories. Approximately 59 percent of the sample are males and 41 percent females. Self-reported levels of knowledge about international air travel were rated slightly above the mid-point of the seven-point scale. The typical sample respondent travels approximately 3 to 4 times per year. International air travel is less than 1 trip per year.

Table 1
Descriptive Statistics for Selected Profiling Variables

Attribute	Canada	U.S.	Mexico
Age	43	45	39
Gender			
Male	61%	54%	60%
Female	39%	46%	40%
Knowledge	4.9	5.0	3.2
Annual Trips			
Domestic	3	5	0
International	1	1	2

Regulatory Attitudes

Eight questions were posed to air travellers that reflected attitudes towards economic regulation in the air sector. Statistically significant differences based on an ANOVA difference in mean values test across the several samples are noted in the comment sections of the following tables. Outlined below are the questions and mean response values across the three samples.

Table 2
Regulatory Question One posed to Sample Respondents and Mean Responses by Groups

Canada/US/Mexico needs to ensure the existence of at least one international air carrier				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	6.36	5.57	6.70	*US different from Canada and Mexico. Mexican men and women differ.*
Female	6.34	5.52	6.22	
Age				
< 20	6.26	5.35	6.27	*US different from Canada and Mexico. No noticeable trend across age categories*
21-30	6.52	5.50	6.86	
31-40	6.54	5.52	6.21	
41-50	6.17	5.51	6.39	
51-60	6.31	5.62	6.53	
61-70	6.21	5.92	6.50	
>70	6.52	5.49	6.63	
Income				*US different from Canada and Mexico. Slight increase in mean values as incomes increase for Mexican sample only.*
<$10K	6.24	5.21	6.36	
$10-29K	6.26	5.51	6.29	
$30-59K	6.25	5.53	6.30	
$60-89K	6.29	5.62	6.76	
$90K+	6.56	5.57	6.52	

The summary finding from Table 2 is that all samples feel an international aviation presence is important. Canada and Mexico much stronger in this attitude than the U.S. Also, Mexican men more convinced in this position than Mexican women. It also seems that respondent's wealth position is a determinant to a small extent—the two highest income groups had the highest mean values.

Table 3
Regulatory Question Two posed to Sample Respondents and Mean Responses by Groups

A merger of the two largest domestic air carriers will be disadvantageous to the average air traveller				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	5.09	5.25	4.53	*Mexico sample much lower values compared to Canada and US. No gender differences.*
Female	5.09	5.27	4.60	
Age				
< 20	4.92	4.86	4.12	*Mexico sample lower values than US or Canada. Oldest Mexico group different from all others.*
21-30	5.12	5.25	4.74	
31-40	5.10	5.23	4.65	
41-50	5.15	5.30	4.29	
51-60	4.99	5.41	4.69	
61-70	4.99	5.37	4.94	
>70	5.34	5.04	5.63	
Income				*Mexico sample lower values than US or Canada.*
<$10K	5.57	5.31	4.52	
$10-29K	5.04	5.09	4.51	
$30-59K	5.12	5.33	4.71	
$60-89K	4.97	5.24	4.55	
$90K+	5.16	5.30	4.65	

The majority of samples and sub-samples indicated agreement with this statement as presented in Table 3. Thus, policies that move the

market towards monopoly are not likely to be well accepted simply because few benefits are evident. Mexican respondents indicated less agreement than Canadian or U.S. respondents and, therefore, are slightly more likely to accept a monopoly model compared to Canadians or Americans. However, older Mexicans tend to agree more that monopoly mergers will prove disadvantageous to air travellers compared to younger Mexican respondents.

Table 4
Regulatory Question Three posed to Sample Respondents and Mean Responses by Groups

Foreign Carriers serving local communities benefit the nation				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	4.66	4.87	5.02	*Canada and US slightly lower than Mexico. No gender differences.*
Female	4.64	4.61	5.24	
Age				*Mexico differs from Canada and US samples. Values for Mexican sample increase with age. Slight increase in the US. No pattern in Canadian sample.*
< 20	4.79	4.65	4.89	
21-30	4.57	4.83	5.01	
31-40	4.79	4.67	5.03	
41-50	4.63	4.91	5.51	
51-60	4.55	4.70	5.27	
61-70	4.50	4.86	5.44	
>70	4.72	4.98	5.75	
Income				*Slightly higher values in Mexico than US or Canada. No significant trend across income levels.*
<$10K	5.33	4.93	5.16	
$10-29K	4.67	4.68	4.96	
$30-59K	4.65	4.70	4.85	
$60-89K	4.55	4.79	5.47	
$90K+	4.67	4.90	5.44	

Table 4 indicates mean values for all samples were above the mid-point on the 7-point scale. However, Mexican respondents felt more strongly that foreign carriers benefit a host country. The table also makes the point that Mexican attitudes are more positive on this point with increases in age categories. A weak pattern is noticeable with the U.S. sample; however, attitudes do not vary across age categories for the Canadian sample. No statistically significant patterns are evident in attitude values across income levels for any of the three country samples.

Table 5
Regulatory Question Four posed to Sample Respondents and Mean Responses by Groups

It is better to have two national air carriers merge than to have them integrate with a foreign carrier				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	4.49	3.90	4.67	*US sample value lower than Mexico or Canada. No gender differences.*
Female	4.62	4.08	4.55	
Age				*US sample values lower tha Mexico or Canada. No pattern across age categories.*
< 20	5.08	4.36	4.42	
21-30	4.47	3.87	4.64	
31-40	4.41	3.91	4.55	
41-50	4.61	3.89	4.85	
51-60	4.73	3.98	4.45	
61-70	4.01	4.46	4.88	
>70	4.42	4.12	5.38	
Income				*Inverted U-shaped patterns in Canada and Mexico. NO pattern in US values. US sample values slightly lower than Mexico and Canada.*
<$10K	4.38	4.07	4.57	
$10-29K	4.49	4.25	4.64	
$30-59K	4.62	4.09	4.88	
$60-89K	4.69	4.08	4.67	
$90K+	4.43	3.71	4.18	

On the question of integration, data presented in Table 5 for Canada and Mexico samples tended to reflect agreement that local merger is preferable than merger with a foreign entity. The U.S. sample was closer to indifference on the issue and, in fact, indicated a weak disagreement within sub-samples reported in Table 5. No patterns were apparent across age and income groups.

Table 6
Regulatory Question Five posed to Sample Respondents and Mean Responses by Groups

Present regulations in our country limiting foreign airline operations should be continued				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	4.42	4.21	4.16	*Values for Canadian males and females higher than Mexico or US samples. No gender differences.*
Female	4.54	4.30	4.06	
Age				
< 20	4.60	4.35	3.97	*No discernable patterns.*
21-30	4.38	4.10	4.39	
31-40	4.49	4.20	4.18	
41-50	4.51	4.21	3.58	
51-60	4.44	4.27	4.50	
61-70	4.32	4.64	3.56	
>70	4.65	4.62	4.13	
Income				
<$10K	4.04	4.07	4.25	*Inverted u-shaped pattern across all three samples.*
$10-29K	4.51	4.27	4.33	
$30-59K	4.57	4.34	4.03	
$60-89K	4.56	4.35	4.21	
$90K+	4.32	4.03	3.54	

Mean values for all three country samples indicated an agreement with the statement. Thus, the general feeling is to limit foreign airline operations within domestic markets. As seen in Table 6, Canadian

sample values were higher, in general, compared to Mexican and U.S. samples implying their interest in preserving their local markets to domestic carriers. U.S. sample values were slightly higher than Mexicans, but not statistically so. No pattern was evident across age levels for either of the three countries; however, an inverted u-shaped pattern was evident across income levels implying that lower and higher income respondents from all three countries agreed less strongly than middle income respondents.

Table 7
Regulatory Question Six posed to Sample Respondents and Mean Responses by Groups

Regulations that protect domestic airline markets from foreign competition are <u>not</u> beneficial to our country's air travellers				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	4.31	4.52	4.42	*No differences across country samples. No gender differences.*
Female	4.11	4.15	4.40	
Age				*No discernable patterns or statistical differences.*
< 20	4.26	4.08	4.58	
21-30	4.18	4.29	4.22	
31-40	4.25	4.28	4.52	
41-50	4.28	4.44	4.18	
51-60	4.23	4.35	5.05	
61-70	4.00	4.54	4.13	
>70	4.53	4.60	5.00	
Income				*No discernable patterns or statistical differences.*
<$10K	4.32	4.39	4.31	
$10-29K	4.16	4.14	4.43	
$30-59K	4.20	4.23	4.15	
$60-89K	4.18	4.41	4.76	
$90K+	4.32	4.48	4.65	

Respondents across all three countries tended to modestly agree that regulations favouring domestic airlines were not beneficial to air travellers. There was no significant differences across gender, age, or income categories as presented in Table 7.

Table 8
Regulatory Question Seven posed to Sample Respondents and Mean Responses by Groups

Our country's national airlines are competitive without integrating with a foreign airline				
	Canada	*US*	*Mexico*	*comments*
Gender				
Male	4.31	4.67	5.23	*Mexican samples significantly higher than US or Canada. No gender differences.*
Female	4.40	4.58	5.16	
Age				
< 20	4.64	4.87	5.20	*Mexico sample values higher than for Canada or US samples. No discernable pattern across age levels.*
21-30	4.29	4.51	5.21	
31-40	4.30	4.52	5.17	
41-50	4.30	4.53	5.13	
51-60	4.40	4.74	5.45	
61-70	4.27	5.02	4.63	
>70	4.90	4.88	6.63	
Income				*Mexican sample values higher than US or Canada values. No discernable pattern across income levels.*
<$10K	4.24	4.18	5.28	
$10-29K	4.29	4.78	5.23	
$30-59K	4.39	4.56	5.48	
$60-89K	4.44	4.73	5.39	
$90K+	4.26	4.62	4.49	

On the statement concerning the competitiveness of domestic airlines without integrating with a foreign carrier, Table 8 indicates average values for all samples surpassed four on the 7-point scale thus indicating general agreement with the statement. Mexican

respondents, however, were more positive about the statement compared to U.S. or Canadian respondents. In fact, Canada indicated the lowest agreement value among the three countries. In all three country samples, the oldest age category agreed more strongly to the statements compared to all other age groups. No pattern was observed across income categories.

Table 9
Regulatory Question Eight posed to Sample Respondents and Mean Responses by Groups

Federal policy should allow foreign investors to buy a national air carrier even if it means the end of a nationally owned and operated airline				
	Canada	*US*	*Mexico*	*comments*
Gender				*All sample values low. Strong gender difference (females lower than males in every sample).*
Male	3.29	3.38	3.55	
Female	2.90	2.92	3.18	
Age				*Declining trend across age levels in values for Canada and US samples. Increases in values with higher age categories in Mexico. All values for all groups are negative on the 7-point scale.*
< 20	3.19	3.27	2.89	
21-30	2.89	3.37	3.39	
31-40	3.36	3.29	3.49	
41-50	3.27	3.27	3.70	
51-60	3.04	2.79	3.44	
61-70	2.87	2.81	3.63	
>70	2.31	2.58	3.63	
Income				*U-shaped pattern in all country samples. All negative values on 7-point scale.*
<$10K	3.19	3.21	3.41	
$10-29K	3.10	3.20	3.42	
$30-59K	3.03	3.08	3.10	
$60-89K	3.09	3.06	3.09	
$90K+	3.31	3.34	4.14	

With regard to the statement that federal policy should allow foreign buyers to purchase national air carriers even at the expense of a complete loss in the country's air presence, respondents from all countries indicated a moderate to strong disagreement. On this point, the data in Table 9 indicate that women were more negative than men across all three countries. However, the negativism appears to dissipate with age in the U.S. and Canada while a more positive attitude appears to occur in Mexico. On the other hand, in terms of wealth, those the least wealthy and those most wealthy appear to have weaker disagreement with the statement compared to middle income respondents.

Summary

The results reported in Tables 2 through 9 represent a snapshot view of several attitudes and attitudinal differences between Canadians, Americans, and Mexicans with respect to aviation regulation. Table 10 summarizes the tendencies across the three samples.

From traveller responses it appears Canadian and Mexican samples tend to hold a slightly more pro-regulatory attitude than do their counterpart respondents in the U.S. Canadians tended to associate the existence of foreign carriers with fewer national benefits in comparison to Americans and Mexicans. They also tended to want to continue regulations limiting foreign airline operations to a slightly greater degree compared to Americans and Mexicans. Canadians also felt aviation regulations conveyed more benefits to national air travellers in comparison to Mexicans. Canadians and Americans felt national carriers would benefit through integration with other carriers while Mexicans were not as confident of this statement. Finally, when threatened with the demise of a national carrier, all samples were negative on the idea of allowing exclusive foreign ownership of domestic airlines.

Table 10
Summary Assessment of Regulation Attitudes:
Canada, U.S., and Mexico Samples

Statement	*Canada*	*U.S.*	*Mexico*
Our nation needs to insure the existence of at least one international air carrier	Strong Positive	Positive	Strong Positive
A merger of the largest two domestic air carriers will be disadvantageous to the average air traveller	Positive	Positive	Weak to Moderate Positive
Foreign carriers serving local communities benefit the nation	Moderate Positive	Moderate Positive	Positive
It is better to have two national carriers merge than to have them integrate with a foreign carrier	Weak to Moderate Positive	Weak Positive	Moderate Positive
Present regulations in our country limiting foreign airline operations should be continued	Weak to Moderate Positive	Weak Positive to Indifferent	Weak Positive to Indifferent
Regulations that protect domestic airline markets from foreign competition are not beneficial to our country's air travellers	Weak Positive	Weak Positive	Weak to Moderate Positive
Our country's national airlines are competitive without integrating with a foreign airline	Weak Positive	Moderate Positive	Positive
Federal policy should allow foreign investors to buy a national carrier even if it means the end of a nationally owned and operated airline	Moderate Negative	Moderate Negative	Moderate Negative

The implications for policymakers is straightforward. First, it is important to understand the orientation of the public with respect to their demand for air services. But, knowledge of the nature of demand patterns is not sufficient for developing acceptable public policy. It is equally important to know the various values and demands from a multitude of market segments. The results of this study indicate that, for certain issues, gender, income, and age make a difference in terms of importance and/or satisfaction of current policy. The real challenge, however, is to acknowledge the important factors that impact public attitudes toward policy. We can

see from the results that differences exist between the three NAFTA countries.

Acknowledgements

Our work was made possible through a major grant from the Social Sciences and Humanities Research Council of Canada. We are thankful for their generous support.

References

Bruning, E.R. (1994). "The Role of Consumer Ethnocentrism in the Choice of International Air Carrier," Journal of the Transportation Research Forum, 19(2), 23-36.

Bruning, E. and Prentice, B. (2000). "Country Loyalty Among Air Travellers: A North American Perspective," Working Manuscript, Transport Institute, University of Manitoba, Winnipeg, MB.

Bruning, E. and L. Oberdick (1982). "Market structure and economic performance in the commuter airline industry", Transportation Journal, 21(3), pp. 76-87.

Labrie, M., Propeck, J., and Arellano, R. (1994). "The Mutual Perceptions of Canadian and Mexican Business People within the North American Market," in J. Cosset (ed.) International Business, (Halifax, NS: Administrative Sciences Association of Canada).

Green, P.E. and Wind, Y. (1975). "A New Way to Measure Consumers' Judgements," Harvard Business Review, July-August: 107-117.

PROBING RAILWAY OPERATING RATIOS

Kells Boland
PROLOG Canada Inc.
Calgary, Alberta

Introduction

The primary purpose of this paper is to determine the degree to which a meaningful understanding of both carrier and shipper competitiveness can be obtained from the ratio of railway operating expenses to revenues; and from the supporting statistics commonly provided in corporate financial reports. A second purpose of this paper is to see what a comparison of these statistics for three railways can show about Canadian competitiveness in a North American context.

The three railways considered are Burlington Northern Santa Fe (BNSF), Norfolk Southern (NS) and Canadian National (CN). Statistics are for 1998 in U.S. dollars and units of measure, reflecting the fact that in future CN will be much more of an American railway.

1998 is the last year that CN corporate reporting can be considered to evaluate Canadian railway competitiveness. Subsequent reporting includes the distortion, from a Canadian perspective, of expanded operations in the United States following merger with the Illinois Central.

Ongoing merger impacts notwithstanding, North American railway operating ratios, that within the last ten years were in the high 80s, have dropped dramatically toward the low 70's. In Canada, CN operating ratios which hung around 100% in recent history are now among the most "competitive" in North America.

Given this impressive improvement and the industry tendency to trot out operating ratios as a universal measure for comparing railway performance, it is understandable if the more casual observer may be misled.

However, most industry observers already understand that operating ratios do not necessarily indicate economic efficiency. Where higher revenues can be extracted, operating ratios can be improved without lowering costs; and conversely the best railway cost structure can be undermined by low traffic volumes, yielding high operating ratios.

Either way, operating ratios can be quite deceiving without at least a cursory look at underlying cost and revenue performance. To that end, revenue ton miles (RTMs) are applied as a common denominator to allow cross comparison of both expenses and revenues over rail systems with vastly different operating characteristics:

Railway	*Revenue Ton Miles*	*Route Miles*	*Employees*
CN	112,929,000,000	14,000	19,000
NS	133,436,000,000	14,000	23,000
BNSF	469,045,000,000	33,000	44,000

A quick glance at these operating characteristics shows BNSF with approximately twice the route miles and employees as CN or NS but producing 3.5 - 4 times the revenue ton miles. This would hardly seem a case for equivalent operating ratios - but it is.

Convergent Operating Ratios

Operating ratios for all three railways fall within very close range of each other:

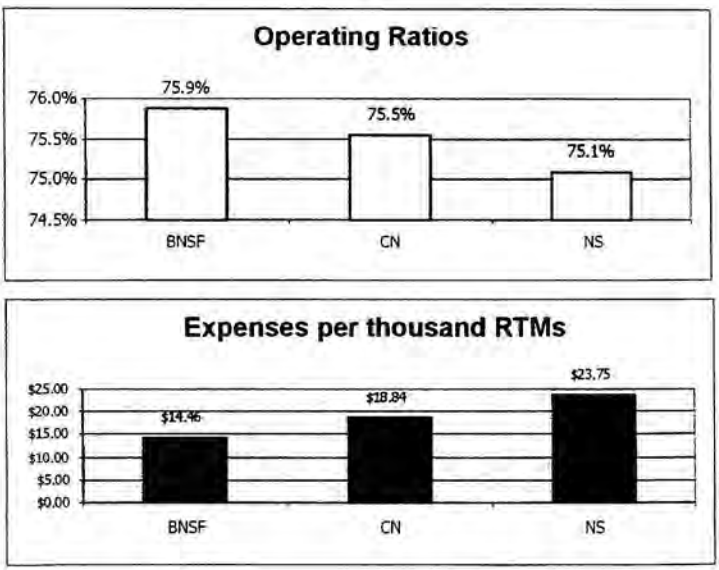
- Burlington Northern Santa Fe 95.9%
- Canadian National 95.5%
- Norfolk Southern 95.1%

However, despite consistent operating ratios, starkly inconsistent carrier competitiveness results from a comparison of operating expenses per revenue ton-mile:

- BNSF- highest operating ratio with the lowest cost structure;
- CN - operating expenses 30% higher than BNSF; and
- NS - best operating ratio with the highest operating expenses.

Figure 1 illustrates the inverse relationship between the operating ratios and the cost structure for these three railways. (Note that the scale of operating ratios has been exaggerated for illustrative purposes.)

Figure 1



These would certainly seem to be contradictory results, if the operating ratio is viewed as a measure of relative economic efficiency among railways.

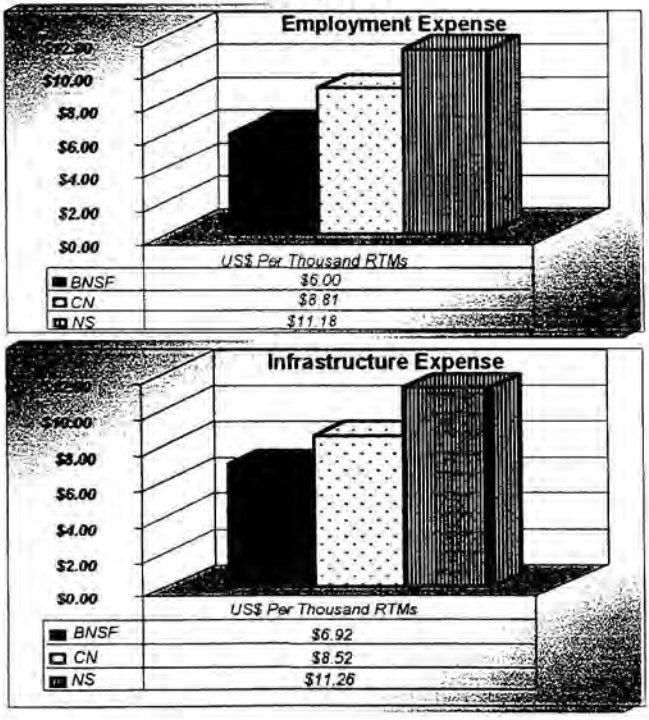
Divergent Operating Expenses

It becomes readily apparent that despite convergent operating ratios, these railways are not equally efficient from a cost competitiveness perspective. The greatest cost divergence is in Employment and Infrastructure Expense:

- CN employment cost is 47% over BNSF but 21% less than NS.
- CN infrastructure cost is 23% over BNSF but 24% less than NS.

Figure 2 illustrates the extent of cost divergence that is not apparent from operating ratios which might otherwise be thought to imply equivalent productivity and efficiency.

Figure 2

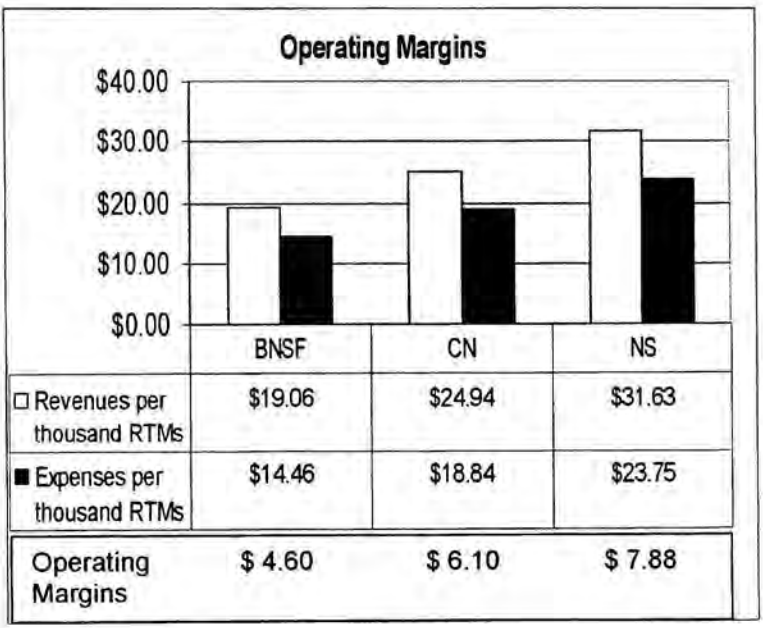


It would appear that CN is in a far more cost competitive position than NS with an equivalent route mile network and a work force proportionately similar to its greater traffic density. However, the NS system is concentrated in the east while CN is spread across the continent. In that regard CN is much more like the larger BNSF system - which is by far the most cost competitive.

Revenue Cover-Up

Given the drastic divergence in costs, revenues must cover the difference to provide operating margins that can yield equivalent operating ratios. Figure 3 shows how this works for the three railways under consideration.

Figure 3



	BNSF	CN	NS
□ Revenues per thousand RTMs	$19.06	$24.94	$31.63
■ Expenses per thousand RTMs	$14.46	$18.84	$23.75
Operating Margins	$ 4.60	$ 6.10	$ 7.88

The somewhat surprising conclusions that can be drawn from the margin of revenues over costs in Figure 3 are that *on average*:

- BNSF with the lowest costs, has the lowest revenue margin;
- CN obtains 33% more revenue over costs than BNSF; and
- NS with the highest costs has the highest revenue margin.

Figure 4 provides a closer look at revenue yields from several major traffic segments that are generally consistent with the conclusions above, and Figure 5 provides two that are not:

- CN coal revenue/RTM is 54% greater than BNSF, and
  NS coal revenue/RTM is 86% greater than BNSF

- CN merchandise and other revenue is 14% over BNSF; and
  NS merchandise and other revenue is 45% greater than BNSF

- CN and BNSF grain revenue/RTM is just about equal, but
  NS agriculture revenue/RTM is 80% greater.

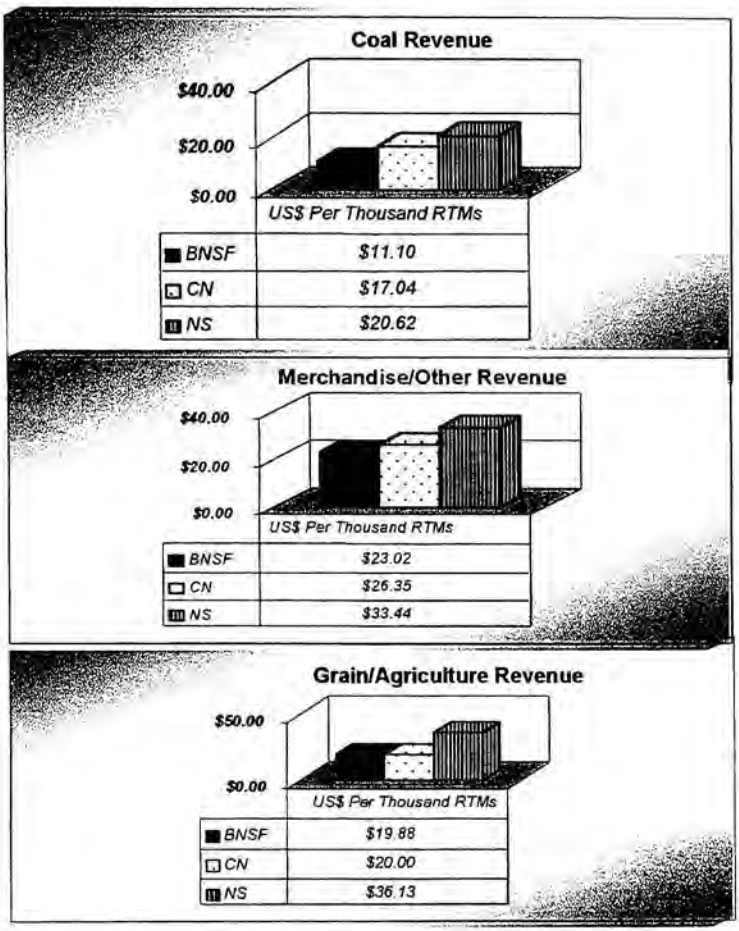
- CN intermodal revenue/RTM is lower than BNSF or NS; and
  CN automotive revenue/RTM is greater than BNSF or NS.

It can only be assumed that these disparate revenue relationships result from the degree of competition, or the lack of it, for shippers' traffic.

Coal is the largest single traffic source for all three railways. While average BNSF coal revenue yields are pulled way down by rail on rail competition for Powder River Basin coal, most other mines are captive to a single railway. The result appears to be much higher revenue yields generated from coal shippers by CN and even higher yet by NS.

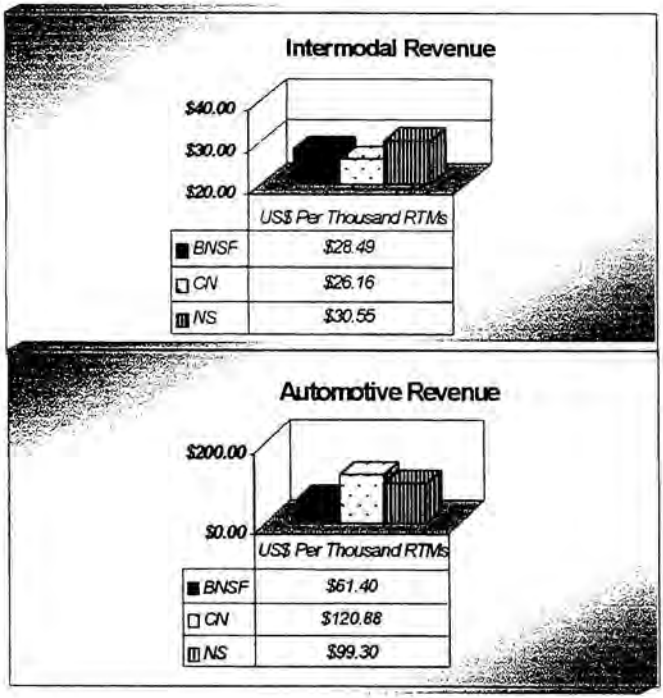
Merchandise and other traffic follows a similar profile but with less variance among the three railways. Grain/Agriculture traffic is also similar but with much closer revenue yields between CN and BNSF (See Figure 4).

Figure 4



The exceptions are intermodal and automotive traffic (See Figure 5). Intermodal traffic is highly competitive as it can easily shift among alternative ports and terminals. CN appears to be pricing intermodal traffic below U.S. counterparts to protect and expand its market share. On the other hand, CN Automotive traffic must be relatively captive, as revenue yields are 22% greater than NS and almost twice those for BNSF.

Figure 5



Conclusions

This paper has explored the misleading nature of operating ratios as a comparative measure of railway productivity and efficiency. While operating ratios may provide a measure of financial profitability, that profitability is not necessarily productivity based. It is just as likely to be maintained with high revenues covering high costs.

Attractive operating ratios do not necessarily mean that the ideal of shipper and carrier competitiveness has been achieved with lower rates from lower cost structures. Accordingly, it has been determined that the railway with the best operating ratio (NS) is not the railway with the most competitive cost structure (BNSF).

From a Canadian perspective (CN), having an operating ratio that is better than BNSF can be equally deceiving:

- Canadian railway costs are not as low as, and mitigate against competitiveness with, the most efficient U.S. railways.

- Canadian railway shippers provide the higher revenues that keep operating ratios attractive despite costs that are not competitive.

End Notes

1) Revenue Ton Mile equals one ton of revenue paying freight moved one mile.
2) Currency conversion assumed at mid-1998 exchange rate of US$.6835 = CA$1.
3) All statistics are derived from 1998 Corporate Annual and Quarterly Reports.
4) Infrastructure expense is assumed to include material, equipment, depreciation and all other costs except fuel and labour.

THE FUTURE OF PRAIRIE BRANCHLINES AND SHORT LINE RAILWAYS

Robert Grant ADI Limited
David Fahlman Saskatchewan Highways and Transportation

1.0 INTRODUCTION

Railways are abandoning branch lines and elevator companies are consolidating to fewer delivery points in the hope of achieving productivity gains through cost reductions and improved economies of scale. Class 1 railways admit that they are inefficient in small markets and their resultant focus is on high volume markets where acceptable productivity levels can still be achieved. Grain companies are highly competitive and can better compete by lower unit costs made possible by larger elevators and inland terminals. Higher volume elevators/terminals also have the advantage of being able to perform value added processing services and blending, previously done at ocean port terminals.

The Prairie Provinces, municipal governments, grain producers and other local interests are concerned about these rapid changes, particularly the abandonment of branchlines. The closure of branchlines and primary elevators raises a number of concerns including increased trucking costs, deteriorating road conditions, loss of local employment and tax base, and the consolidation of businesses in larger centres. Retention of grain elevators and rail service have always been keys to the survival of Prairie communities. Most communities continue to subscribe to this premise.

The Canada Transportation Act of 1996 (Sections 140 to 146) established a process for the Federal railways (CN and CP) to discontinue service or transfer the branchlines to a shortline railway (SLR) operator. This process generally entails the railways developing three-year plans for their systems, which identify lines

that they plan to discontinue or transfer. The process formally kicks into gear when the railways publicly advertise the lines. At that point, there is a strict process and timelines to allow companies and organizations to express interest in buying or leasing the lines and negotiating a purchase/lease agreement. Should no private group successfully negotiate a purchase, local and provincial governments are offered the ability to purchase the line at its salvage value. The CTA process, however, does not provide any means for negotiating commercial arrangements such as revenue sharing or interchanging, which must exist between the main line carriers and any shortline that is to be successful.

The current CTA process has brought to a head the conflicting objectives and interests of grain companies and railways on one side and communities and producers on the other side. The first group approaches the issue from a strict profitability point of view. Whereas the local community interests have a much broader perspective, specifically the sustainability of their communities, businesses and road infrastructure.

The class 1 railways are interested in supporting SLR operations that complement their operations (i.e. add value) and are successful businesses. Babcock, Prater and Morrill[1] identify the types of factors that typically lead to a successful railway operation, including shortline railways.

- Adequate, stable traffic density.
- Non-seasonal traffic.
- Diversified traffic base.
- Some high-valued traffic generating higher revenue per carload.
- Motivated, skilled, flexible employees with extensive rail experience.
- Management skilled in operation, marketing and finance.

---

1 *Babcock, Michael, M. Prater and J. Morrill, A Profile of Short Line Railroad Success, Transportation Journal, 1994.*

- Good understanding of customers' markets; home office close to shippers.
- Good control of cost.
- Multiple connections; access to Class 1 overhead traffic and rail cars.
- Reasonable switching charges and joint rates with Class 1 railroads.
- Control of local rates for on-line movements.
- Mutually beneficial feeder relationship with Class 1 railroad.
- Equity investment by both railway and shippers.
- Realistic business plan and rigorous analysis of the competition.
- Reasonable purchase price and appropriate capitalization.
- Investment in track soon after acquisition.
- Government financial assistance or loan guarantees; Provision of technical information and contacts.
- Government promotion of economic development.

It is clear that most Prairie branchlines do not meet the above criteria. This is the reason that CN and CP are not encouraging more SLR's.

Local communities and producers, on the other hand, are interested in maintaining rail service to their areas to retain their businesses that depend on rail service. The people in these communities are also looking for new business opportunities in their areas. The retention of rail service makes it feasible to attract new business, such as agriculture processing and specialty crops. These export-oriented businesses are reliant on rail service to serve distant markets in the US and overseas. Railway property and operations also provide a direct tax income through property taxes and employment in the area, either directly employing locals or through subsidiary employment providing services to the railway and its crews.

2.0 BRANCHLINE ABANDONMENT AND SLR'S

Exhibit 2.1 provides an historical summary of the Western Canada branchline closures since 1981. The closures in 1996 were pursuant to subsection 142(2) which specifically authorized the abandonment

of a group of low volume lines. The subsequent closures followed the new CTA process for the transfer or discontinuance of branchlines.

There are a couple of observations that should be made about the information presented in this exhibit. First, Saskatchewan has experienced the most branchline abandonment. Second, the rate of abandonment appears to be decreasing. There was general acceptance that the abandonment of many of the lines in the early 1980's was inevitable. As the network continues to shrink, the impacts and opposition have increased.

Exhibit 2.1
Branchline Abandonment by Province 1981-99
(miles)

Province	1981-94	1996	1997	1998	1999	Total
Manitoba	387	153	143	0	0	**683**
Saskatchewan	587	287	54	167	113	**1208**
Alberta	368	74	162	22	68	**694**
British Columbia	368	0	0	0	0	**368**
Total	**1710**	**514**	**359**	**189**	**181**	**2953**

Sources: National Transportation Agency of Canada
Transport Canada
Note: With the changes to the WGTA, there was no branchline abandonment during 1995.

Exhibit 2.2 lists some of the existing SLR's in Western Canada. There are a number of observations that can be made about this list of SLR's. The SLR's fall into two general groups. The first group of SLR's are operated by major rail corporations and entail a network of lines and a mix of traffic. These lines are generally operated in a similar manner as mainline railways, although with somewhat greater flexibility. The second group of SLR's are operated by small co-

Exhibit 2.2
Western Canada Shortline and Regional Railways

Railway (year)	Length	Traffic
Hudson Bay (OmniTRAX 1997)	810 miles	Grain, minerals, forest products and petroleum, passengers
Carleton Trail (OmniTRAX 1997)	279 miles	Grain and forest products
Alberta RailNet Inc. (RailNet 1999)	364 miles	Grain, coal, sulphur, forest and industrial products 40,000 cars
Central Western (RaiLink 1984)	103 miles	Grain
Lakeland & Waterways (RaiLink 1999)	472 miles	Petroleum coke, pipe and forest products and grain
Mackenzie Northern (RaiLink 1998)	650 miles	Grain, forest products, fuel and northern supplies
Esquimalt Nanaimo (RailAmerica 1998)	181 miles	Forest Products, minerals and chemicals
Kootenay Internal SLR	164 miles	Forest products, passengers
Okanagan Valley (OmniTRAX 1998)	94 miles	Forest products, feed, fertilizer, aggregates, chemicals
Kelona Pacific (Nighthawk 2000)	105 miles	Forest products, logs, other resource products
Southern Rails Cooperative (1989)	57 miles	Grain
Red Coat Road and Rail (1999)	72 miles	Grain
Central Manitoba (Cando 1999)	110 miles	Coal, petroleum, forest products and grain
Southern Manitoba (1999)	144 miles	Grain
Prairie Dog Central	16 miles	Seasonal Tourist train
Alberta Prairie Steam Tours	21 miles	Year round Tourist Train

operatives or companies, entail a much smaller network and are primarily reliant upon grain traffic. These lines operate in a much different manner. These lines operate on different principles than mainlines and the larger SLR's. The operations are typified by employees with more general job descriptions, greater customer focus (there is often only one or two customers) and the willingness to have smaller train runs on the line. Power sources for SLR's need not consist of traditional locomotives, several are experiencing success using Road Railers.

The first SLR operation on the Prairies was the Central Western Railway. The CWR took over the operations of the CN Stettler Subdivision in 1984. Later the CP Coronation subdivision was also acquired by CWR. Declining grain traffic led to the recent closure of the Stettler subdivision, however the remainder of the CWR continues to operate. Saskatchewan's Southern Rails Co-operative (SRC) was established in 1989, when 150 farmers paid membership fees of $50 to form a co-op to haul grain from Avonlea to Parry and a former CP line from Rockglen to Killdeer. The co-op purchased the two lines and worked out agreements with both railways and the Canadian Wheat Board. The Saskatchewan government provided technical assistance and a $650,000 loan guarantee. Though one of the farmers' goals was to help communities on the line remain viable, their main aim was to save time and money by avoiding the truck haul to more distant rail points.

There was a ten-year wait before the next grain branchline became a SLR. In 1999, the following branchlines, which were slated for closure, were successfully transformed into SLR's.

- CP Assiniboia line in Saskatchewan was purchased by a locally owned corporation, the **Redcoat Road and Rail Ltd**.
- Cando Contracting of Brandon, Manitoba purchased the Pine Falls and Carman subdivisions from CN in April 1999 to form the **Central Manitoba Railway**
- The **Southern Manitoba Railway** purchased the Miami and Hartney subdivisions from CN

CN rail has worked with major SLR companies to establish five Western Canadian regional railways. For the most part, CN identified the groups of lines that it felt could be successfully operated as regional or SLR's. It then advertised them as transfer candidates and solicited proposals for their purchase and operation.

- **Alberta RailNet** acquired CN's Grande Prairie Railway network which entails 364 miles of track handling 40,000 carloads of grain, coal, sulphur, and forest products. Alberta RailNet is a subsidiary of North America RailNet, a Texas based SLR operator.
- **RaiLink's Lakeland and Waterways Railway**, is headquartered in Edmonton and provides rail service to Northern Alberta including the tar sands region. It includes 472 miles of track with a range of traffic including petroleum coke, pipe, forest products and grain.
- **RaiLink's Mackenzie Northern Railway** operates in Alberta's Peace River Valley area and North to Hay River, NWT. This extensive system, 650 miles, handles 30,000 carloads of grain, forest products, fuel and other supplies for Northern Alberta and NWT.
- **Carleton Trail Railway** is owned by the US rail company, OmniTRAX and operates two separate lines in Northern Saskatchewan (279 miles in total). Both lines are heavily dependent upon grain traffic but it also handles forest products including lumber, pulp and paper.
- **Hudson Bay Railway**, and the Port facilities at Churchill, Manitoba are owned by OmniTRAX. This railway hauls export grains to Churchill and serves Northern Manitoba mining operations in Lynn Lake, Thompson and Flin Flon. It has also handled some inbound traffic through Churchill as well as re-supply goods for the Eastern Arctic communities.

Regional and SLR's have grown dramatically in Canada since the introduction of the CTA. The majority of this growth has come from a number of major regional railways that CN and CP have developed.

At the end of 1998, regional and SLR's accounted for over 26 percent of the total rail network in Canada.

Exhibit 2.3 compares the 1990-98 Canadian totals in terms of rail discontinuances versus transfers to SLR's and regional railways. The clear message is that on a national basis, discontinuances are declining and transfers increasing.

A similar but somewhat different situation has developed in Western Canada. In recent years, there has also been growth in Western SLR's and regional railways. Before 1996, there were two small SLR's on the Prairies plus a number of others in British Columbia totaling less than 400 miles. Today, there are over 3,000 miles of SLR's. Since 1996, less than 5 percent of the rail network has been closed whereas almost 15 percent have been transferred to SLR companies. Saskatchewan appears to have poorest record in terms of creation of SLR's. It has had 621 miles of branchline closed and only 386 miles transferred to SLR's. (See Exhibit 2.4)

Exhibit 2.3
Cumulative CN and CP Rationalization
1990-98
(Kilometres)

Year	Discontinuances	Transfers
1990	1,324	68
1991	1778	68
1992	2475	380
1993	3096	751
1994	4269	1174
1995	5290	1174
1996	6640	2238
1997	7458	5349
1998	7835	7719

Source: Transport Canada

Exhibit 2.4
Western Canada Rail Restructuring
1996-2000
(miles)

Province	Total Rail Network	SLR Transfers	Rail Closures
Manitoba	4,555	1,080	296
Saskatchewan	7,669	386	621
Alberta and NWT	6,620	1,486	326
British Columbia	6,620	544	0
Prairie Total	**25,464**	**3,496**	**1,243**

Source: Statistics Canada and Transport Canada

3.0 ISSUES

The following is a summary of some of the major issues and concerns related to the current process and policies concerning branchline abandonment and transfers to SLR's.

1. Process for Transfer and Discontinuance of Branchlines

- **Local communities generally feel that they are not given sufficient time to decide if they wish to acquire a branchline.**

A community can have as little as 120 days to determine if a branchline is financially viable as a SLR and if it has the capability and support to purchase and operate it. The railways, on the other hand, feel that once the negotiation process begins, it is too open-ended.

- **The process allows the railways to offer small sections of rail line that have no potential to be viable as SLR's.**

There are a number of examples of community based organizations expressing an interest in a network of lines, that they feel would be viable as a SLR operation. However, the railways are not prepared to part with the entire network, only the lowest volume sections. This issue calls into question the intent of the CTA with respect to branchlines and SLR's. It allows the railways to shed their unwanted

branchlines without really giving anyone else an opportunity to retain them as operating SLR's. Thus, the railways can pursue their efficiency/profitability gains without regard for the interests of communities and producers.

- **Transfer candidates are treated differently than discontinuance candidates.**

The negotiations for branchlines identified for discontinuance can be termed "hostile"[2]. The Class 1 carrier is taking the position that the branchline(s) in question are not viable and should not be operated. The community based proponent's efforts to purchase and operate the line therefore, go against the plans of the Class 1 railway. Furthermore, the community proponents' motivations are to maintain rail and elevator services, preserve local tax and employment base, and reduce road impacts. Profitability of the SLR is not a major objective. The local community expects to experience a major downside if a purchase agreement is not achieved. These different perspectives put both negotiating parties in a difficult position.

- **CTA does not help the creations of SLR if Class 1 railways are not willing.**

The CTA provides a process for the transfer and discontinuance of branchlines. The transfer process is working well. However, in the discontinuance process, the provision that allows the various levels of government to purchase unwanted branchlines for the net salvage value has had little success in terms of creating SLR's There is no requirement and little incentive for the Class 1 railway to share its revenue for the traffic originating on the SLR

- **Some grain branchlines that are being closed could be part of a viable SLR network.**

SLR operators indicate a willingness to take on some of the branchlines that are being discontinued, if they were offered a larger

---

2 The term 'hostile' is used to refer to an offer to purchase a branchline and establish a SLR when this is not the preferred option for the railway. It does not refer to the tone or nature of the actual discussions and negotiations.

network. Instead, the railways are only offering the very low volume lines that just are not viable businesses on their own, even for a local cooperative.
The agendas or objectives of the local communities conflict with those of the railways. The railways feel it is in the best interest of their shareholders to close the lines as traffic declines, whereas the local communities want to retain rail service to meet their broader objectives (preserve road system, local employment and tax base etc.).

2. Policy Issues

- **SLR could be an element in improving competition.**

The establishment of viable and substantial SLR's could facilitate competition within the grain transportation industry. If SLR's could have the option to negotiate revenue sharing agreements with either CN or CP, shippers would not be captive to one railway. Currently, the SLR's are locked into their connecting class 1 railway. Furthermore, there could be a third long haul carrier if SLR's, such as the Carlton Trail Railway, could access the Hudson Bay Railway. Instead, CN controls all access to this route.

- **Small shippers are at the mercy of railways and grain companies.**

There are small shippers located on low volume branchlines that are dependent on rail transportation. These small shippers include small processors, specialty crops and seed companies. They ship by rail to distant locations in North America as well as to export marine ports. However, they typically require frequent service (i.e. weekly) but their volumes are well below the minimum train run requirements. These shippers have had to relocate or use truck transportation to connect with rail mainlines to obtain adequate service. The businesses that are highly reliant on rail services have had to stop using their local branchlines because their rail transportation requirements are not compatible with the export grain industry.

- **Trucking provides the producer and grain companies with marketing and transportation options and flexibility.**

Long haul trucking provides the producer with much greater flexibility in terms of choice of grain company and location.[3] The grain companies also benefit by being able to source grain from a large area in order to meet its market requirements. Many producers and grain companies place a high value on these advantages which can not be delivered by small branchlines or SLR's.

- **Railways are at a disadvantage because they must provide their own infrastructure.**

Heavy haul trucks account for the majority of the impacts to the rural road system, yet the trucking industry does not pay for the majority of the costs of road maintenance and construction. Railways, including SLR's, on the other hand are expected to pay the full cost of their rail systems as well as fuel taxes and property taxes.

- **The long term viability of the small grain dependent SLR's is in question.**

Despite the success of the few SLR's that have been established, there is speculation that they are only delaying the inevitable. Even the major SLR companies are uncertain that they will be able to retain the grain on their lines. New terminals continue to be built and the competition for grain continues. Most of the SLR's have taken over branchlines that are in good condition. Eventually there will be a requirement for major upgrading. The SLR's are not generating the revenues required for major upgrades or track replacement.

- **The branchlines and small elevators are being de-marketed.**

The present system allows and encourages the de-marketing of selected branchlines and elevators. The railways and grain

---

3 The term long haul trucking, in this situation, refers to trucking to more distant delivery rail points up to 200 or 300 km. Normally long haul trucking refers to much longer distances such as several thousand kilometres. This is not yet occurring in the grain industry!

companies are rationalizing their systems, which is expected to result in better financial performance and lower rail and elevation costs. This process will no doubt generate some benefits to the grain producers. However, local communities, road agencies and other rail dependent businesses are experiencing the downsides.

- **The Grain companies are not willing partners in SLR's.**

The grain companies have made massive investments in grain handling facilities on the mainlines. The grain companies are competing with each other to capture the grain traffic from the branchlines, regardless if they are SLR's or not. The only time grain companies are motivated to work with SLR's is if they have no opportunity to attract the grain to one of their mainline facilities.

Grain companies, once they have established a new terminal, make it a priority to maximize grain volumes at these locations. The grain companies believe that it is in their best interest to focus on these new facilities where they (and their customers) can benefit from blending and incentives from the railways.

- **SLR's must be competitive with truck transportation and the inland terminals.**

This is the ultimate viability test for SLR's. Large commercial trucks are transporting grain. The trucking industry is very competitive which has resulted in improved efficiencies and low operating margins. Grain terminals offer a range of financial incentives to grain producers to entice grain to their facilities. SLR's and their grain handling facilities must be cost competitive. The issues of road damage, loss of tax base and community impacts are recognized as important by the grain producers but do not seem to entering into the day to day decision making of where grain is shipped.

3. Other Issues

- **There is a pessimistic attitude towards the retention of branchlines.**

There is significant interest in maintaining branchlines and local elevators. However, most feel there is nothing that can be done about

the rationalization process and, in the end, the grain companies and railways will get their way. Attempts to establish SLR's will eventually fail so the logical response is to accept it and make the appropriate adjustments. For some, this means changes to their farm operations. Specialty crop and processors are relocating, closing, or switching to truck transportation. Road agencies are having to adjust their planning and operations to handle the new demands of long haul grain trucking.

- **Most of the rationalization has already occurred.**

The previous sections demonstrated the extensive rail network that has been eliminated on the Prairies. This trend is not expected to continue at the same pace, as there are fewer rationalization opportunities. However, there are still a number of lines identified for discontinuance on CN and CP's three-year plans. As well, it is expected that there will be more added over the next few years, particularly in Southern Saskatchewan and Alberta.

4.0 POSSIBLE SLR DEVELOPMENT INITIATIVES

1. Working Group 3 Recommendations

The Working Group on Competition and Safeguards, established by Mr. Kroeger, examined the branchline abandonment process. This group, involving all the major stakeholders, agreed on a number of changes that should be made to improve the process for discontinuance or transfer of branchlines. These include:

- **Line Designation and Notice Period**

Lines designated for discontinuance must be identified on the 3 year plan for at least 12months instead of the current 60 days. The negotiating period would be extended from four months to six months.

- **Enhancements to Branch Line Transfer Process**

A set of guidelines applicable to negotiations for the transfer of grain branch lines listed for discontinuance, including items surrounding salvage value determination, revenue divisions,

interchange and service provisions would be prepared by Transport Canada.

A third party mediation process would be available for both parties to facilitate the negotiation of the value of line, revenue division, interchanges and service provisions.

- **Compensating Communities**

The railway abandoning a line should pay adjustment assistance to municipalities (rural and urban) when a line in the municipality is abandoned. Payment would be three annual amounts of at least $10,000 per mile of line abandoned.

2. Other Possible SLR Initiatives

- **Limited Running Rights**

The existing Prairie SLR's are directly dependant on their mainline connecting railway. The SLR's are paid to deliver and collect cars on the branchlines. However, if the SLR had the option of dealing with either of the two Class 1 railways through some form of running rights or open access, it may improve the SLR's viability and enhance customer service. However, it is unclear if many SLR's would take advantage of running rights, given their current contractual relationships with their Class 1 railway partner.

- **Review of Branchline Segmentation**

Railways have the freedom to abandon lines or segments of lines as the grain traffic migrates to other lines. However, there may be an opportunity for local groups and SLR companies to establish a viable SLR operation if it had access to the entire line or local network. **There is a need for a mechanism to ensure that the branchlines are operated by an entity that has an interest in maintaining the traffic, not one that is offering incentives to divert the traffic to other lines.**

Re-Inventing Public Transit in Canada: Why Jitney Buses Need a Fare Chance

Dr. Darren Prokop
Research Associate & Lecturer
Transport Institute
University of Manitoba
631-181 Freedman Crescent
Winnipeg, Manitoba
R3T 5V4
tel. (204) 474-9842
fax. (204) 474-7530
e-mail: prokopdj@cc.umanitoba.ca

(1) Introduction

Canadian public transit systems, in general, are facing a double-edged sword in the form of a trend decline in their ridership base and a trend increase in operational and capital costs. In the present era of firmer government control of spending, responsibility for transit subsidies has fallen more so onto municipal governments which are burdened by a much narrower tax base than are provincial and federal governments. In fact, unlike the United States, the federal government in Canada is neither involved in transit policy nor transit finance.

Deregulation has occurred in the for-hire trucking industry in all provinces and territories. And only the provinces of British Columbia, Manitoba, Nova Scotia, Quebec, and Saskatchewan fully regulate their inter-city bus services. However, every urban centre in Canada that maintains a transit service does so with strict municipal or provincial control. Each system is a monopoly that tolerates no form of fixed-schedule competition from private sources. To the extent that the private sector is involved at all in the provision of transit, it is in the form of contracting-out on the part of the public transit system. Out of 67 transit services in Canada, only 10 engage in some form of contracting out of fixed-schedule services (***Canadian Transit Factbook*** **1998**).[1]

This paper will examine the performance of Canadian transit systems in terms of their initiatives to achieve efficiency gains. However, all of these initiatives are based on supply; the real problem facing public transit is demand responsiveness. In this regard, the paper examines the viability of a neglected alternative to public transit---- the owner-operated bus or what might be called the jitney bus. The jitney bus was, for the most part, legislated out of existence by the 1930s; but its time may have returned. The "cream skimming" argument used by the old transit monopolies against the jitneys will be shown to be a hollow one today. Finally, the paper poses the question: Why is it that urban transportation is the last hold-out against the tide of deregulation that has swept through the transportation sector?

(2) Some Numbers

Public transit (exclusive of intercity and school bus services) was a $3.8 billion industry in 1997 in terms of revenue generated. It is by far the largest revenue generator of these three bus services (***Transportation in Canada 1998*** **1999; Figure 13-4**).[2] Of course, government subsidization plays a large role in financing public transit. In 1997, total subsidies were $1.99 billion or 52% of total revenue generated. This allowed for an operating ratio (non-government sources of revenue divided by total costs) of only 46.3% (**Table 16-24**). In other words the direct beneficiaries of public transit services (i.e., their riders) pay less than do the taxpayers. Throughout the 1990s total rolling stock has been stable at around 13,000 vehicles with 70-77% being standard motor buses (**Table 15-3**).[3]

Average annual government expenditure on transportation for all modes between 1991 and 1997 was approximately $17 billion (**Table 2-3**). Over this period, urban transit subsidization represented about 15% of those expenditures and was the fastest growing component (13% period-growth). Road construction and maintenance, the largest component at about $11 billion of average annual expenditure, grew by only 3% over the period. Provincial/territorial government expenditures on urban transit (their highest transportation expenditure before roads) declined by 5% over the period (**Table 3-14**). On the other hand, local government expenditures on urban transit (likewise, second only to roads) increased by 26% (**Table 3-17**). The large increase is understandable when it is noted that federal-provincial

transfers to local governments fell by 28%. Cities are having to increase their direct financing for public transit through their narrower tax base.[4]

In 1998 average household expenditure on transportation was $6,846 (**Table 2-4**). Of this, just $134 (or 2%) was devoted to urban transit usage. In fact, parking expenses incurred by households using their own vehicles was almost half the size of these transit expenses. The household budget devoted to vehicle use and maintenance was $2,409 (or 35% of total expenditures). Public transit is not a large component of household expenditure because its usage has been declining for some time. Between 1961 and 1998, Canada's general population grew by 22.1% mirrored by a 26.3% increase in the urban component (**Figure 2-6**). But the growth in the number of households was 36.7% and the growth in transportation expenditures was 56.5%. This household growth relative to population growth indicates households with fewer members. And this urbanization relative to population means a higher proportion of urban dwellers. Therefore, the high growth in transportation expenditures may be attributed to, or reflected in, increased traffic congestion in urban areas. In that regard it may be noted that only 40% of Canada's urban population lived in suburbs in 1951; by 1986 the number had risen to 73% (**Cox and Love 1995; p. 145**). Suburbia and cars go hand in hand.

Between 1986 and 1997 the average annual growth of transit fares has been 5.5% combined with a 0.8% per annum drop in ridership (**Table 16-21**). For this 11-year period these numbers imply an 80% increase in fares and an 8% drop in ridership. On a per capita basis Canadians took 100 transit trips per year in 1950; by 1990 the number had fallen to 53 (**Cox and Love 1995; pp. 146 and 149**). Annual growth in transit's total factor productivity during 1986 to 1997 was -0.9% (**Table 16-23**) which, for the 11-year period, indicates a decline of 9.5%. At the same time, unit costs rose by 3.8% annually indicating a period growth of 51%.

Throughout the 1990s, public transit has consisted of around 40,000 employees with about 60% representing full-time workers (i.e., transit operators) which is to be expected given that the industry is heavily unionized. Over all classes of workers and administrative personnel, only about 4% were part-time (**Table 8-15**). Between 1985 and 1998 average

earnings for all employees in public transit rose by about 38% which was about the same for air and trucking. Employees working within the rail and water modes received the largest increases which were 68% and 48%, respectively. However, transit operators by themselves received an average salary in 1997 of $55,000 which was up 43% from 1986. A little known fact is that transit operators are the best paid transportation employees over all modes except for rail; however, on a per hour basis transit operators would indeed have the highest earnings (***Transportation in Canada 1998*** **1999; p. 305**).

These numbers are sobering. They call into question the sustainability of the current system of public transit provision. Taxing people evermore for a service they use all the less cannot be maintained indefinitely. As well, taxing people out of their cars and onto buses is a coercive form of taxation. Taxes provide disincentives; it may be time to consider incentives instead. Fortunately a market-based solution is possible and, ironically, it is an old solution. The next two sections will outline this alternative.

(3) What are Jitneys?

Jitneys have often been defined in terms of a physical vehicle-type. This tends to confuse the issue. It would be more useful to define a jitney in terms of a *service* provided. In this way, any vehicle-type may rightly qualify as a jitney.[5] The service that a jitney provides is, in general, a ride made available to persons wishing to forego the public transit alternative. Consider, as well, what a jitney service is *not*. A private carpool is not a jitney service because all users typically either: (1) know each other; or (2) are going to approximately the same destination. Thus a jitney is a for-hire service drawing from a random class of riders. A jitney is not a taxi because taxi rides are exclusive to the user and proceed from door-to-door. Thus a jitney may pick up several different riders and will follow a defined route.[6] Therefore, any vehicle that plies the route(s) of the established transit system and picks up paying passengers in designated areas or on a hail-a-ride basis would qualify as a jitney.

During the WWI years jitney services swept through the United States and Canada. In 1915, there were about 3,500 in use in Canada and 62,000

in the United States. Of course, it is the case that most of the 24 Canadian cities that did have jitneys had less than 25 units in operation. Vancouver, Winnipeg, Hamilton, and Toronto, however, would each operate more than 600 (**Davis 1989**). While the numbers differed, what each city did have in common were jitney services that operated during the early-morning and late-afternoon traffic peaks. The jitneys were profit-maximizing services and therefore chose only the most profitable times and routes to operate. Because operating cost per seat-mile was higher for a private car or pick-up truck-conversion relative to a 30-50 foot streetcar, peak operation, with its guarantee of waiting passengers, was the only time for a jitney to make profits.[7] The streetcars companies, on the other hand, were mandated by their franchises to provide off-peak service. And because they operated with rail and trolley lines, streetcars could not deviate off of the their own routes the way that jitneys could. Such a feature was positive for the jitneys because it gave them some extra flexibility should the passenger require it.

Needless to say, the streetcar companies would accuse the jitneys of "skimming the cream" off of their franchised routes. To them the peak-time "cream" was necessary to counter-balance the off-peak "dust". In other words, jitneys were seen by the streetcar companies as a form of destructive competition in need of either strict regulation or outright prohibition. The next section examines the validity of this accusation.

(4) Skimming the Cream or Thinning the Monopoly Power?

The cream skimming argument started almost as soon as the first jitneys appeared in Los Angeles in 1914. Consider the following two excerpts from ***Electric Railway Journal*** **1915**:

"[T]he opportunity of the unregulated auto-bus to compete only on those streets whose highly profitable short-haul railway traffic pays the expense of operating unprofitable suburban lines may involve losses that are really serious. Since the wave of jitney-buses began to sweep over the [United States] hardly a month ago, one vital fact has become apparent. This is that regulation by law can be and must be applied..."[8]

"The electric railway system of Portland pays to the public every year in

direct taxes, bridge tolls, paving costs and franchise charges about one dollar in every five it receives from passenger revenue... If the jitney is the coming means of transportation and can carry the load, if it is to be permanent, adequate and can bear the load of traffic efficiently, and the just tax load as well, then the jitney is the thing for the public. But that cannot be proven until the jitney is put on a business basis and made to carry the burdens the public forces present transportation corporations to assume when serving it." (Franklin P. Griffith, President, Portland Railway, Light & Power Company)

The streetcar interests wished the jitneys to play, as they defined it, on a level playing field. The first quote above called for regulation which, in and of it self, is reasonable given that many jitneys at the time were free-wheeling Ford Model-T owners who often operating without liability insurance or adherence to public vehicle safety standards. But regulation was called for in terms of preventing shorthaul, central business district (CBD) activity. The second quote implies that the jitneys should face the same tax burdens as did the monopolized streetcar companies. Certainly license fees, and insurance are worthy of consideration but certainly not a tax burden befitting a franchise when each jitney alone could hardly be characterized as such.[9]

The fallaciousness of the cream skimming argument will be examined in a modern context; that is, a public transit system dominated by motor buses. Since this is not an historical paper the streetcar example will not be carried any further except to say that the prevention of jitneys did not stop the streetcar companies from going bankrupt anyway and falling into the arms of municipal governments. Ironically, the growing use of the private automobile (an imputed jitney, if you like), combined with increased suburbanization, put an end to the popularity of mass transit in North America.

First, the fallacy of the argument will be established by labeling a jitney service as, what an economist would call, a *positive pecuniary externality*[10] with respect to public transit's fleet of buses. Why is the effect positive? The answer provides proof that competition, in some markets, can lower costs. Consider the present structure of public transit in many Canadian cities. Since these public monopolies have total control of peak-time mass transit

it is efficient for them to run 40 foot standard or 50-60 foot articulated buses in order to handle the traffic. Of course, these vehicles will face excess capacity during the off-peak. Labour can be hired on shifts but the rolling stock cannot.[11] If jitney competition means that public transit buses at peak-time can be reduced in their size, efficiency gains to public transit will accrue. This is the positive pecuniary externality provided by the jitneys. And there will be lesser or no excess capacity at the off-peak as well because public transit now has an incentive to invest in smaller, say 30 foot, buses or van-conversions. In summary, what is being proposed is that public transit have complete access to off-peak traffic but share peak traffic with the jitneys.[12]

Second, buses plying through CBDs face more congestion than streetcars ever did on their tracks situated as they were on the median of the road. This leads to the proposition that modern peak-time jitney operations cannot be cream-skimming since the "cream" may, in fact, exist on the off-peak. Consider the effect of a bus fare that is not time-sensitive (i.e., is uniform). The cost per vehicle-km of running a bus is higher at the peak than at the off-peak which means that the off-peak riders are, in effect, cross-subsidizing the peak riders.[13] If jitney competition serves to hold down the total peak-fleet costs for public transit, this cross-subsidization drops and the positive pecuniary externality is, again, established.[14] To paraphrase the work of **Klein *et al.* (1997)**: monopoly control of a "thin" market may be acceptable but such control of a "thick" market should not be.

(5) Urban Transportation Deregulation: Its Time Has Come

If the efficiency gains outlined in section 4 are to be achieved they will have to come at the expense of breaking the monopoly control of public transit in the cities. Fortunately, deregulatory processes have occurred in many transportation modes. Should urban transportation be exempted from such a deregulatory process? This section will make the case against such a view; but will also discuss why it continues to hold out.[15]

Cities are teeming with transportation infrastructure and vehicles. While the connection between private automobiles and the proportion of the population living within cities is loose in correlation and causality such is

not the case with the private automobile and suburbanization. Cities are becoming more dispersed in their land area. The city has split into two distinct urban cultures: those of suburbia and those of the core; those that are property-owners and those that are not; and those that commute to work and those that do not. While the labels for each group may change, their views do not.

What is unique about trying to effect change in an urban environment is that all of the interests on each side of an issue are concerned about the happenings within the same concentrated area. Furthermore, most if not all of these people actually live together in that area. Changes in the urban landscape are much easier to discern and, therefore, harder to change. Political change occurs through either consensus (which is hard enough to achieve) or through the appeasement of one interest at the expense of another which either did not have the same clout or did not express enough indignation at being unfavorably treated.

Deregulation within the trucking and air industries, for example, encompassed change over large physical areas whose net effects were, therefore, hard to imagine for individuals living day-to-day within relatively smaller areas. And with respect to trucking its deregulation merely involved the movement of freight and not passengers. With air the issue would be improved movement of passengers *between* cities. To individuals living in cities, there may be several trucking firms and several airlines from which to choose but there is only one public transit system. This philosophy reaches back over the last 100 years of urban life. To talk of competition in public transit, to some, may seem like talking about removing a sacred trust. The pursuit of profits could mean the removal of unprofitable routes; or excessive cost saving measures such as running buses that are decrepit. Worse, the service could be unpredictable because of the need to always have to adjust to the market. Such sentiments are hard to change. But consider again what is being proposed: the "public interest" (however defined) will be achieved during the off-peak while "competition" will be sought during the peak.

Urban deregulation would be required to the extent that jitney operations need to be made legal again. Certainly, a measure of public safety and

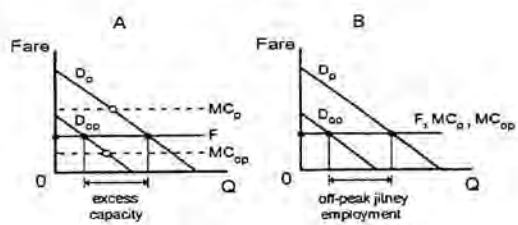
insurance would be required and would have to be spelled out in a new and different set of regulations. During the peak, however, the market would be subject to freedom of entry and exit. It would also seem reasonable to allow jitneys to make use of pre-existing bus stops and make use of all transit-friendly traffic devices that may be in use.

In a modern context a reasonable set of regulations should be easier to carry than they were in the early 1900s. Today's jitneys would likely be more than just private automobiles. They may very well be taxicabs or even courier vehicles. Unlike in the past when jitneys were pick-up trucks with benches installed in the cargo area, today's vans come with removable seats. Such a vehicle can be used as a courier service during the off-peak and as a jitney during the peak once the seats are installed.[16] This allows the courier to take advantage of what economists call economies of scope. Gains through economies of scope could also accrue to inter-city bus operations that run a well-defined route in particular cities while on their way to and from the bus terminal. Quite often these buses may pick-up or drop-off passengers along this route provided that they are inter-city passengers. The picking-up and dropping-off of a passenger within the city would be efficient and yet akin to an illegal cabotage operation if the proper deregulation were not in place.[17]

(6) A Transit Model

A simple model summarizing the jitney effect is provided in figure 1. Panel A shows the effect of a uniform fare (F) in a market served by a public transit monopoly. Panel B shows the effect of a uniform fare but with jitneys operating during the peak traffic periods.

Figure 1



In both panels, quantity (Q) may be interpreted as the number of passenger trips per unit of time. The excess capacity in panel A is indicative of empty or idle 40-foot buses while, in panel B, this same segment now represents jitney buses that are not operating during the off-peak. Of course, these jitneys will not really be idle because they can take advantage of economies of scope as outlined in section 5. The public transit "monopoly" in panel B is also operating smaller buses geared to off-peak requirements. It should also be noticed that the marginal cost curves, as drawn, have converged in panel B. Though there is no *a priori* reason to assume perfect convergence; any degree at all is indicative of efficiency gains. Peak marginal cost (MCp) is expected to fall because of the forces of competition: easier maneuverability and lower unit costs associated with smaller buses; lesser incentive for cost capitalization on the part of transit unions; and lesser dependence upon municipal bureaucracy for transit decision-making. Of course, off-peak marginal cost (MCop) is expected to rise since smaller buses will be more crowded. As such, the generalized cost [18] of the off-peak service will be higher. Nonetheless, the jitney option provides for efficiency gains that a public transit monopoly alone cannot achieve. And notice that simply instituting peak-load pricing is not the answer. The hollowed out points in panel A do show a lesser degree of excess capacity than that under a uniform fare but jitney competition serves to eliminate all excess capacity and bring about the cost savings shown in panel B.[19]

(6) Conclusions

Because of the positive pecuniary externality afforded to public transit through jitneys it may be said that while jitneys were outlawed in order to save the old transit systems, a new environment has emerged that may yet see transit saved by allowing jitneys to take their place among the other modes of urban transportation. Like all deregulatory initiatives urban deregulation would be an experiment but it seems a logical one to embark upon since infusing public transit with market incentives is further recognition that cities should be treated as a marketplace and not a place where the "public interest" alone is to be maintained as defined within fractured urban politics. Mass transit should no longer be seen as a means for elusive and subjective "urban renewal"; it should be rider responsive. Innovative ways to improve quality would seem to be the only way to

reverse the negative trends facing transit systems today.

Endnotes

[1] Numerical operating and capital data from this source is available for use only by members of the *Canadian Urban Transit Association* (CUTA). All data cited in this paper will come from other sources.

[2] All data in this section, as indicated by specific table and figure references, come from this report unless otherwise indicated.

[3] This configuration does not include articulated buses, low-floor buses or trolley buses. All have a minor share in the rolling stock. It is the case, however, that many transit systems are beginning to acquire only low-floor buses because of their ease in passenger access. In fact, once many routes are serviced by these buses, the exclusive (and relative more costly) paratransit services for the handicapped may be scaled back. Only Vancouver and Edmonton operate a network of trolley buses in Canada. Because of the lack of manufacturers in North America these trolley systems are being phased out.

[4] Local governments unlike the other levels of government do not tax income, sales or goods and services *per se*. Their choices are between property taxes and user fees. In fact, the class of local taxes are considered by public sector economists to be less equitable than those levied by the other levels of government.

[5] Literally, *jitney* is a colloquialism for a 5-cent piece. During 1914, when the first jitneys appeared in Los Angeles, many cities required the streetcar companies to charge their users a regulated fare of 5 cents as part of their franchise agreement. To be competitive, in terms of pure monetary cost, the jitneys (usually private cars) charged the same fare. For a thorough discussion of the origins, and differences of opinion, concerning the word see: **Davis (1989; *supra*-note 20)** and **Davis (1990; *supra*-note 17)**.

[6] What jitneys and taxis do have in common are: they are both

hail-a-ride services; can be owner-operated; have no fixed stops; and no fixed schedules. These aspects of the jitney service, combined with a more flexible route structure, lead many cities to ban jitneys in the early 1900s.

[7] It was also the case that gasoline for jitneys on a per passenger basis was much higher in cost than the electricity that ran the streetcars. In fact, it was not uncommon for the electric companies to be subsidiaries of the streetcar companies. In 1902, for example, the Winnipeg General Power Company was purchased by the Winnipeg Electric Street Railway Company.

[8] It should be kept in mind that most North American cities, *circa* 1915, were characterized by shorthaul traffic because most of the population lived in or near the city centre. The longhauls were to the outlying, sparsely populated suburbs. Today's urban population distribution is the inverse of this.

[9] Essentially the streetcar interests were powerful and united while the jitney interests were weak and incohesive. Many U.S. cities, under pressure from the streetcar interests, forced jitney operators to carry indemnity bonds of $1,000-$5,000 ensuring that most would no longer make adequate profits. In Canada, cities such as Edmonton in 1921 and Toronto in 1924 gave their streetcar companies veto power over jitney licenses while others such as Winnipeg in 1918 and Ottawa in 1923 simply had the streetcar franchise agreements expanded to cover all forms of public transportation.

[10] This is defined as any action by one agent that has a positive effect on the action of another that occupies the same market. In this way, the market valuation of both jitney services and public bus services are co-dependent since they compete for the same passengers. A real externality, on the other hand, represents an external action not reflected in market prices; for example, a rise in the price of gasoline may be seen as a positive *real* externality for diesel-powered public transit.

[11] A related point applies to trolley bus operations. Edmonton, for

example, has to maintain one standard diesel-powered bus in storage for every trolley bus in operation. The reason is that trolleys, of course, are susceptible to power failures. Furthermore, street works force all trolley lines in adjacent areas to be shut down as a matter of safety.

[12] Certainly merely requiring public transit systems to use only smaller buses and yet maintain monopoly control during the peak misses the point and, in fact, worsens the problem. Not only does such a plan leave one bus in storage during the off-peak; it requires two drivers during the peak instead of one. Recall from section 2 that drivers represent the largest cost component for public transit.

[13] This cross-subsidization is, in welfare terms, public transit's procurement of extra consumer surplus from the off-peak users in order to obtain less from the peak-users.

[14] In 1997, of the 11 Canadian cities that have a population of over 400,000 people, only Vancouver maintained a peak-load pricing mechanism. Ottawa discontinued its own form of peak-load pricing in 1996. Also note that an equity argument in favor of cross-subsidization is a weak one. For evidence that most of the low income, transit dependent are not peak-users, see: **Starrs and Perrins (1989)**. Furthermore, public transit is most often a less efficient way to increase social welfare as compared to a simple cash grant.

[15] Precedent for urban transportation deregulation may be found in Great Britain's *Transport Act* of 1985. Since October 26, 1986 all local bus services in cities other than London (which was, and still is, exempted from deregulation) have been able to run whenever and wherever they please using vehicles and fares of their own choosing. Any changes to service merely require a 42 day notice to the local traffic commissioner. The results have been mixed in that operating costs have fallen, service areas have increased, but ridership continues to fall and fares continue to rise in real terms. For a complete discussion see: **Bayliss (1999)**; **Glaister (1997)**; **Mackie and Preston (1996)**; and **Pickup *et al.* (1998)**. As will be seen in this section the type of deregulation proposed here is much more measured than that taking place in Great Britain.

[16] I am grateful to Barry Prentice for suggesting this idea.

[17] For an introduction to the implications of cabotage regulations for surface transportation, see: **Prokop (1997)** and **Prokop (1999)**.

[18] This is defined as the full cost of using transport as seen by the user as well as provider. Time, flexibility, comfort, and safety are quality-attributes over and above the monetary cost that the user would include in his calculation of generalized cost. The generalized cost approach may further explain the drop in MCp. Many illegal jitney operations in the United States during the 1970s and 80s proved popular because the drivers were people from the riders' own neighborhood (usually low-income areas, poorly serviced by public transit). Such familiarity was a definite quality attribute.

[19] The model is simplified in that it does not allow for deregulation to be designed to include the right for jitneys to independently set their fares. If such were the case, any cost savings due to competition could be passed along to the rider. In Great Britain, urban deregulation lead to a few large (private) bus companies buying up routes with the requisite low bids but keeping fares high in order to protect their investments. The result has been a vicious circle of rising fares and a falling ridership leading to a fall in total passenger revenues (**Bayliss 1999; tabs. 7, 8, and 15**). Of course, the peak-only deregulation afforded by the jitneys offers less incentive for such negative action since none would ever be in a monopoly position.

Bibliography

Bayliss, D. (1999). "Buses in Great Britain: Privatisation, Deregulation and Competition." Halcrow Fox: Monograph.

Canadian Transit Fact Book: 1997 Operating Data. (1998). Toronto: Canadian Urban Transit Association.

Cox, W. and J. Love. (1995). "How the Competitive Market Can Make Canadian Transit Efficient and Effective." in F. Palda. (ed.) *Essays in Canadian Surface Transportation*. Vancouver: The Fraser Institute. pp. 141-78.

Davis, D. (1989). "Competition's Moment: The Jitney-Bus and Corporate Capitalism in the Canadian City, 1914-1929." *Urban History Review*. vol. 18. no. 2. pp. 103-22.

Davis, D. (1990). "The North American Response to the Jitney Bus." *Canadian Review of American Studies*. vol. 21. no. 3. pp. 333-57.

Electric Railway Journal. (1915).

Glaister, S. (1997). "Deregulation and Privatisation: British Experience." in G. de Rus and C. Nash. (eds.) *Recent Developments in Transport Economics*. Brookfield, Vermont: Ashgate Publishing Co. pp. 135-97.

Klein, D, A. Moore, and B. Reja. (1997). *Curb Rights: A Foundation for Free Enterprise in Urban Transit*. Washington, D.C.: Brookings Institution Press.

Mackie, P. and J. Preston. (1996). *The Local Bus Market: A Case Study of Regulatory Change*. Brookfield, Vermont: Ashgate Publishing Company.

Pickup, L., G. Stokes, S. Meadowcroft, P. Goodwin, B. Tyson, and F. Kenny. (1998). *Bus Deregulation in the Metropolitan Areas*. Brookfield, Vermont: Ashgate Publishing Company.

Prokop, D. (1997). "The Welfare Gain from Trucking Deregulation: Transborder Trucking and Cabotage." *Canadian Transportation Research Forum*. Proceedings of the 32nd Annual Conference. pp. 555-73.

Prokop, D. (1999). "In 1988 We Freed Trade. Now Let's Free Transport." *Policy Options*. June. vol. 20. no. 5. pp. 37-40.

Starrs, M. and C. Perrins. (1989). "The Markets for Public Transport: The Poor and the Transport Disadvantaged." *Transport Reviews*. vol. 9. no. 1. pp. 59-74.

Transportation in Canada 1998: Annual Report. (1999). Ottawa: Transport Canada.

Car Bus Demonstrator

By David Petrie, *PETRIE TRANSIT CONSULTANTS*

Abstract

The general solution to congestion in low-density urban areas will employ a *Car Bus* that transports the personal car at 130 km/h on a barriered inside lane of the freeway. Stations will be located above the freeway at 10-km intervals, accessed by ramps emanating from the outside lanes. Loading of occupied personal cars will be automated, 20 seconds elapsing from **stop** to **restart** of the *Car Bus*.

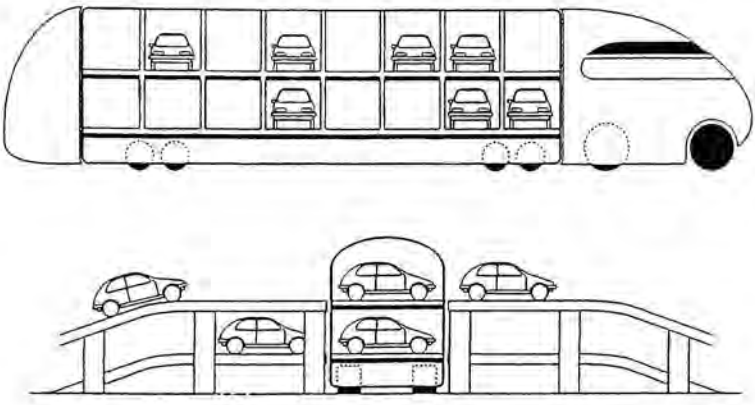
Since the *Car Bus* will be fuel cell powered and the motors of the transported cars will be OFF during the freeway portion of a typical commute, pollution due to fossil-fueled transport will be roughly halved. It is anticipated that *Car Bus* will capture 40-70% of all commuter-miles.

The capacity of this guideway will be so enormous that many high-performance freight trucks, equipped with automation kits, can be interwoven with *Car Bus* via entrance/exit gates.

The transporters will be automated with a computerized safety control sub-system, effectively adding up to 20 lanes of capacity on a single dedicated guideway, as 2.5 meter long electric/hybrid microcars become available for general commuting and errands. The entrance of all cars and trucks into this unified transportation network will be computer-coordinated by GPS navigation feed into an automated cell-phone based communication system.

Since the transporters, microcars, stations, guideway, and central computer control should operate as an integrated system, a proof-of-concept demonstration should be built. This will also serve as a developmental tool to perfect operating software, proof-test hardware, establish patron use patterns, and gain operational experience.

Rudimentary manually driven versions can be in operation while the more advanced version is under development. This early version will target transport of full-sized cars pending mass production of microcars; the latter destined to be the most numerous car in the 21st Century.



CAR BUS

Congestion

In the modern low-density city—typical in the USA--only 3% of commuters use public transit. This is because the car/highway system over the past seventy years has shifted concentration of homes, workplaces, and shops from within walking distance of mass transit rail/bus stops to lower density suburbia. Such distributed development is not compatible with conventional mass transit. Stated more simply, people who want to use public transit must first get to the rail/bus station from their homes, then get from the station to their destinations. To walk the usual 1-10 kilometers distance to/from the stations is quite impractical for most commuters. As a result, 13 out of 14 commuters in the USA drive alone, giving rise to the term "SOV" (single occupant vehicle).

Mass production techniques have made the personal car affordable to almost every citizen. In the USA, there are now 1.08 cars per licensed driver, with many owning vehicles designed for specific purposes: vans/sport utility vehicles, pickup trucks, sport cars, and motorcycles.

We have now built a society based on the car/highway system from which there is no turning back. Car pooling is near impossible, because few commuters can readily find a nearby neighbor who works at the same plant, on the same shift, and doesn't have personal requirements to stop by the child care center or buy groceries for dinner. High Occupancy Vehicle (HOV) lanes in the USA, intended to coerce SOV commuters into car pooling, have failed to mitigate congestion. The necessary dependence on the SOV results in massive congestion on urban freeways and intra-city arterial roads.

Transit in the 21st Century

Sometime within the next 15 years, the microcar will largely replace the conventional ICV for daily use, the latter now consuming inordinate road and parking lot space. Many families will still retain (or rent) an ICV van/sedan for long-range family trips, camping outings, and heavy hauls. But they will become 'dust catchers', due to their infrequent use.

The Car Bus will have a profound impact on urban travel in particular, and quality of life in general. In 7-20 years, the microcar will become the most popular car in the industrialized world, reducing the wasteful use of the conventional-sized ICV for SOV commuting.

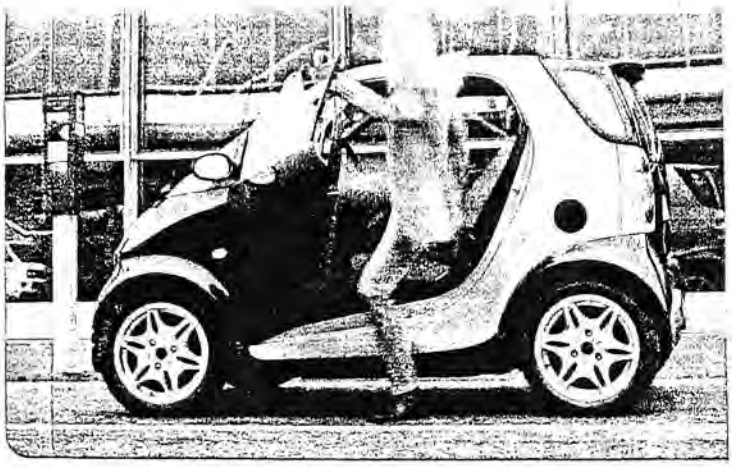
A typical family with two working parents and a college student will own a seldom used ICE minivan, with three hybrid/fuel cell powered microcars angle-parked within the second garage stall.

Freeway congestion will be virtually eliminated. Up to 80% of workplace and shopping mall parking lots will be redesigned, near tripling capacity. Human energy and time, now wasted in freeway traffic, will be available for more productive use.

Microcar

The conventional sized car is too large for its most used mission-commuting and neighborhood errands. But if we are to maximize the efficiency of *Car Bus* and parking lots in our war on congestion, a purpose-built car is in order.

The minimum sized microcar was selected to be 2.5 meters long, to match the typical width of a transporter for transverse unload/load.



Two-passenger microcars are already being built in Europe, typically 600 CC ICE powered, 100 km/h, $8K in mass production. The SMART (above) is a well-engineered example of the microcar.

An interesting microcar design employing composite structure and EV/hybrid power has three seats, the driver sumptuously seated in the center, providing better balance for this 350 kg. microcar.

The 3-passenger model is designed primarily as a purpose-built car for SOV commuting and neighborhood errands—what some might think of as a 'second car'. However, families consisting of more than 2-3 people and living in apartments or high-density areas may not afford the cost or parking space of owning a microcar for each licensed driver and a standard-size car for the family. A four-passenger microcar (1.35 meters wide) is possible if the owners accept seating density equivalent to economy class in an airplane.

The four-passenger model might better fit their needs.

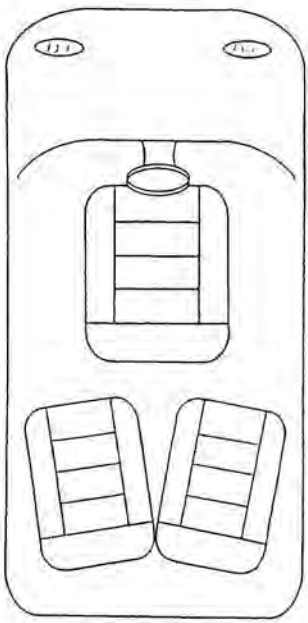
The dilemma of which car to buy could also be solved by a growth in local auto rentals. Automation will permit reservation via phone keypad, followed by dispensing of a minivan or truck adjacent to the microcar as the renter drives into the neighborhood rental lot. Turnaround could be done in a minute.

THREE-PASSENGER MICROCAR

Specifications
Curb Weight: 350 kg.
Battery Weight: 80 kg
Length: 2.5 meters
Width 1.25 meters
Speed: 100 km/h
Range: 120 km.
Composite Const.

Design Objectives
- **Maximum passengers at minimum size**
- **Lateral balance as SOV**
- **Driver seat same as business-class airline**
- **Passengers seats same as economy-class airline (knees are narrower than shoulders)**
- **Slim enough for two EV lanes on single lane**
- **Driver exit on either side**

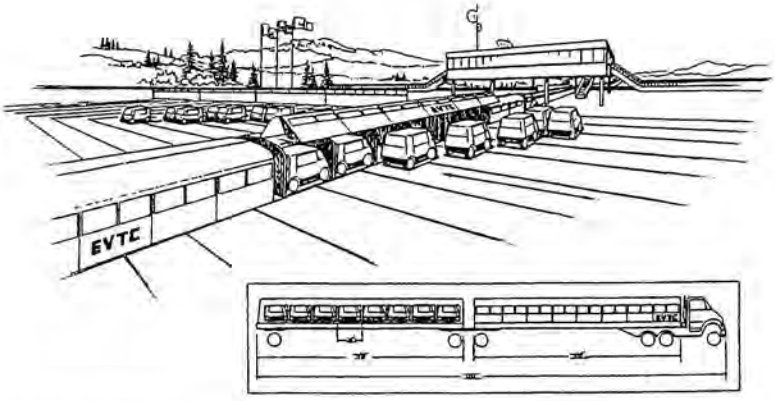
Destined to become the most popular car in the world: compatible with *VMT*



Stations

The stations for load/unload of microcars are located every 10-km above the freeway. This arrangement gives the microcars access to the transporters without interfering with conventional traffic. The station shown overhangs the typical 60-meter freeway width due to the autoloader design. The space beneath the main platform contains parking for the small percentage of commuters who work in the crowded central business district (CBD) where shuttles or taxis supplement walking.

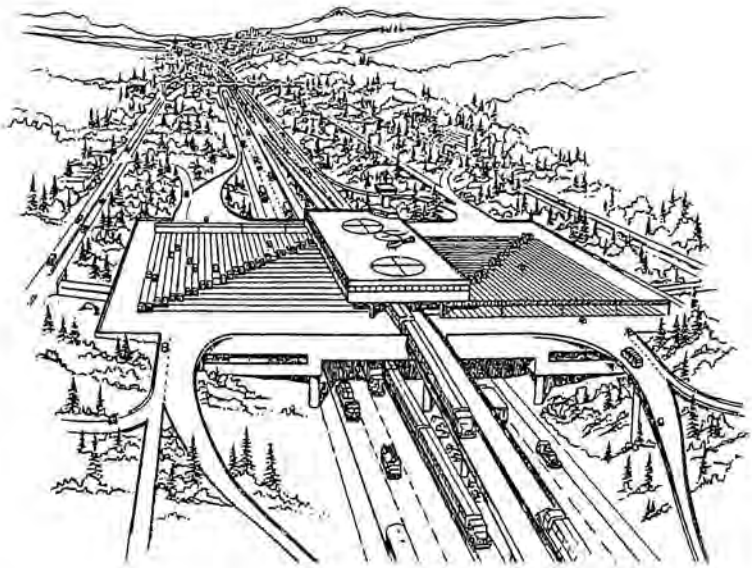
EVTC Truck/Trailer



EVTC- Electric Vehicle Transportation Company

Autoloader

Rapid load/unload of microcars is essential to attract a maximum number of patrons: delays in excess of two minutes will make those needing only a 10-20 km 'hitch' decide to drive the conventional way. The loading platform (and thus the station) can be made much narrower by swiveling the pallets 45 degrees clockwise for debarking cars, then 90 degrees counter-clockwise to accept embarking cars. A simpler scheme from that shown is to load/unload the cars by a drive on/drive off operation. In its simplest form, this requires a lateral-facing car onboard the transporter. The lateral stowage permits a very simple loading operation, the cars being either manually or remotely driven. An unload/load cycle within 10 sec. is achievable with this method, particularly if automated. Another advantage of this method is that the station footprint can more readily fit within the freeway or arterial width.



Staging

A widened staging area is provided just before loading so as to permit juggling of microcars. This operation is desired so as to cluster embarking microcars to match destination stations as they proceed into a loading cycle (resembling a marching band breaking out into platoons at a football half time).

The complexity and timing of the staging operation is such that automation is desired to minimize delay and avoid the occasional snarl due to human error, if manually driven. Control data cables are laid into the roadway ramp and staging area, permitting 'hands off' remotely-controlled driving of microcars from the freeway to the loading pallets.

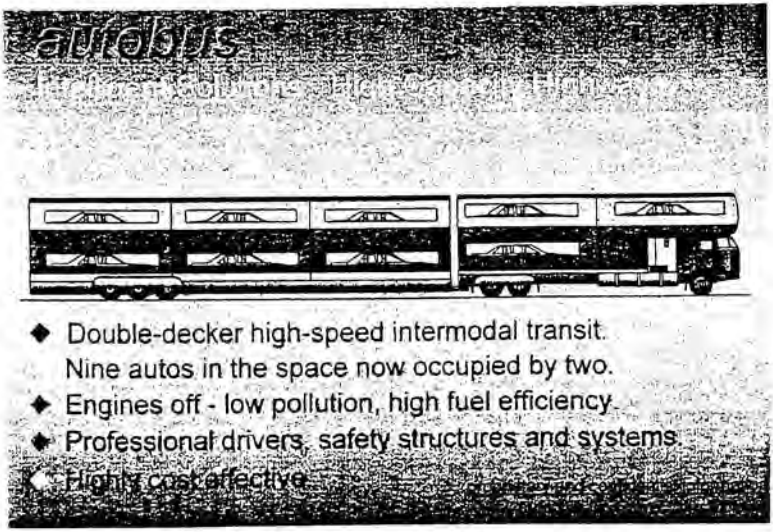
The scheme shown carries two forward-facing microcars abreast. It was considered a requirement that each microcar be able to embark or debark at any station independently. A 30 sec. cycle from transporter stop to start was the design target.

Transporter Design

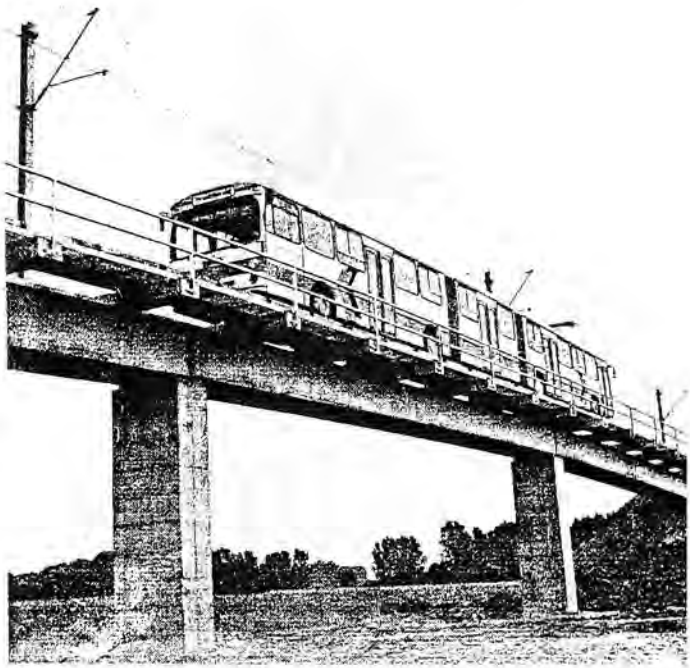
Lateral versus forward-facing cars aboard the transporter is a major design consideration. A disadvantage of lateral-facing cars is that conventional-length cars, such as today's ICV, cannot be accommodated in lateral loading. In the case of forward-facing conventional ICE cars, the transporter can carry only one-third as many cars as with the microcar. But being able to accommodate the longer conventional ICV may be important for gaining early acceptance of *Vehicle Mass Transit (VMT)*. Thus, transporter designers in the early part of the 21st Century will be presented with a challenge, as the most favored commuter car evolves from a 5-meter long ICV to a 2.5-meter long EV. A modular design that could accept a variable mix of lengths and widths, without wasting valuable transporter capacity, would be ideal.

Example Transporters

The initial demo of *Car Bus* should be able to accommodate conventional sized cars because that constitutes the majority of vehicles now in service. The *Autobus* was designed specifically for that purpose.



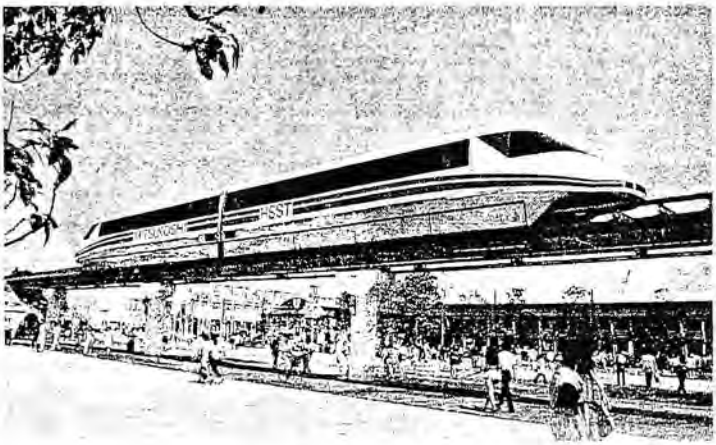
As the microcar becomes popular, the 28-meter long *O-Bahn* (German) bus could be converted to a microcar transporter by replacing the body structure with a double-deck configuration: 16/deck for a total of 32. The 2.5-meter long microcars would handily fit in a lateral orientation, this also being favored for ease of unload/load, automated at 10 second per cycle.



The *High Speed Surface Transportation (HSST-200)* requires modification above the chassis to carry 32 microcars. The weight of the microcars, containing up to 128 passengers in the four-passenger model, is exchanged for the 158 passengers, their seats, and air

their seats, and air conditioning equipment of the passenger-only version. Two gull wing doors on each side are required because of the bi-directional capability; that is, a transporter operating on a North-South route would retain that orientation because the front/rear ends of the 40-meter long articulated transporter are identical.

Energy cost to transport 32 microcars on the *HSST-200* is $0.23/km (based on 10 km inter-station spacing, average 150 km/h, $0.037/kwh@50kv feed). In comparison, the energy costs (from the same power utility) to drive each microcar are $0.007/km, but at less than half the maglev transporter speed.



Central Control (CC)

The CC sub-system coordinates efficient utilization of all system elements using modern communication links, computers, and the all-important software. The location and status of every microcar and transporter is known at all times by the CC computer. The Global Position System (GPS) receiver onboard the microcar, and keyboard entries from each driver are sent to CC via digital multiplex super-imposed on the cellular phone link. Since microcar activity around stations during rush hour will resemble a beehive, a high degree of automation is desired to assure delay-free load/unload action.

Load/Unload Management

The central computer assigns microcars, desiring to embark, to empty (or debarking) berths in arriving transporters. This berth assigning process begins when commuters start their trip at the home driveway, entering their destination on the keyboard in the dash of the microcar.

It is not reasonable to expect clusters of microcars, based on a common destination station, to arrive simultaneously at the departure station along with their assigned transporter. Accordingly, juggling is done in the two-lane moving queue on the station approach ramps, assembling the clusters by the time they reach the loading platform. It is possible in early versions of *VMT* to direct this assembly by automated commands to drivers through the cellular phone link. But remote control using Automated Highway System (AHS) technology is much preferred.

Transporter Control Sub-System

A modification of the standard headway control used for trains is required to realize the growth goal of 80 meter minimum headway, required for 20 lane equivalent throughput of conventional traffic.

In order to achieve this throughput capacity, the crude century-old spacing criteria for conventional railways must be set aside, recognizing the fail-safe monitoring and control technology now available. Speed commands to individual transporters and switch commands to the guideway are CC automated functions. Back-up manual control is available for special operations. Fail-safe operation is a design requirement. For example, a major failure in a transporter results in simultaneous emergency braking of all succeeding transporters that threaten to overrun the failed transporter.

Freight Trucks

Eventually, freeways—typically having 4-6 lanes each way--will have **two** automated lanes each direction: One for 400 km/h maglev transporters carrying a mix of walk-on passengers; and microcars containing passengers (similar to the Chunnel *Le Shuttle);* and a second lane for 130 km/h rubber-tired freight trucks, operating between the inside lane dedicated to maglev transporters, and the

remaining 3-4 lanes would carry conventional manually-driven cars and trucks.

Demonstration Project

Since the microcars, transporters, stations, guideway, and central control are designed as an integrated system, they should not be installed piecemeal into an existing transportation system without first conducting a proof-of-concept demonstration. The purpose of the demo is to establish patron use patterns, fine-tune operating software, proof-test hardware, and gain operational experience.

Test Facility

To ensure that all the components of the system play together requires a working model, complete with station, autoloader, test track, and CC. The autoloader, automated clustering of microcars on the staging ramp, and the CC software that coordinates this activity are all critical to delay-free operation.

However, a primitive (early) system, employing a rubber-tired chassis like *Autobus* transporting conventional-sized cars, is more likely to gain support because of the familiar technology. Such a demo would require less system-level testing, emphasis being placed on station and autoloader design. The guideway, using existing freeways, should plan for conversion to maglev, consistent with the long-term goals to achieve the ultimate transit system.

Urban Mobility Initiative

Polls taken in most urban areas of the USA reveal that traffic congestion is the most vexing problem facing our society. However, global warming is often given more attention, possibly because the scientific community and our legislators assume that congestion is something that is a given part of a modern society, not curable.

Both issues can be addressed through the synergy of the *Car Bus*, in concert with the new hybrid and fuel cell powered family of cars being developed in the USA under the *Program for a New Generation of Vehicles (PNGV).*

An ideal way to attack these coupled problems would be via an ***URBAN MOBILITY INITIATIVE*** at the federal level. Considering that the feds spent $26B (year 1960 $) on the APOLLO man-to-moon program, it is reasonable to assume that we should be willing to allocate $30B (year 2000 $ averaged at $3B/yr over ten years) to solve our #1 societal problem.

A proposed program is outlined below, involving progressive technology. The initial proof-of-concept demonstration employs the low-tech rubber-tired *Autobus*, eventually evolving to the ultimate "dream" transit system using silent, smooth maglev.

DEMO 1A- Los Angeles; Santa Monica-Ontario E-W on I-10 (54 miles), manually driven *Autobus* transporting nine conventional-sized ICE cars. Stations located off the freeway within cloverleaves. Operational 2002.
DEMO 1B- Los Angeles; San Fernando-Irvine N-S on I-5 (60 miles). Same as Demo 1A, except 'hands off' automated operation on a dedicated inside lane (busway) of the freeway. Stations are located over the freeway to assure an unobstructed right of way (ROW). Operational 2004.
DEMO 2- Seattle; Lynnwood-Tacoma on I-405 (59 miles). *HSST* maglev truck carrying 32 2½ meter long EV microcars. Designed for urban applications and 200 km/h intercity use. Operational 2006.
DEMO 3- Houston; Galveston-Dallas on I-45 (270 miles) 500 km/h cryogenic maglev on elevated guideway over freeway medians, carrying 64 PNGV composite/FC hypercars. Operational 2010.

Demo 1A will effectively double car throughput on a five lane (each way) freeway. Demo 2 with microcars will effectively add up to 20 lanes (each way) car throughput to a typical 10-lane (total) freeway, effectively quadrupling cars/hr capacity, using existing ROW freeway footprints.

On Demo 1B, automated high performance freight trucks can be interwoven (called 'zipping') with the *Car Bus*. On Demo 2, an automated truck lane can be added alongside the barriered and shrouded at-grade guideway for *HSST*. This configuration has three lanes (out of five) remaining for conventional traffic.

AUTOMATED RAPID TRANSIT

Robert J. Slade
Proprietor
Skytrek Systems

Introduction

In the past 50 years the accident, death and injury rate, on a per capita basis, has remained approximately the same. This continues, in spite of all the new legislation that has been passed, all the improvements in roads and vehicles, and all the increased requirements in driver training. The reason is that cities have grown at a faster rate than improvements can keep up with. Public transit, if used by enough people, could reduce the congestion on our streets, which is the basic cause of our accident rate.

Over 80% of our population live in cities. If we are ever going to resolve some of the problems that face us, this is where we obviously must start.

The Problems

1. Congested city streets.

2. Carbon Dioxide Emissions.
3. Over 4000 deaths annually from accidents. (1)
4. Over 500,000 hospital stays annually by accident victims.
5. The need to conserve energy.

If our peacekeeping forces abroad suffered one percent of these figures, as casualties, there would be a huge public reaction. Forty deaths and five thousand wounded, would people agree with that? Then why is there no outcry about the traffic casualties across the country? Could it be because it has always been there, and people are used to it? We have to travel, so we travel and take our chances. It could also be that, in a city like Toronto, where there are one hundred and ninety accidents per day, only the most spectacular one gets to be seen on the evening news. Everybody talks about it, but nobody knows what to do.

Traffic Congestion

The formulae used for calculating the complexity of traffic problems is the square of the number of vehicles on routes that cross each other.

For example:

7 vehicles crossing 7 vehicles = a complexity factor of 49

10 vehicles crossing 10 vehicles = a complexity factor of 100

It can be seen from this that reducing the number of vehicles from 10 to 7 (a 30% reduction) reduces the overall complexity factor by 51%. We only need a transit system that appeals to 30% of the city's population to achieve this.

Carbon Dioxide Emissions

Emissions are directly related to the amount of fuel burned. The elimination of 30% of the traffic gives the same decrease in emissions. However, it would also result in smoother traffic flow in the remaining traffic. It would also shorten the distance traveled by car for a lot of commuters. Both of these factors would result in a further decrease in emissions.

The Annual Traffic Death Rate

Supporting the families of these victims with welfare payments contributes heavily to the tax burden of every community, at every level of government. Added to this is the cost of disability payments, for life, of those that survive but can no longer work. The costs of this to governments are tremendous. Additional costs are paid by the public, especially in high insurance and repair bills, and lost income from lost work time.

Hospitalized Accident Victims

It is reported that traffic accidents account for more than 90% of all accidents that require hospitalization. Governments at all levels try to

reduce these costs, usually to no avail. The surest way to reduce them is to reduce the number of accidents.

The Need to Conserve Energy

The events of recent months should be sufficient to convince most people that our oil supplies will not last forever. The world's usage of oil is three times that of new discoveries. The law of supply and demand will cause prices to rise farther, as supplies become scarcer. Now is the time to make more of our transportation electrical, instead of oil dependent. Some of the automated systems under development will result in a saving of 70% of the energy we now used.

The Cure

Provide a more sensible way for people to get around in cities. We need to build a transit system that is designed specifically to move people within a city. It has to have enough features to entice more people to use it, and leave their cars at home. These features have to include short walking distances, no waiting, high speed, individual travel, and operate in all weather. Build it, and all of these problems will begin to cure themselves. It can never be totally cured, and it can't be done in one year. However, if we made a start this year, and extended it year by year, in 15 years all these problems will be reduced by about 50%.

The cure I am talking about is Automated Rapid Transit. By this I do not mean automated trains or busses. We have not had any new form of transportation since the invention of the helicopter, and it is time to look at whatever new technology is available to us.

In the United States, an association has been formed to promote better and more modern forms of transport. This is the Advanced Transit Association, dedicated to promoting new systems that people will find convenient enough to use them in greater numbers. The main reason people shy away from public transit is inconvenience.
This Association has formulated a definition for Personal Rapid Transit (PRT) as follows: (2)

1. Fully automated vehicles operating without drivers.
2. Vehicles captive to a reserved guideway.
3. Small vehicles available for exclusive use by an individual or small group.
4. Small guideways that can be located on or above ground, or underground.
5. Vehicles able to use all guideways and stations as a fully coupled PRT network.
6. Direct origin to destination service, with no intervening stops or transfers
7. Service on demand rather than fixed schedules, 24 hours daily.

I did not have these definitions available to me when I started my project. Instead, I started with a list of things that I did not like about existing transportation, and this list led me to the same conclusions, along with a couple more. For the sake of convenience, I wanted everybody to be within a two-block walk of a station. For safety, I wanted enough emergency backup power to ensure that nobody is ever stranded. The other consideration was that it had to be something that can be built with existing technology.

All over the world, the conveyor is one of the most useful pieces of equipment that we have. It is used to move billions of items and thousands of tons of ore, coal, wheat, and almost everything imaginable every day, but very few people. While some have belts, many do not, and some of them operate at high speed. When we carry people, it is always on a belt, and at walking speed. People step on at one end, and step off at the other. Some improvements were obviously needed to carry people at higher speeds, and to allow them to get off at many points along the line.

For obvious reasons, to move people safely at high speeds we must enclose them in some kind of a vehicle. Let's say a small, flat-bottomed, lightweight vehicle, about the size of the interior of a small car, with two seats and not much else. We still need ten feet of rubber belt, fastened to the bottom of the vehicle, so we still end up with a belt, running on a conveyor system. Now, however, as we power the

conveyor rollers or wheels to go faster and faster, we have a vehicle that accelerates just like the family car.

The next problem is to allow people to get on and off wherever they happen to be, not just at the end of the line. I investigated and experimented with many different ways of doing this. Most of them involved many moving parts, and were discarded. This is the part of the system that has to be perfect, because it is here that accidents can happen. I needed to have my system operate like a super-highway, to allow vehicles to enter an exit lane, before decelerating to enter the stations.

I finally came up with the answer to my problem. It basically consists of only one moving part, repeated a few times. In practice, it allows vehicles to follow one of two guide rails. One rail, on the left side, goes the whole length of the line. The other, on the right side, curves to enter an exit lane, and lead the vehicle into the next station. This gives the vehicle the ability to enter the exit lane and then slow down to proceed into the station.

I have built this device, and it is really the only new invention in the whole system. I have tested it to my satisfaction, and I am satisfied with its performance, as well as with its ability to operate for a very long time without failure or repair problems. It is also a very simple device, which makes it inexpensive and easy to mass-produce. I plan

to patent it when I can afford to do so. I therefore cannot describe it in more detail, otherwise the patent would not be granted.

The last problem was to plan a station layout that would allow people to enter and leave the vehicles as rapidly as possible, while at the same time allowing elderly and handicapped passengers to proceed at their own pace, without delaying everybody else. I have settled on an arrangement whereby vehicles enter the station, stop, and move laterally to the loading/unloading platform. Passengers can take as long as they want getting on or off. Nobody is delayed, because the vehicle that is ready to depart first simply moves laterally to the departure lane. The computer-controlled acceleration system then takes it to where it merges, at full speed, with the main-line traffic.

Once I had thought of this arrangement, I found that I did not have to invent it. It has been working successfully, for many years, in the factories where automobiles are manufactured. Nobody should be too surprised that their family car traveled its first few miles on a conveyor like this, before the wheels were installed.

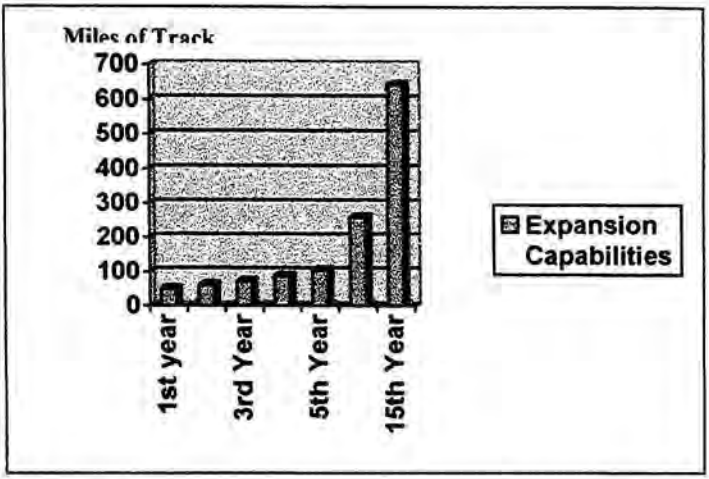
My working model has a very simple station, suitable for one vehicle to enter while another departs. This was done to keep the model as easy as possible to construct. In actual fact, this would be my last choice of where to put a station, in a real system. It would be preferable to have the main line along alleys or side streets, and have

the stations close to the areas being served. Negotiations with businesses that already have parking lots, to use the space overhead for elevated stations, should not be difficult, since it could bring thousands of potential customers. Suitable stops would also include near (or even inside) large office buildings, apartment buildings, stadiums, city parks, and shopping malls. This system design has enough flexibility to allow stations to be constructed almost anywhere, with minimum cost and problems. It has been planned in such a way that it will make travel as simple as riding an elevator.

The capacity of the first system should be 7200 vehicles per hour, which is the approximate capacity of a six-lane highway. While it is impossible to provide any firm estimate of the cost per mile, I expect it to be approximately 10 million dollars per mile. The test of this system will not be its capacity. It will be whether it makes travel convenient enough, for enough people, that transit use will increase from present levels to allow it to operate at a profit. The other obvious advantage is that it can be built in existing cities, where there is no room to expand or change existing streets, except at tremendous cost.

Based on the quoted estimate, a 50-mile system could be built at a cost of 500 million dollars. Allowing for a 20 percent profit annually, after operating and maintenance costs, with profits used to keep expanding the system, expansion would be like this:

CAPITAL REINVESTMENT GROWTH



After fifteen years, the city would have 641 miles of operating PRT. This would continue to grow, almost 1600 miles in 20 years, and about 4000 miles in year 25, and all for a startup cost of half a billion dollars.

There are many other concepts published on the internet. Some are just that, concepts only, for which the operating equipment has not even been invented yet. Some promote huge systems, trains running on automated schedules, which I disregard, because I don't think it is what people want. Others show some promise, and two of these, one in Seattle and one in Los Angeles, are in the design stage and ready

for development. All of these can be seen at a very all-inclusive website maintained by Jerry Schneider at the University of Washington. It can be seen at: http://faculty.washington.edu/~jbs/ You will find a link to my system there also, but it can be seen separately at:
http://www3.sympatico.ca/karen.graham/skytrek/Skytrek.htm

You will notice that mine is the only Canadian system mentioned anywhere. If there are others, I am not aware of them. The speed I have mentioned is the speed that I think would be most practical in a city, and does not preclude the possibility of going much faster when inter-city links are built.

There is, however, a necessity to get started soon, otherwise the other Countries may get too much of a head start on us. If this happens, we may end up importing from them, rather than having our own product to export. Some of the problems I have encountered in trying to get started are:

1. Ontario Provincial R & D money was already allocated.
2. A letter to the office of the Premier of Ontario brought a response that indicated no interest.
3. My contacts with cities have brought similar response.
4. Federal money (Canada Research Council) requires me to have funds equal to any grant I might receive, and
5. I have only my pension to work with.

When any project that is new is presented to anybody at senior levels of either government or industry, it gets referred to subordinates for evaluation. There is the main problem. Just as when the computer was new, there were no experts, outside of the company that developed it, that could evaluate it. Unlike the computer, this project is too big to be able to build a full-sized model inside a building, to be put on display. There are no programs anywhere that makes R & D money available to individuals, even though the Patent Office statistics indicate that ninety-three percent of patents are filed by people who have no post secondary education. Unless something changes, my project has gone as far as it can go.

ENDNOTES

(1) General news media reports.

(2) ATRA website: www.advancedtransit.org/

ISSN#
1183-2770

Photo: Tourism PEI/John Sylvester



Photo: Tourism PEI/KAZ



Photo: Tourism PEI/Ron Garnett

DESIGNED AND PRINTED BY PRINTING SERVICES • UNIVERSITY OF SASKATCHEWAN • CUPE 1975