
CTRF
Logistics in a Changing Global Economy
La logistique dans une économie globale en mutation
Canadian Transportation Research Forum
Proceedings of the 33rd Annual Conference
Edmonton, Alberta May 25-28, 1998
Le Groupe de Recherches sur les Transports au Canada
Actes de la 33ième conférence annuelle
Edmonton, Alberta 25 au 28 mai, 1998

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

PROCEEDINGS
of the 33rd Annual Conference

ACTES
de la 33ième Conférence annuelle

LOGISTICS IN A CHANGING GLOBAL ECONOMY
la logistique dans une économie globale en mutation

Edmonton, Alberta
May 25-28 / 25 au 28 mai
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President's Message

Welcome to the CTRF's 33rd Annual Conference!

The CTRF Conference *Proceedings* stand as a permanent record of the policy debate and emerging ideas that have permeated the last three decades of this century. Past proceedings of the CTRF present views on the regulatory system and arguments for and against reform, the potential impacts of free trade agreements and deregulation, and the implications of significant policy modifications, such as privatization and user-pay. This year the conference addresses the theme: *Logistics in a Changing Global Economy*. This is a fitting topic for conference members to ponder as industry is confronted with mega-mergers and the formation of hemispheric trading blocks. The challenges of efficient logistics and effective transportation policy have never been more important to our place as a leading industrial economy.

The conference *Proceedings* present the membership's current work and include articles from the winners of the student paper competition. The *Proceedings* allow participants to review in detail the presentations discussed at the meetings, and give those who were unable to attend the opportunity to remain current. A summary of the keynote address, panel discussions and the Bison Transport Cup Debate will be distributed subsequently in the *Forumation* and at our website (www.vemax.ca/ctrf).

As the conference setting journeys from coast to coast, the task of organizing this major undertaking is shouldered by a different committee. *Team Alberta* was led by Lloyd Ash, VP Program & Publications, and Keith Scott, VP Meetings. The Van Horne Institute, the University of Calgary, KPMG, Trimac, Rohr Consulting, Alberta Government (Industry Development Branch), and Vemax Management deserve special recognition for their part in assisting the conference. The preparation and printing of the *Proceedings* by the University of Saskatchewan were managed by Gail Sparks, CTRF Secretariat. Finally, on behalf of the Board of Directors, thanks to all the CTRF members and conference sponsors for their continuing support.

Dr. Barry E. Prentice
President

MESSAGE DU PRÉSIDENT

Soyez les bienvenus à la 33e Conférence annuelle du G.R.T.C.

Les Actes de la Conférence du G.R.T.C. constituent un recueil permanent des débats de politiques et d'idées en émergence qui ont imprégné les trois dernières décennies de ce siècle. Les Actes précédents du G.R.T.C. exposent des positions sur le système réglementaire, des arguments positifs ou défavorables sur la réforme, les impacts potentiels des accords de libre-échange et de la déréglementation et les implications de changements significatifs de politiques, comme la privatisation et la tarification aux usagers. Cette année, la conférence s'attache au thème de **La logistique dans une économie globale en mutation**. Il s'agit là d'un sujet approprié à méditer par les congressistes du fait que l'industrie est confrontée aux mégafusions et à la formation de blocs commerciaux à l'échelle des hémisphères. Les défis d'une logistique efficiente et d'une politique de transport efficace n'ont jamais été aussi importants pour notre place en tant qu'économie industrielle avancée.

Les Actes de la conférence présentent les travaux courants des membres de même que des articles des gagnants du concours des étudiants. Les Actes permettent aux participants de revoir en détail les présentations mises en discussion lors des séances et, à ceux qui n'ont pu assister, de rester à jour. Un résumé du discours principal, des discussions en panel et du débat de la Coupe Bison Transport sera publié ultérieurement dans **Forumation** et à notre site web (www.vemax.ca/ctrf).

Comme la conférence déclenche des déplacements d'un océan à l'autre, la responsabilité de l'organisation de cet événement important incombe à un comité différent. **L'équipe Alberta** est menée par Lloyd Ash, V-P Programmes et Publications et Keith Scott, V-P Conférences. L'Institut Van Horn, l'Université de Calgary, KPMG, Trimac, Rohr Consulting, le gouvernement de l'Alberta (département du développement industriel) et Vemax Management méritent une reconnaissance spéciale pour leur contribution à la tenue de la conférence. La préparation et l'impression des Actes par l'Université de la Saskatchewan ont été dirigées par Gail Sparks, secrétaire du G.R.T.C. Finalement au nom du Conseil d'administration, merci à tous les membres du G.R.T.C. et aux commanditaires de la conférence pour leur appui constant.

Dr Barry E. Prentice
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- 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.

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Volume I

Session/Séance 1: *Opening Plenary Session/ Séance Plénièré d'ouverture*

Logistics In A Changing Global Economy

Chair: Peter Wallis - Van Horne Institute, President and CEO
Panelists: Michel Beauregard – CP Ships Logistics, President and CEO
Tom Culham – Weldwood of Canada Limited, Director of Purchasing and Transportation
Michael Sabia – Canadian National, Executive VP and CFO
Darrell Toma – Toma & Bouma Management Consultants, Partner

Session/Séance 2: *Grain Supply Chain*

- *Regulation, Logistics and Efficiency – Introducing Competition and Market Pricing to Western Canada's Grain Handling & Transportation System.* Dr. Graham Parsons 1
- *Volumes of Pulse/Special Crops Exports and Transportation Methods from Western Canada: 1996/97.* Jake Kosior, Dr. Barry E. Prentice and Doug E. Campbell 23
- *Emerging Trends in Western Canadian Grain Transportation.* Dr. Barry E. Prentice 35

Session/Séance 3: *Data Issues*

- *The Challenge of Using International Trade Data to Enhance Transportation Statistics.* Jeff Allen 50
- *Canadian Vehicle Survey: Methodology.* Sophie Dionne and John Lawson 74

- *An Overview of The Application of ITS to Commercial Vehicle Operations in Texas.* Dan Middleton, Jeannette Montufar and Susan Bryant 88

Session/Séance 4: *Network Analysis*

- *Facility Location and Staffing Analysis for TransAlta Utilities.* Erhan Erkut, Tony Myroon and Kevin Strangway 102

- *Trucking In The Prairie Region of North America: Using Geographical Information System Applications.* A. Clayton, B. Ritchey, M. Alam, M. Melchiorre, K. Mruss, J. Montufar, W. Price, L. Escobar, K. Han and S. Zhi 112

Session/Séance 5: *Rail Transport: Serving Global Markets In The Year 2001*

Chair: Jan Bowland – KPMG, Partner
Panelists: Rick Sallee – Canadian Pacific Railway, VP Agri Products and Coal
Gordon Clanachan – RaiLink Limited, President and CEO

Session/Séance 6: *Air Competition In A Global Environment*

- *Open Skies and Open Gates.* J. Nolan, P. Ritchie and J. Rowcroft ... 119

- *Consumer Attitudes Towards Aviation Regulation: A Comparison of Canadian, American and Mexican Air Travellers.* Edward R. Bruning, Barry L. Prentice and Patty-Jo Bellamy 129

- *Success of New Non-Stop Services in the Aviation Transborder Market.* Robert Lund and Harold Kohn 142

Session/Séance 7: *Logistics Panel*

Chair: Stephen Shepherdson - Coopers & Lybrand Consulting

Session/Séance 8: *Marine Issues: Competition On Land And At Sea*

- *Canada's East Coast Container Ports, Do They Compete With or Complement One Another In The Race For North American Container Traffic?* Doug O'Keefe..... 154

- *A Time For Change – An Internationally Competitive Canadian Flag? Pragmatic Reform of The Canada Shipping Act Is The Answer.* Jonathan Seymour..... 170

- *A Bidding System For Port Pricing Optimization.* Jia-Ming Cao, Henry Fan and Soi-Hoi Lam..... 185

Session/Séance 9: *Urban Transportation: Current Developments and Concerns*

Chair: David Cape - Ryerson Polytechnic Institute
Panelists: Ed Levy - Chairman of BA Consulting and Chair of the Transportation Committee of the Toronto Board of Trade
John Morrall – University of Calgary, Professor of Civil Engineering
Alex Lee – Edmonton Mobile Equipment Services

Session/Séance 10: *Logistics And Transportation Research*

- *Exploring Sources of Productivity Gains and Their Financial Implications: A Comparison of Aggregate and Disaggregate Approaches.* W. G. Walters II..... 198

- *Estimating The Derived Demand For Transport: A Gravity Model Approach.* Dr. Barry E. Prentice and Zhaokun Wang..... 215

- *Locating A Meat Processing Plant In The Prairies.* Mark Gannon, Laura Morrison and Les Stelmach..... 229

Session/Séance 11: *Performance And Issues In The North American Trucking Industry*

- *Value of Goods Transported By Truck In Ontario.* Rob Tardif 243
- *Technical Change In Capital And Energy Conservation In The Canadian Trucking Industry: An Empirical Analysis Of An Experiment.* Michel Boucher 258
- *Key Indicators And Best Practices In The North American Trucking Industry.* Jan Bowland and Don McKnight 273

Session/Séance 12: *Logistics Issues*

- *Conference Legislation – Emerging Developments, Trends And A Few Major Issues.* Joseph Monteiro and Gerald Robertson 286

Session/Séance 13: *Airline Competition*

- *Alliances In The Airline Market: An Empirical Perspective.* David Jarach 315
- *An Analysis of Profitability of The World's Major Airlines.* Tae Hoon Oum and Chunyan Yu 331

Session/Séance 14: *Grain And Rural Issues*

- *The Public Policy Problem of Grain Transportation.* Baylis, Brooks, Fulton and Gray 350
- *Saskatchewan Area Transportation Planning.* Robert Grant, Mack Howat and Paul Rachar 369
- *Allocation System Incentives To Improve Grain Loading And Unloading Performance In Western Canada.* Dr. Barry E. Prentice and Doug E. Campbell 384

Session/Séance 15: *Information Technology And Logistics: Getting Past the Buzzwords*

Chair: Clarence Woudsma
Panelists: Debbie Pullman – CP Rail
Roy Masrani – RADSS Technologies
Jeff Connie - CGI

Session/Séance 16: *Safety*

- *Railway Safety In Canada, 1987 – 1997.* John Heads 396
- *The Influence of CTI On Road Life And Vehicle Stability.* John Woodrooffe and Norm Burns 412
- *Improving Compliance With Motor Carrier Safety Regulations.* Edward S.K. Fekpe 428

Session/Séance 17: *Airport Management: Strategies For The Future*

Chair: Ed Bruning – University of Manitoba, Professor of Management
Panelists: Scott Clements – Edmonton Airport Authority
Murray Siglar – Winnipeg Airport Authority
Mike Trethaway – Vancouver Airport Authority

Session/Séance 18: *Urban Issues*

- *Transportation Challenges For The New Toronto: Mushrooms, Misinformation, Missed Connections and More...* David M. Cape .. 441
- *Urban Goods Movement Revisited.* Clarence Woudsma 453
- *Canada's Commitment On Greenhouse Gas Emissions Under The Kyoto Protocol And The Potential For Reductions In Transport.* John Lawson 465

Session/Séance 19: *Economic Development And Regional Impacts*

- *Applications of Artificial Neural Networks To Transportation Systems And Planning.* Saeed Moshiri and Darren Prokop 480
- *Competition Policy Activities Related To The Transport Sector, 1976 – 1996.* Joseph Monteiro and Gerald Robertson 503
- *A Thumbnail Sketch of Writings On Canadian Transport History: 'Its Past And Its Future?'* Michael Butt and Wade Derkson 533

Session/Séance 20: *Air And Airports*

- *Canadian Civil Aviation History: Nationalism, Modified Competition, And The Rise of A 20th Century 'Competitive Age Ideology'.* Michael Butt and Dr. Ed Bruning 548
- *Economic Impact of A Night Restriction At Winnipeg International Airport: A Time Trend Analysis Measuring Potential Impacts.* Scott J. Shurvell 563

Session/Séance 21: *Environmental And Safety Issues In Transportation*

- *FORETELL™: Integrating ITS With Advanced Weather Prediction.* Peter Davies and Omar Choudhry 579
- *Heavy Truck Safety On Low Volume Highways: Questions Concerning Policy And Enforcement.* Jeannette Montufar, Alan Clayton and Al Popoff 589

Session/Séance 22: *Risk Analysis And Safety Issues*

- *Incorporating Risk Analysis In Municipal Hazardous Materials Network Design.* Jianjun Zhang, Erhan Erkut and John Hodgson 604

Session/Séance 23: *Bill C-9: Positioning Canadian Ports In The Global Economy*

Chair: Don Krusel – Prince Rupert Port Corporation, President
Panelists: Bruce Bowie – Transport Canada, Executive Director of Marine Policy Reform
Don Downing – Canadian Coal Association, President
Norman Stark – Vancouver Port Corporation, President
John Gratwick – Hickling Corporation
Jonathan Seymour – Jonathan Seymour & Associates Inc.

- *Canadian Ports Legislation – Does One Size Fit All?* Jonathan Seymour 616

Student Paper Winners:

- *Automated Quality-Control Evaluation of Traffic Volume Estimates For Manitoba Highways.* Marina M. Melchiorre 632
- *Le problème du commis-voyageur.* Martin Trépanier..... 647

Regulation, Logistics and Efficiency

Introducing Competition and Market Pricing to
Western Canada's Grain Handling & Transportation System
by Dr. Graham Parsons, President,
Organisation for Western Economic Cooperation.

Introduction

Western Canada's grain handling and transportation system is the subject of public inquiry by Justice Willard Estey and his Grain Review Commission to determine how system efficiency can be improved. This development is not new. In most decades of the 20th century there have been reviews into the western grain industry, often involving some aspect of the grain handling and transportation system.

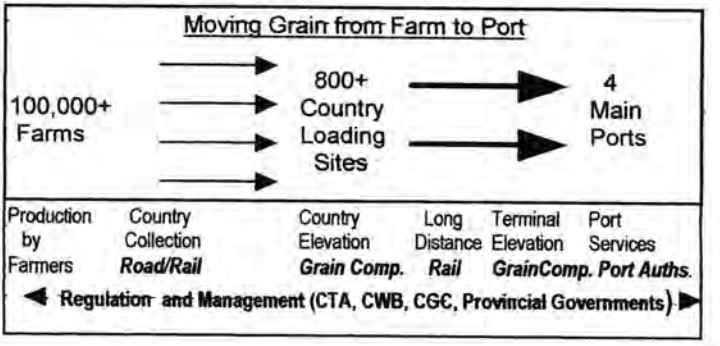
Commissions and Inquiries into
Western Grain Handling and Transportation

Date	Review
1889	Senkler Royal Commission
1900	Royal Commission into Railway Service
1906	Royal Commission on the Grain Trade
1910	Saskatchewan Elevator Commission
1916	Drayton-Acworth Commission
1923	Royal Grain Inquiry Commission
1931	Duff Commission
1931	Stamp Commission
1936	Turgeon Commission
1948-51	Turgeon Commission
1959-61	MacPherson Commission
1975	Hall Commission
1988	Economic Council of Canada
1995	Western Grain Marketing Panel
1998	Estey Grain Commission Review

Western Canada's Grain Handling and Transportation System

The grain handling and transportation system is, in reality, the co-ordinated operation of five transport and handling services in the form of:

1. country collection services by truck and/or rail from farms to country collection points;
2. country elevation services by grain handling companies;
3. long distance movement services, mainly by rail, from the country to terminal export position;
4. the terminal elevation services including elevation and cleaning at port position; and ,
5. port fobbing services to move grain from terminals to waiting vessels.



Efficiency

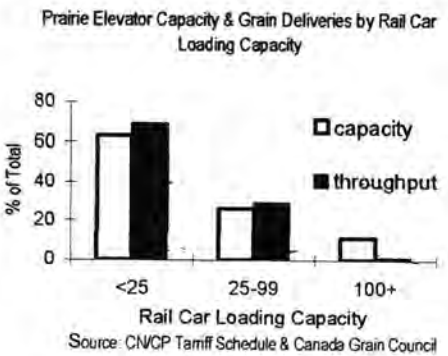
Efficiency is a measure of the ratio of inputs to outputs. There are various concepts of the term efficiency. Engineering efficiency measures the physical amount of one input used to provide a fixed amount of output. Thus the engineering efficiency of a railway locomotive engine can be measured by the amount of fuel used in generating a quantity of power. Engines consuming less fuel for a given amount of power generated can be considered to have a higher level of engineering efficiency.

Technical efficiency is a measure of the total physical amount of all of the factors used in producing a commodity or a service. The production of a given output can be said to be technically efficient if there are no other combinations of resources that would produce the same or more output. The concept takes into account the way in which factors of production must work together in order to achieve an overall level of output.

Economic efficiency introduces the economic concept of value into the definition of efficiency. Thus output is seen as economically efficient when: *"there is no other way of producing the output that will use a smaller total value of inputs."*[ii] Conversely, inefficiency exists when: there are other combinations of factors, prices and values that can produce a given output for a lower total value. Economic efficiency builds on the concepts of engineering and technical efficiency to incorporate the prevailing market, price and regulatory conditions that will affect the total value of producing a given level of output. Empirical evidence suggests that grain handling and transportation is not an economically efficient system due to the large number of inefficiencies that exist within the system.

Inefficiencies in Grain Handling

Today, it is widely known by industry, farmers and government that there are improvements that can be made to grain handling and transportation efficiency. Many discontinuities have been identified in the movement of grain from farm to port. For example:

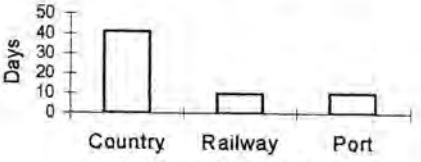


There is continued use of high cost, less efficient country loading locations where multiple car unit trains cannot be loaded. The economies of scale associated with country elevation, handling and cleaning in new inland terminals with multiple railway grain car loading facilities is well known. Yet, in 1996/7 nearly 70% of Prairie export grain moved through rail car loading locations of less than 25 railway grain cars, even though 11% of the rail loading points can now load grain into 100 car units.

Relatively few grain train movements take the form of efficient single point to point movements. For example, nearly 85% of a sample of over 100 grain trains moving to the west coast in June 1997 involved more than six origins. At the other end in Vancouver, there are eleven destinations for

CN alone. Unloading therefore commonly involves multiple destinations. Multiple origins and destinations require increased switching and train assembly costs. This increases car cycle times to nearly double other commodities and means that grain moves to the coast at a snails pace of nearly one kilometre an hour.

Dwell Times for Grain moving from Country to Port for an Average 1,020 mile Haul 1997

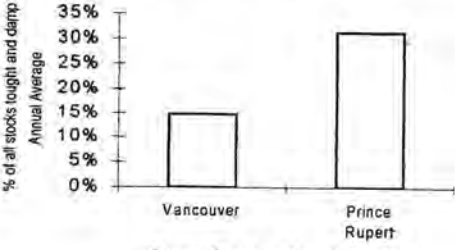


Source: Just in Time Report, 1995
Canadian Grain Commission

System accountability problems are seen when the wrong quality or grade of grain arrives at port position at the wrong time. The problem starts with grain deliveries and works through the grain pipeline of country elevators, railways and terminals to the port where waiting vessels pay demurrage while they wait for the right grain to arrive.

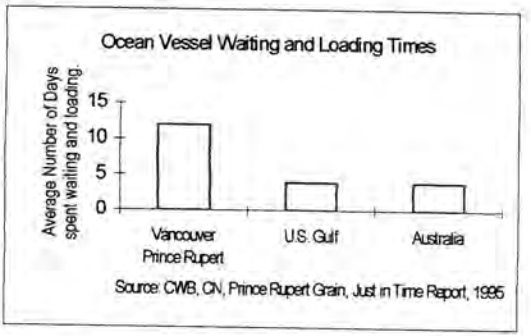
Tough and damp grain may accumulate at port position as it did at Prince Rupert through the 1996/97 shipping year when 30% of the grain was tough and damp. On average 15% of Vancouver storage was tied up in tough and damp grain that had moved to port position from the country and could not be exported until it was either dried, or new sales for the reduced grade of grain had been completed. This leads to reduced storage capacity at port and increased congestion.

Tough and Damp Grain at West Coast Terminals, 1997



Source: Canadian Grain Commission

Additional costs of vessels waiting are passed on by the CWB in the pool accounts in demurrage charges that have amounted to $60 million since the 1990/91 shipping season.[ii] Equally significant is the fact that through the 1993 - 1995 period Canada's west coast ports, that now account for the majority of western grain movements, were far less competitive than our international competitors in the US Gulf and Australia, where average vessel waiting times were four days - three times lower than Vancouver and Prince Rupert.



The system has been characterized as a supply push system.[iii] Much time and attention has been spent documenting and defining the many problems found in the grain handling system.[iv] There has been much discussion of how the applications of new technology could reduce costs and increase efficiency. For example, the new jumbo grain hopper cars that are larger and can carry more weight, provide for a 20% increase in the grain they can carry. Larger high through elevators can dramatically reduce the cost of handling grain. These and other investments in new technologies, when applied, can provide for major improvements in system efficiency.

Technological efficiency gains, however, do not take place in isolation. They are an operating response to the economic signals of the day. It is therefore useful to consider the efficiency problems of grain within two frameworks.

1. The operating and logistics framework that has already seen so much attention.
2. The statutory and regulatory framework that requires more evaluation for its effects upon system inefficiency - the focus of this paper.

Regulation of Grain Handling and Transportation

Grain handling and transportation is controlled through two main pieces of legislation around which a number of regulations, policies and operating practices have developed. These are:

1. The Canada Transportation Act (CTA) that controls railway pricing, sets maximum rates and applies those rates to 58 grains commodities moved through the grain handling and transportation system on the railways. The Act also provides for the setting of the rates through costing procedures.

2. The Canadian Wheat Board Act provides for *"Control over Grain Companies and Railways."* In addition, CWB involvement in pooling, freight adjustment, farmer deliveries, rail car allocation, allocation of grain to terminals and elevators, and selection of destination ports all affect system efficiency.

Also, the Canada Grains Act, federal port and fiscal legislation and provincial highways and fiscal legislation also influence system efficiency. The regulatory structure, therefore, introduces regulatory inefficiencies at each stage of the movement of grain from farm to port that contribute to overall system inefficiency. Some of these are summarized below.

Examples of Regulatory Inefficiencies

Regulatory Inefficiency	Transportation Service	Regulatory Authority
Freight Rate Caps	Country Collection	CTA
Road/Rail Tax Structures		Fed/ProvGovts
Road Limits		Prov Govts
Contract Calls		CWB
Contract Calls	Country Elevation	CWB
Car Allocation	Long Distance Moves	CWB
Statutory Rates		CTA
Cleaning	Terminal Elevation	CGC
Terminal Assignments		CWB
Delivery Patterns		CWB
Vessel Arrivals	Port Services	CWB

The following examples illustrate the effects of some of these measures on system efficiency.

Statutory Freight Rates - (CTA)

Distance related freight rates do not take into account either line or system efficiency of particular regions, or the need to restructure movements in response to local circumstances - weather, port congestion etc. Fixed and maximum rail freight rates limit use of the most efficient lines, investment in new technology and competition. Furthermore, the absence of price differentiation between locations means that farmer demand and use of inefficient locations continues. The result is subsidization of high cost

locations by more efficient locations and facilities. Statistical analysis of the freight rate structure shows that rail freight rates do not reflect any of the system characteristics - volume, loading efficiency etc. that might be expected to reduce rates.

For example, statistical analysis of the rail freight rate structure for grain movements to Vancouver and Thunder Bay was undertaken to identify rate determinants. Theory, empirical observation and commercial practice makes it clear that there are significant operating economies associated with volume of movement, multiple rail car loading and elevator capacity. It might be expected that freight rates would reflect such potentially significant economies of scale in the statutory rate structure. However, regulated rail rates do not reflect these opportunities for efficiency gain.

Determinants of Variations in Railway Freight Rates to Vancouver

Explanatory Factor	% of Variation Explained
Distance	99.91
Rail Car Spots	0
Volume	1.57
Elevator Capacity	0.42
Elevator Turnover	1.35

Nearly all of the variation in freight rates (99.991%) is explained by the distance variable for all rates to Thunder Bay and Vancouver. Less than 1% of any variation in rail freight rates is explained by the introduction of the major technological and scale developments that increase efficiency in the grain handling system.

Thus the economic and commercial benefits that are available to farmers from increased investment in grain handling facilities, the loading of multiple cars or increased volumes of handling are not reflected in the statutory railway rate structure. In effect, the regulatory structure of railway freight rates does not make provision for any system economies of scale, or new, more efficient, technologies.

With rate regulation prices cannot play their role in commercial markets of allocating resources between competing uses. There can be only limited price competition, and few incentives to attract new investment, technology or other sources of increased efficiency.

Cost Based Pricing

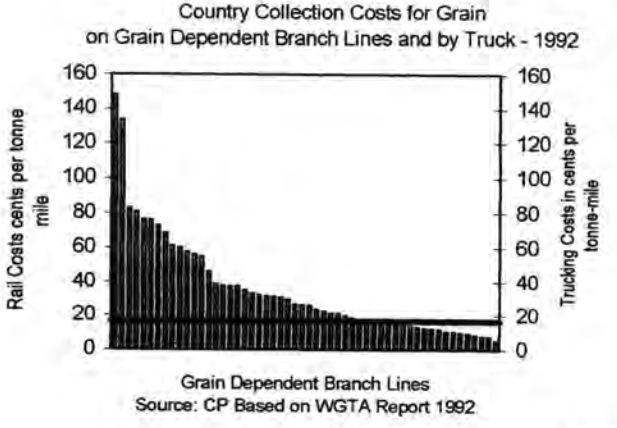
Recent experience in Canada through cost based rate regulation for railways in the National Transportation Act, 1967 was not successful and led to many of the subsequent reforms included in the Canada

Transportation Act. (IBI, 1992) Kessides (1995) and others have shown that compensatory rates cannot be determined by either regulators or on the basis of formulas for cost data alone. Yet, this was the approach adopted under the Western Grain Transportation Act and continued into the Canada Transportation Act.

The financial viability of the price for any transport service depends not only on the cost of providing the service, but also on the quantity of grain transportation services (country handling, rail, terminal handling or port), that customers are willing to buy at that price. The World Bank has shown that there is no relationship between demand considerations and any cost accounting convention.[v]

Regulated pricing based on the allocation of fixed and common costs, without taking into account any demand considerations, invariably produces inconsistencies in patterns of shipper demand. [vi] Some rates will be too low, and consequently the supplier of the service (country elevator, railway, terminal elevator or port), will receive less than the optimal contribution from those services. Services will be provided at levels that do not earn the cost of capital and in time the capital intensive infrastructure for these services will deteriorate. Financial losses may be experienced.

This has been the case with many country elevator operations and railway branch lines for decades. The misallocation of resources was most readily seen in the 1992 Western Grain Transportation Act estimates of the costs of operating branch lines where volumes are inadequate to significantly reduce operating costs, and the maximum freight rates for branch line movements have been regulated through statutory rates and costing formulas.



In a 1992 analysis of the CP Rail Grain Dependent Branch Lines, the range of operating costs extended from 5.2 cents per mile to 148 cents per mile. Significantly, over one half of the grain network was above the estimated cost of trucking at 16.3 cents/mile.

Furthermore, where prices are regulated at less than the cost of providing service, demand increases and further increases costs. Other cost based regulated transport rates may be set too high so that the service provider will either earn less than the optimal contribution or, no contribution at all, as users choose not to use the service. In short, in transport industries with high fixed and common costs, like grain handling and transportation, the pricing of individual services on the basis of any cost allocation is contrary to the interest of both operators and shippers - in this case western Canadian farmers. Rational determination of prices must be based on both cost and demand conditions.

Rate setting through maximum rates does not allow railways to cover the full costs of operation. Commonly, regulators "over-assign" or "under assign" the carrier's unattributable costs to particular services. This leads to a loss of traffic for which demand cannot be supported by the assigned price. In this event remaining shippers are left with a larger portion of the unattributable costs, since they can no longer share those costs with the lost traffic. Accordingly, demand considerations, as well as cost information, are essential prequsites in decision making to allow producers access to adequate revenues to pay for the cost of capital and to achieve system efficiency. In economics, Ramsey pricing provides for such resource allocation by apportioning all unattributable fixed and common costs of carriers on the basis of their demand characteristics. A practical example of this follows in Figure 1 on the following two pages.

Lack of Product Differentiation in Rail Rates

Inefficiencies are created by extending the statutory rates to the 58 grains named in the Act. Statutory rates make no provision for density of product. A highly dense grain like wheat carries the same rate as a lighter product like canola. When rates are applied to normal movements they create shipping anomalies and send false economic signals that affect development throughout agriculture. For example, a rail car of wheat can be shipped from Yorkton to Vancouver at the statutory rate in 1998 of $42.00 per ton. On average a hopper car might carry approximately 90 tons of wheat and 65 tons of the less dense canola meal.

Figure 1:

An Example of Railway Fixed and Variable Costs
in Demand Based Pricing Effects on Prices, Costs & Viability

Railways have high fixed costs (track, roadbed, facilities and taxes). These costs are incurred whether railways run few or many trains. In addition, railways must charge a variable cost to cover the costs of moving a shipment from a specific origin to a specific destination. Variable costs include rail crews, use of equipment, fuel and taxes. Assume a railway has $1,000 in fixed costs per month paid regardless of traffic. In practice there are one hundred shipments on the railway over the course of the month. These shipments share the fixed costs at a rate of $10/ shipment. (See Table 1). In addition, the railway must charge each shipper a share of their variable costs of the movements. Assuming the average variable cost per shipment was $5/shipment, then the total cost (TC) of the months' shipments equals:

[FC (Fixed Cost/Shipment) times NS (# of Shipments)] plus [VC (Variable Cost/Shipment) times NS (# of Shipments)] or TC=[FC*NS] + [VC*NS]

Table 1 - Allocation of Fixed and Variable Costs in Rail Operations

Shipments (NS)	Total Fixed Costs	Fixed Cost /Shipment (FC)	Variable Cost /Shipment (VC)	Total Variable Cost	Total Cost(TC)
100	$1,000	$10	$5	$500	$1,500

In practice, the demand for railway services varies with commodity, by location and over time. Table 1 can be extended to include three levels of shipper demand for railway service - high, medium and low. Table 2 shows the fixed, variable and total cost of rail services for each level of demand.

Table 2 - Railway Cost Allocation under with Variable Demand

Shipper Demand	Shipments [NS]	Fixed Costs /Shipment [FC]	Total Fixed Costs	Variable Costs /Shipment(VC]	Total Variable Costs	Total Costs [TC]
High	40	$10	$400	$5	$200	$ 600
Medium	35	$10	$350	$5	$175	$ 525
Low	25	$10	$250	$5	$125	$375
Total	100		$1000		$500	$1500

Low demand customers, with high levels of price elasticity, might find the unit cost of shipment too high and use another mode of transport such as truck. In this case the $1,000 in fixed costs must now be shared by the remaining 75 shipments. The fixed cost per shipment will therefore rise to $1000/75 shipments or $13.33 per shipment. Variable costs of movement remain the same. Table 3 provides the detail on this scenario and shows that the costs for remaining shipments are higher.

Table 3 - Rail Cost Allocation Less Demand and Equal Distribution of Fixed Costs

Shipper Demand	Shipments [NS]	Fixed Costs /Shipment [FC]	Total Fixed Costs	Variable Cost /Shipment [VC]	Total Variable Costs	Total Costs [TC]
High	40	$13.33	$533.33	$5	$200	733.33
Medium	35	$13.33	$466.67	$5	$175	$641.67
Total	75	$13.3	$1000		$500	$1,375.00

(Continued) An Example of Railway Fixed and Variable Costs in Demand Based Pricing Effects on Prices, Costs and Viability

Higher price shipments may in turn lead shippers with a medium level of demand to reconsider use of the rail system. In the event that these also chose to divert their shipments from rail to truck, the high demand rail shippers are forced to bear all of the fixed costs of railway operations over a much smaller level of business. (See Table 4 below). Under this scenario total costs to the high demand shipper rise and revenues to railways fall to $1,200.

Table 4 - Railway Cost Allocation For High Demand Shippers Only

Shipper Demand	Shipments [NS]	Fixed Costs/ Shipment [FC]	Total Fixed Costs	Variable Costs per Shipment [VC]	Total Variable Costs	Total Costs [TC]
High	40	$25	$1,000	$5	$200	$ 1,200
Total	40	$25	$1000		$200	$1,200

In a worst case scenario decreasing railway revenues and increasing shipper costs remove the basis for commercially viable operations by either the railway or the shipper. The increased burden of carrying all of the fixed costs cause shippers to cease shipping on the railway and the railway closes down operations. It is for these reasons that railways and regulators in the United States have adopted differential pricing based on levels of demand rather than regulated costing formulas. Pricing to the level of market demand allows the railway to retain traffic and allocate shares of total fixed costs on the basis of levels of shipper demand for transportation services. Table 5 below shows such a distribution in which the overall level of railway shipments and revenues have been retained.

Table 5 - Railway Cost Allocation under with Variable Demand

Shipper Demand	Shipments [NS]	Fixed Costs / Shipment [FC]	Total Fixed Costs	Variable Costs per Shipment [VC]	Total Variable Costs	Total Costs [TC]
High	40	$12.25	$490	$5	$200	$690
Medium	35	$11.00	$385	$5	$175	$560
Low	25	$5.00	$125	$5	$125	$250
Total	100		1000		$500	$1,500

The ability to allocate the fixed costs in relation to demand now also offers the opportunity to attract new business to the railway and to spread the fixed costs over a larger volume of shipments. Table 6 outlines such a scenario in which shipments have increased to 130. Costs for all levels of demand are reduced, while railway shipments and the related revenues increase.

Table 6 - Rail Cost Allocation - Variable Demand & Increased Shipments

Shipper Demand	Shipments [NS]	Fixed Costs / Shipment [FC]	Total Fixed Costs	Variable Costs/ Shipment [VC]	Total Variable Costs	Total Costs [TC]
High	40	$9.75	$390	$5	$200	$590
Medium	40	$9.00	$360	$5	$200	$560
Low	50	$5.00	$250	$5	$250	$500
Total	130		$1000		$650	$1,650

At January 1998 market prices, wheat was worth approximately $175 per ton in Vancouver, while canola meal was worth $211 per ton.

Statutory Rail Cost of Moving a rail car of Wheat and Canola Meal from Yorkton to Vancouver, January 1998

	Wheat	Canola Meal
Rail Car Capacity (tons)	90	65
Statutory Rate ($/ton)	42.00	42.00
Rail Freight per rail car	3,780.00	2,730.00
Delivered Price/Ton ($S)	175.00	211.00
Deliver Value/Car ($)	15,750.00	13,715.00
Freight Charge as % Delivered Value	**24.00%**	**19.90%**

The statutory rail freight rate therefore creates an economic incentive against wheat movements when the rail freight charges for wheat account for 24.00% of the delivered value and only 19.90% of the canola meal movement.

Maximum Freight Rates, Investment, New Technology

Equilibrium in the free market occurs when the quantity demanded equals the quantity supplied.

Maximum freight rates form a price cap that hold prices at some disequilibrium value that would not be maintained in the absence of the regulation. Some controls hold the market price below its equilibrium value. This creates a shortage, with quantity demanded exceeding quantity supplied at the controlled price. Other controls hold price above equilibrium. This creates a surplus, with quantity supplied exceeding quantity demanded at the controlled price.

This is the situation of the western GHTS. Statutory freight rates leave some parts of the rail system with costs that are well above the cost of service provision. Other more efficient locations operate below the cost of the statutory freight rate. In both cases there will be a misallocation of resources. The effects of price ceilings are shown below which establishes the following conclusions:

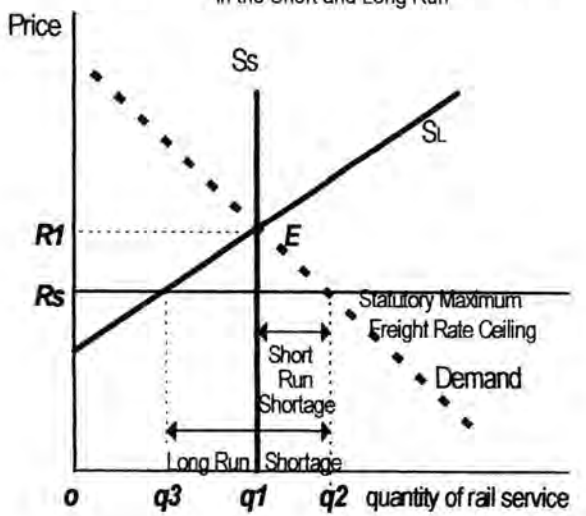
1. There will be a shortage in the supply of transportation in the sense that quantity demanded will exceed the quantity supplied. This has been the case in the supply of railway country collection services on branch lines where the statutory price is well below the cost of supply.

2. The quantity of rail transport services will be less than if free market prices had been charged.

The shortage created by the price ceiling will lead to alternative allocation schemes. This has involved the physical allocation procedures of the Canadian Wheat Board.

Price ceilings fail in markets where there is a long term increase in demand for rail services. This has been the case for Prairie bulk rail exports that have increased steadily. When statutory rates are imposed in the face of long term increases in demand for rail services, they prevent railways from earning short run profits and also limit the investment in new capacity, rolling stock, line infrastructure and technology that provide operating and system efficiency gains. Capacity constraints have been a perennial problem of the grain handling and transportation export delivery system

Effects of Price Ceilings or Statutory Maximum Freight Rates in the Short and Long Run



Statutory maximum freight rate price ceilings cause shortages that worsen over time. The statutory rate of Rs sets prices below the free market equilibrium value of R1 where the market is in equilibrium at E. The short run supply of transportation is shown by the inelastic curve Ss. Thus in the short run the quantity of rail services supplied remains at q1. The extra demand of q2 leads to a shortage of q1q2.

Over time, the quantity supplied falls, as shown by the long term supply curve SL In the long run there are only q3 units of rail supply provided and fewer than when controls were established. *The grain rail supply shortage of q3q2 after the long term adjustment is larger than the initial shortage of q1q2.*

Historically, shortages in the supply of capital to finance railway expansion has been addressed by the federal government with tax dollars for branch line construction, rail car purchases or twin track and tunnel construction in the Rocky Mountains. The lack of private sector funding for these activities is a direct result of the lack of market returns and profits on grain transportation. While rail costs may be aggravated by regulatory and other system inefficiencies described previously, it is ultimately the statutory maximum freight rate that forms a price ceiling on the rail market for grain transportation that limits investment.

Canadian Wheat Board (CWB) Act

CWB involvement in the single desk marketing of wheat has recently been the subject of extensive public discussion and debate. However, the Board's direct involvement in the logistics of grain handling and transportation is less well known and understood.

In 1997, one quarter of western grain farmers believed the CWB to be involved and to regulate all parts of the grain handling system. Thirty four percent believed the Board had no or very limited involvement in transportation.

Part II of the CWB Act provides *"Control over Elevators and Railways"*. Other sections of the Act provide for the Board to co-ordinate and regulate all grain movement from farm to export position.[vii]

Selected CWB Statutory Involvement in Western Grain Handling and Transportation

CWB Involvement in Country Collection:
- Timing, quantity, and quality of farmer deliveries to elevators with permit books and contract calls;
- Deferred Delivery of grain to elevators;
- Allocation of railway cars to branch lines.

CWB Involvement in Country Handling:
- Operation of elevator facilities;
- Receipt and release of grain from elevators;
- Quantity and quality of grain stored in country elevators.

CWB Involvement in Rail Movement:
- Allocation of railway cars;
- Specification of collection and delivery points;
- freight rate adjustments.

CWB Involvement in Terminal Handling:
- Operation of terminal facilities;
- Receipt and release of grain from terminals;
- Quantity and quality of grain stored in terminals;
- Allocation of grain between terminals;
- Terminal freight adjustments.

CWB Involvement in Port Services:
- Coordination of the arrival of ocean vessels;
- Selection of port of departure;
- West Coast grain coordination.

Source: CWB Act and Policies

It is a system that has been in place for decades and has seen little change until very recently. The CWB regulations introduce a barrier between market pricing of transportation services and the economic allocation of resources. The Act provides for regulatory distortions and inefficiencies in the movement of grain.

Efficiency in grain handling is achieved when there is no other way in which grain can be moved from farm to port at a lower cost. In practice this requires a large amount of economic coordination between all of the transportation services involved in moving grain. Commercial markets achieve this through market pricing.

Physical Resource Allocation

CWB regulation introduces physical restrictions into the movement of grain that over ride normal market allocation procedures. The Board physically intervenes in the system when it defines delivery times and locations for farmers to bring the grain to the elevator, when it allocates railway cars, and when it assigns grains to grain terminals based on historic delivery patterns. These interventions increase the difficulty of achieving economies of scale that have lowered the cost of grain movement in many other countries.

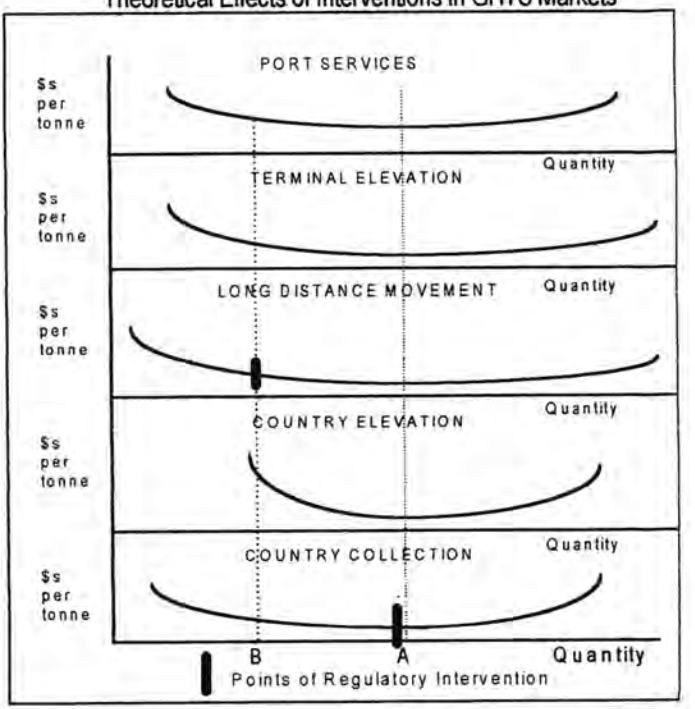
Conceptually the problem can be described as a series of nested cost curves for each of the transportation services. When all transportation services are operating at their lowest cost, the total costs for the whole grain handling system is minimized. This is point A in Figure 1 on the next page.

When the CWB calls grain into the system or allocates rail cars it is physically allocating resources. If these allocations vary from the lowest cost position (point B in the diagram), they extend the decision in one sector forwards and backwards throughout the system.

In commercial markets, pricing between transportation services at different stages of a transportation system will provide a means to allocate resources and achieve optimal system efficiency.

In practice, higher prices ration use and encourage more investment to increase capacity and to reduce costs. Lower prices attract increased volumes to reduce costs and to balance flow throughs in the vertically integrated market. For example, car allocation and management is central to service competition and the efficiency of CN operations. Procedures for car allocation on western grains is based on past shipping practices, reflecting old technologies and past geographies of supply that incorporate CWB equity requirements into delivery principles.

Figure 1.
Theoretical Effects of Interventions in GHTS Markets



The rules of allocation ignore emerging technologies, efficiencies of scale and new cropping patterns. This effectively slows the rate of change in adopting best practices. In 1997 only 15% of CN grain was shipped at multiple car incentive rates, in contrast to the 72% of North Dakota grain shipped in large car lots of 25 cars or more. Montana is moving towards 100 car loading spots at all locations.

Rail Car Allocation and Logistics Management

Procedures for car allocation on western grains is based on past shipping practices, reflecting old technologies and past geographies of supply that incorporate CWB equity in delivery principles. The rules of allocation ignore emerging technologies, efficiencies of scale and new cropping patterns. This effectively slows the rate of change in adopting best practices. In 1995 only 25% of CN grain was loaded at multiple car locations, partly as a result of car allocation practices. Investors in new

system capacity in both rail and handling facilities are put at risk when car allocation and other policies do not allow them full use of their assets. This was the case with a number of early Prairie inland grain terminals where it took years before their car allocations reflected the size and efficiency of their operations.

Rail car allocation in western Canada has been distorted to provide priority for CWB grains at the expense of other grains. An industry/CWB committee CAPG[viii] has been created to allocate cars following state guidelines. Unlike the commercial car allocation systems railways use for other commodities and for grains in the United States, the CAPG process lacks accountability and choice, limits railway competition and involves seven separate mechanisms for allocation. Further problems exist in:[ix]

- planning horizons for both shippers and carriers which are far too short to allow any operational or capacity adjustments to changing demand or to manage risk,
- car allocation goals related to historic allocations and equity rather than transportation efficiency,
- limited use of multiple car loading, even where capacity exists risking returns to new capital investment, and
- no provision is made for car delivery or loading guarantees, car demurrage or, priority service pricing.

The car allocation system works on the basis of the historic *command and control* transportation system. Existing rules and procedures cannot provide for any level of service differentiation, even for those farmers willing to pay premium prices for premium services where, for example, current market prices might more than justify an increased freight rate. The car allocation policies extend the regulated effects of the CWB grain economy throughout the western agricultural export economy and distort production, transportation and marketing efficiency.

Competition and Accountability

The regulatory measures of the CTA and the CWB were initially introduced to protect farmers from predatory pricing by grain companies and railways. Today many conditions have changed. There is aggressive head to head competition between railways and grain companies, ports are being privatized and terminal elevator facilities compete for non-Board grains. Increased trucking provides most farmers with the ability to choose between different elevators and railways. The regulatory structure of grain handling, however, has not adjusted to these new market realities and has the effect of extending the Board monopoly throughout the rest of the system. Statutory freight rates limit areas of service competition that have brought large efficiency gains to the United States.

There are many forms of service competition that have made major contributions to efficiency gains for other commodities in Canada and for grain movements in the United States. These include such items as car supply, forward ordering, incentives for high efficiency locations and delivery guarantees. Service competition through effective grain car allocation procedures have been in place in the US since 1987 with the introduction of Burlington Northern's Certificate of Transport (COTs) program. COTs provide for forward guarantees to grain shippers using a bidding mechanism. Shipper prepayments serve as cancellation penalties and discourage phantom orders. Other major US railroads also introduced similar programs. In the 1990s longer term guaranteed freight programs were introduced to allow grain companies to enter into binding contractual relations with railways on the basis of guaranteed trips. Such programs have involved cancellation penalties for both shippers and carriers. Together these instruments increased shipper options, improved integration between transportation and marketing and increased system efficiency.[x]

The GHTS does not have an infrastructure of normal commercial accountability. The regulated structure of the industry has meant that grain is moved through a series of general agreements and understandings enforced through the CWB Act, regulations and policy. Such agreements are reflected in the CWB/farmer contract call procedures, CWB/grain company agency agreements, the car allocation policy and other instruments of resource allocation, management and financing. These differ from normal commercial contracts in the following respects:

There is no direct agreement between farmers and handlers, or between shippers and carriers. Rather the CWB acts as third party between farmers and carriers on the basis of general, rather than specific movement guidelines. This situation differs from other jurisdictions and commodities. For example, the Interstate Commerce Commission in the United States in evaluating its regulatory regime over railway regulation in 1992 noted: *"The rail rate contracting authority is a cornerstone of the modern rail economic regulatory scheme. It is generally hailed as significantly benefiting both railroads and contracting shippers, by providing for longer-term traffic commitments, greater price stability, and individual tailoring of rail services and prices. It allows the parties to lock in predictable prices and services, and helps railroads to manage their cash flow. Therefore, we recommend that it be retained."*

The Western Canadian Wheat Growers commented on this situation stating: "*Full accountability is created by the sales contract. If it is met, the company is rewarded, and if it is not, the company is in breach of*

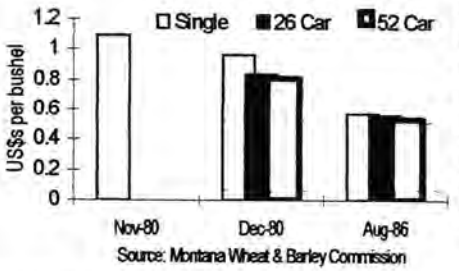
contract with corresponding penalties...In contrast, none of these disciplines is present in Board grains. For Board grains, delivery, storage and shipping largely rely on "command and control" mechanisms administered by the Canadian Wheat Board." [xi]

Regulating for Price and Service Competition

The regulatory structure for all rail commodities changed with the passage of the Canada Transportation Act. Principles of competition and market pricing were applied to all Canadian commodities, except grain. Similarly, nearly thirty years ago the US rail system was deregulated with the objective of increasing efficiency. The results were impressive, with real railway rates for grain falling by as much as 40%, even in monopoly markets like Montana.

A key feature of the US reforms was the introduction of a new regulatory standard that involved only intervention in exceptional cases and on a new definition of market dominance that involved inter-modal, inter-market and inter product competition. Grain prices were set in the market place and only to be administered on an exceptional basis. This test focused on the economic realities that competition comes in many forms and has the capacity to transform markets and that prices must be set by both supply and demand.[xii]

In spite of recent problems with US rail systems, the results of deregulation were spectacular. In Montana, normally assumed to be a captive shipper state with one railway, investment increased, service competition was introduced and as a result productivity increased. The benefits were shared with shippers in real railway rates between 1980 and 1996 that fell by nearly one half for the 26 car multiple unit rate and by 52% for the 52 car rate.



Significantly, the efficiency gains were created by investment and system adjustment. While 133 single and multiple car loading points closed, 125 new state of the art inland terminals and multiple and single car loading points were added to the system. Access in 1996 was comparable to the level in November 1980, prior to deregulation.

Conclusions

Regulations in grain handling and transportation introduce significant barriers to achieving improved efficiency in the grain handling and transportation system. Many technological and logistics innovations that may be feasible cannot be fully implemented within the existing regulatory framework. It will be just as important to assess the full effects of these regulatory interventions as to develop new technologies and information systems for new logistics management.

Commercial markets work well to allocate resources, finance technology and investment and to create competition and efficiency. This long standing economic concept works well for most commodities moved in the Canadian economy and for grain in most parts of the world. Canada's regulatory system does not meet the needs of a modern, internationally competitive grain economy. Command and control resource management by the state may have been required at an earlier time. Today conditions have changed. Most prairie farmers live within reasonable trucking distance of two railways. Following removal of the Crow subsidy, food processing demands for grain are creating large domestic demands for both feed grains and for processing. Expanded access to US ports and their transportation and handling system provide the opportunity for increased market competition.

Yet, today, the regulatory structure for grain limits competition, and extends monopoly power. Fundamental reform of the regulatory system for grain in Canada is an essential pre-requisite if the opportunities for efficiency gain with investment and technology are to be realized.

Canada has two clear options in considering increased efficiency in grain handling. These are further modification of the existing administered system of grain handling. It is the approach that has brought a century of commissions of inquiry and continuing inefficiencies, lack of investment and capacity constraints. The cost to the taxpayers of continued public investment in grain has been high. Further modifications of the system are unlikely to bring beneficial results.

Alternatively, Canada can finish the work of the CTA in which regulatory reform can establish the framework for a fully commercial grain handling and transportation system. At the heart of the transformation will be an assessment of the continuing need for the CTA and the CWB to be involved in the day to day management of grain handling and transportation. A decision for reform will also provide the framework for many of the technical solutions for system efficiency that engineers and others have on their drawing boards. Clearly, however, it will be political

decisions on regulatory decisions that will determine whether these new engineering technologies can, in reality, enter into the marketplace.

Endnotes

[i] Lipsey, R., Purvis, D, and Steiner, P., Microeconomics, Seventh Edition, Harper Collins, 1993.p.202.

[ii] CWB Annual Reports, 1990/91 - 1995/96, Winnipeg

[iii] ATKearney, Saskatchewan Highways and Transportation, Grain Logistics Strategy, September 30, 1994.

[iv] see for example, ATKearney, op.cit.; IBI Group, "Alberta Agriculture, Grain System Efficiency (1994); and Railway Financial Viability, The Challenge of Becoming More Competitive (1992 and 1994); KPMG, & Sandwell Inc., Rapid Grain Flow, Transforming Grain Logistics (1995); University of Manitoba Transport Institute, International Competitiveness of Western Canadian Transportation (1994); Collin Carter & R.M.A. Lyons, Single Desk Selling Of Western Canadian Grain, (1996); Federal/Provincial Ministerial Issues, Transportation Efficiencies, Final Report, (1997); Just In Time Committee, Report of the JIT Committee, (1995); Western Canadian Wheat Growers Association, Second Submission of Arguments in Respect to the CWB Application (1997)Car Allocation Policy Group, A Framework for Grain Car Allocation Regulated Corridors, (1997).

[v] World Bank, Regulatory Reform in Transport, Washington, 1993.

[vi] Kessides, 1993 in Willig, R.D., Restructuring Regulation of the Rail Industry for the Public Interest, World Bank, Washington, 1995.

[vii] Canadian Wheat Board Act, Ottawa.

[viii] Car Allocation Policy Group (CAPG), A Framework for Grain Car Allocation Regulated Corridors,1997.

[ix] CAPG "A Framework for Grain Car Allocation in Regulated Corridors, A Discussion Paper for the Technical Committee of the Western Canadian Grain Industry Car Allocation Policy Group, Feb, 1997.

[x] Priewe, S., and Wilson, W., "Forward Shipping Options for Grain by Rail" Agricultural Economics Report No 372-S, 1997.

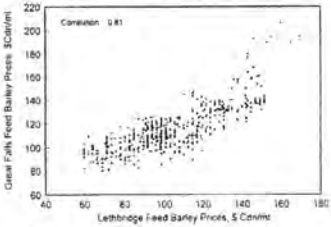
[xi] Western Canadian Wheat Growers, Second Submission of Arguments in Respect to the CWB Application, 1997.

[xii] Interstate Commerce Commission, Regulations, Washington, 1992.

dependable estimate of the level of CWB prices to expect. Without a reasonable price forecast, the relative prices which are essential to economic decision making are not available. A senior CWB official has argued that this decision making process is made worse if producers try to assess CWB prices by comparison with U.S. spot prices (Brooks, 1994). Faith in how well the CWB may sell grain is one matter. Making production decisions in an environment in which part of the information required to determine price relatives is simply not available represents a fundamental economic problem. Resource allocation problems must necessarily follow. To illustrate the fact that grain price signals are poor in western Canada, we provide a set of four figures below (Figures 7.8-7.11). The first figure compares barley price movements between Lethbridge and Great Falls, while Figure 7.9 compares price movements in the Great Falls and Portland markets. What these graphs show is that the Canadian-U.S. market is poorly arbitraged. The same message comes through in Figures 7.10 and 7.11 for wheat. Figure 7.10 is an example of a well arbitraged market and Figure 7.11 is an example of a poorly arbitraged

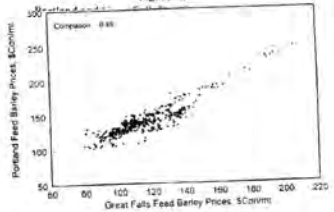
Some inputs are underutilized in Saskatchewan relative to Alberta and Manitoba.

Figure 7.8
Great Falls and Lethbridge Feed Barley Prices, 1985-95.



Source: Alberta Agriculture

Figure 7.9



Source: Alberta Agriculture

Volumes of Pulse/Special Crops Exports and Transportation Methods from Western Canada: 1996/97

Jake Kosior, Dr. Barry E. Prentice, Transport Institute University of Manitoba, and Doug E. Campbell, Campbell and Associates

Introduction

Information on the transport of pulse/special crops has been very limited. Aside from aggregate export data, published information is unavailable on the method of transport used to move these crops from origin to destination. Primary data collection was undertaken by the Transport Institute to ascertain the volumes and methods of moving products to export position for the 1996 crop year.

A survey of 33 pulse/special crop exporters was developed with the assistance of the Canadian Special Crops Association, Saskatchewan Pulse Growers, Pulse Canada and other industry associations. A telephone interview and faxed questionnaire were extended to each company. In total, 20 companies cooperated fully. Most of the 13 companies that refused to cooperate are minor players. Based on comparison with 1996 crop year export figures, the survey captured approximately 81 percent of all movements.

Prairie Outflow by Equipment Type and Port Destination

Exporters were asked to indicate the method of shipment and the port of clearance for edible and feed crops. The survey data are presented for the combined Prairies in Table 1. The aggregate volumes of Western Canadian pulse/special crops exports are displayed by mode of inland transport and port of exit. Edible crop exports are presented in the top half of the tables,

and feed exports are arranged in the bottom half. Only three western ports, Vancouver, Prince Rupert and the U.S. Pacific Northwest (PNW), and three eastern ports, Montreal, Thunder Bay and Halifax, were recorded as having export clearances.

The eastern and western ports are almost balanced in aggregate. The eastern ports account for slightly more exports of edible crops, while the western ports have a greater share of feed exports.
Inland transport of pulse/special crops varies significantly by commodity and shipping method. Feed crops are moved almost exclusively in bulk with roughly 80 percent of feed shipments moved in hopper cars. Edible crops rely more on boxcars and domestic intermodal (containers and trailers on flatcars). About two thirds of edible crops are shipped in sacks or bags. Boxcars are most important for packaged product movements to the western ports, while domestic intermodal is more important for eastern shipments. Hopper cars are important for export of certain edible crops, such as yellow peas, which are moved in bulk.

Marine containers account for a relatively small proportion of inland movements. The majority of edible crop exports are transloaded to marine containers at the ports. Marine containers source-loaded (MSL) on the Prairies represent less than ten percent of total inland transport of edible crops. Movements of source-loaded marine containers to eastern ports are four times greater than to western ports.

Truck movements of pulse/special crops are generally limited to edible crops. The eastbound volumes are more than double those shipped to western ports. Although the distance to the western ports is shorter, these shippers face "front haul" rates, and the carriers have difficulty finding return loads from the western ports. In contrast, the shipments to eastern ports enjoy lower "backhaul" freight rates. Truck movements are a minor component of the total, but illustrate the efforts of the industry to find every available means of transporting these products to port positions.

Table 1 Exports by Mode of Inland Transport of Inland Transport and Port of Exit, Tonnes

	Western Ports			Eastern Ports		
Mode	Vancouver	Prince Rupert	U.S. PNW	Montreal	Thunder Bay	Halifax
EDIBLE						
Intermodal (MT)	7,115	0	0	132,100	280	1,164
Marine Containers (MT)	8,454	0	44	35,789	0	291
Tractor-trailers (MT)	2,098	0	19	5,502	0	0
Boxcars (MT)	92,303	5,724	748	50,622	1,416	1,164
Hopper Cars (MT)	84,792	11,727	0	24,071	22,581	0
Total Edible	194,762	17,451	811	248,084	24,277	2,619
FEED						
Intermodal (MT)	0	0	0	0	0	0
Marine Containers (MT)	362	0	0	0	0	0

Table 1 Exports by Mode of Inland Transport of Inland Transport and Port of Exit, Tonnes

	Western Ports			Eastern Ports		
Tractor-trailers (MT)	0	0	0	0	48	0
Boxcars (MT)	49,996	0	0	24,990	0	0
Hopper Cars (MT)	407,763	0	0	11,257	265,887	0
Total Feed	458,121	0	0	36,247	265,935	0
Grand Totals	**652,883**	**17,451**	**811**	**284,331**	**290,212**	**2,619**

Freight rate and service options vary with location and availability of equipment. Incentives to export through alternative ports are reflected in the commodity flow patterns of each province. Montreal dominates eastern port exports of edible pulse/special crops, while Thunder Bay accounts for an equal volume of feed exports. Domestic intermodal, which includes trailer-on-flatcar ("piggy-back"), is the dominant method of moving edible crops. The disproportionate share of Montreal reflects favourable freight rates granted to reposition this equipment.

The domestic market and exports to the United States must be added to the port data to complete the picture of Western Canada's pulse/special crops industry. Figure 1 illustrates the flows of edible pulse/special crops from the Prairie provinces to the end markets. Total shipments to the domestic market (59,396 tonnes) are about equal to exports to the U.S. (62,721 tonnes). As a result, overseas markets receive approximately 80 percent of production with the other 20 percent consumed in North America.

Figure 1 Edible Pulse/Special Crop Directional Flow: 1996/97 Crop Year

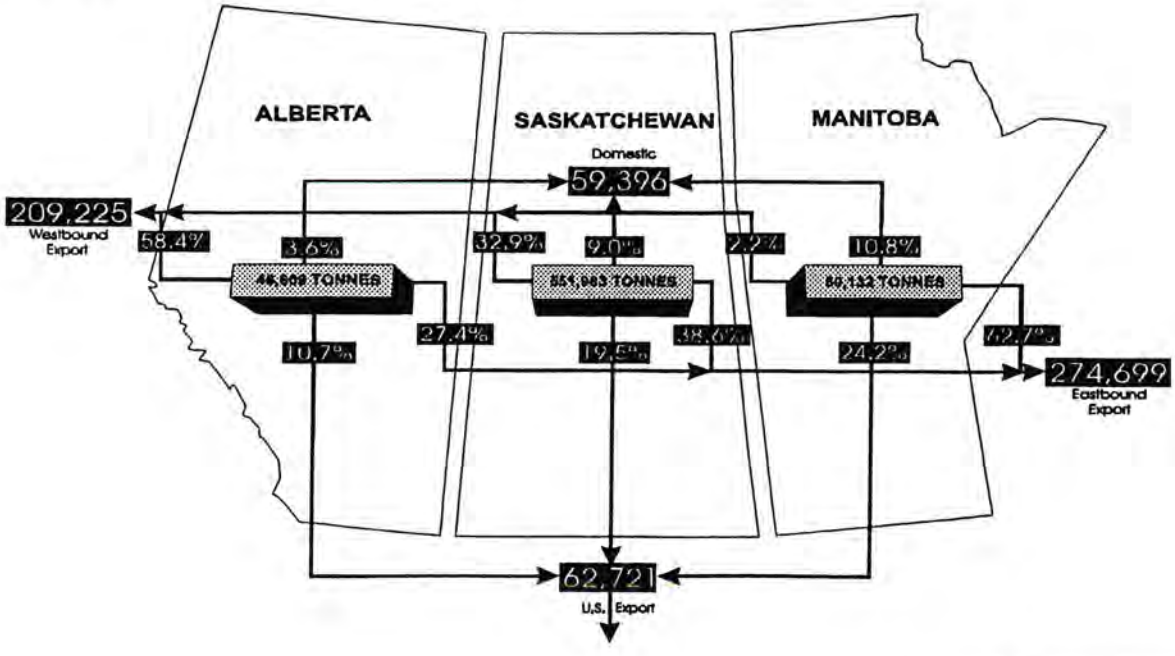
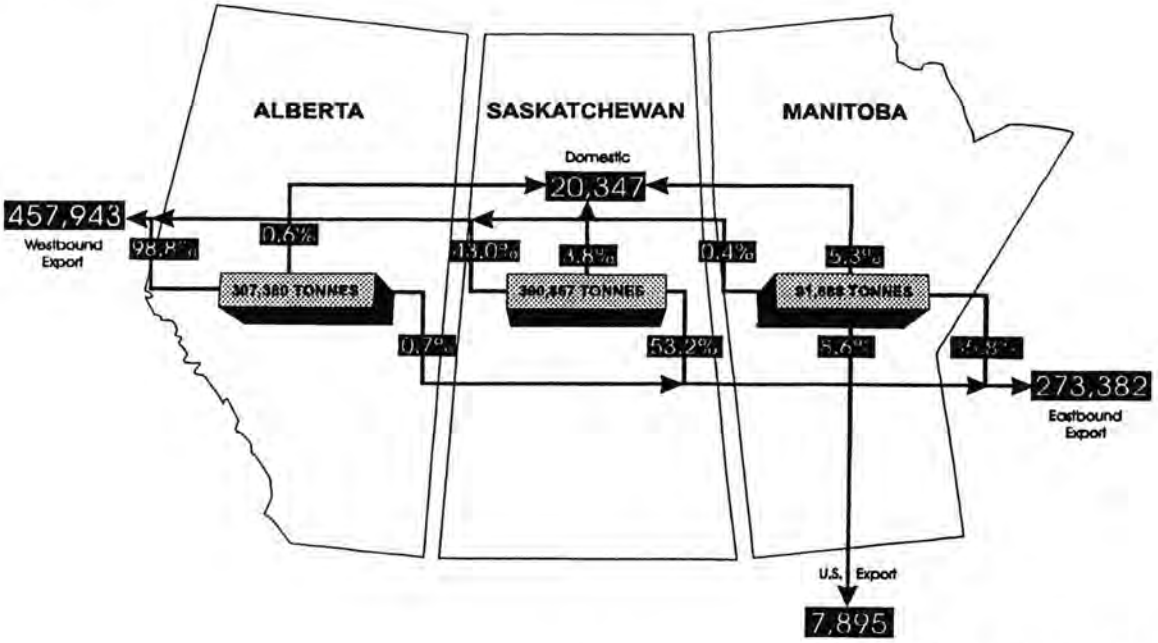


Figure 2 Feed Pulse/Special Crops Directional Flow: 1996/97 Crop Year



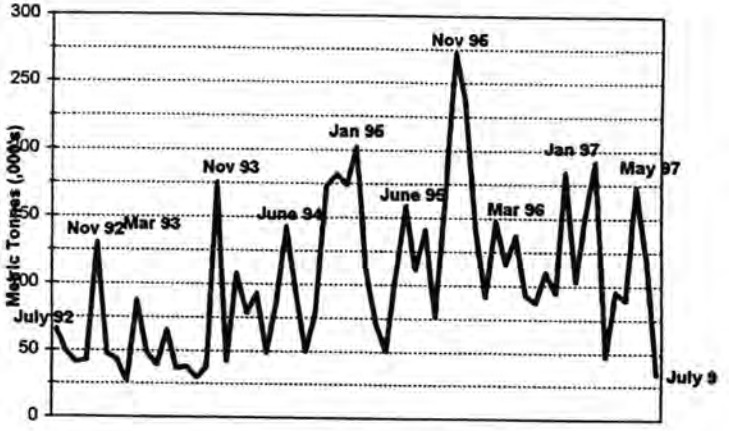
Saskatchewan accounts for four times the volume of Alberta and Manitoba combined. The shipments from Saskatchewan are evenly balanced east and west, with the domestic market accounting for 9 percent of shipments and the U.S. market representing 19.5 percent of shipments. The shipments from the other provinces have been discussed previously.

Figure 2 presents the shipments of feed pulse/special crops from Western Canada. Overseas markets consume a greater proportion of pulse/special crop feed than edible exports. Feed shipments to North American markets account for less than 4 percent of total production. This can be explained by the abundance of feed supplies in the U.S. and Canada, but may change as the hog industry of Western Canada expands. Feed peas are now being used to replace part of the imported soybean meal in hog rations on the Prairies.

Seasonality of Marketing Patterns

Figure 3 shows Canadian pulse/special crop export volumes from July 1992 to July 1997. Over the past five years pulse and special crop exports have risen steadily with increasing production. The reason for the decline in the past eight months has not been established, but it coincides with the shipping problems experienced during the severe winter of 1997.

Figure 1 Pulse/Special Crop Exports By Month July 1992 to July 1997



A seasonality peak occurs between October and January each year. Several reasons can be advanced to explain the peak: 1) farmers want cash immediately after harvest to pay their bills; 2) European demand for soups and stews increases in the winter months; 3) a premium is available to the fresher product; 4) processors use this period to pack products; and 5) this season coincides with the Arab world celebration of Ramadan. A second, less pronounced, peak occurs from mid to late spring (May to June), with the opening of navigation on the Seaway. The annual seasonality based on the average of the past five years is presented in Figure 4. The largest single month for pulse and special crop exports is November with 14.5 percent of total shipments over a five year average. December and January account for 10 and 11 percent of shipments. For edible and feed markets

combined, nearly 45 percent of annual production is exported during the period from October to January.

Seasonality and product requirements influence the demand for transportation equipment. Figure 5 presents the demand for equipment by type during the 1996/97 crop year for edible shipments. The demand for boxcars, hopper cars, and intermodal equipment capacity is evenly distributed during the peak period of October to January. Marine source load and tractor-trailer shipments account for lesser proportions of shipments, but remain a vital element in the movement of pulse/special crops.

Figure 2 Pulse/Special Crop Export Seasonality Crop Years 1992 to 1997

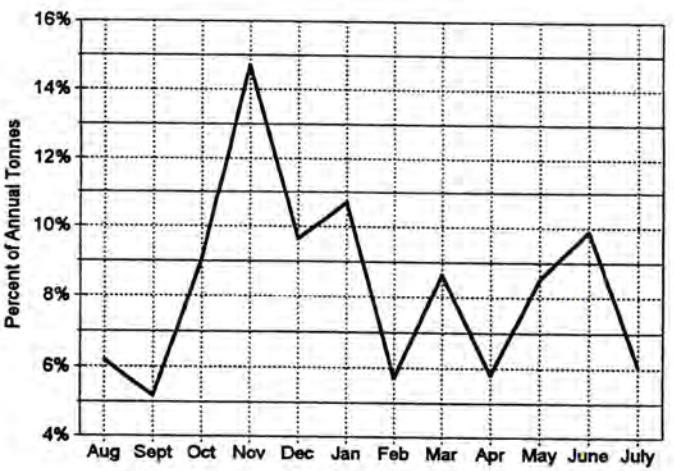
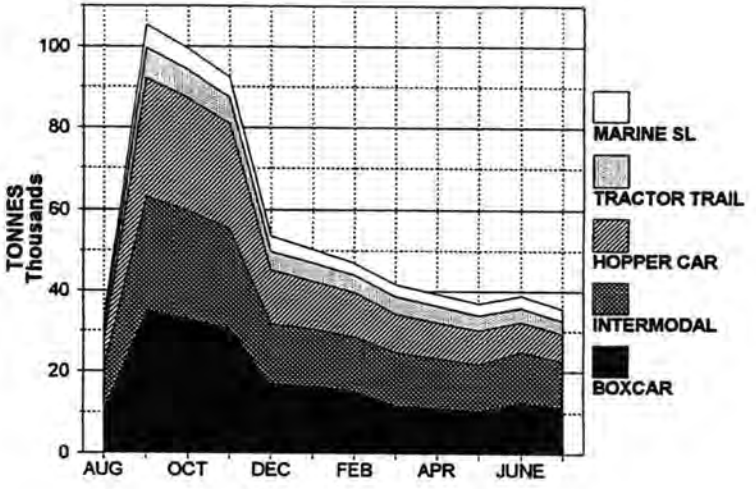


Figure 6 shows the demand for equipment for feed exports. Hopper cars are overwhelmingly the choice for this market sector, with approximately 90 percent of shipments by this mode. Boxcar, intermodal, and tractor-trailer account for the remaining 10 percent.

At the present time, intermodal containers account for a minor share on inland transportation, but this is likely to change. In 1997 the railway movement of containers in Canada increased by 11 percent. The Canadian railways are making significant investments in locomotives and terminal to

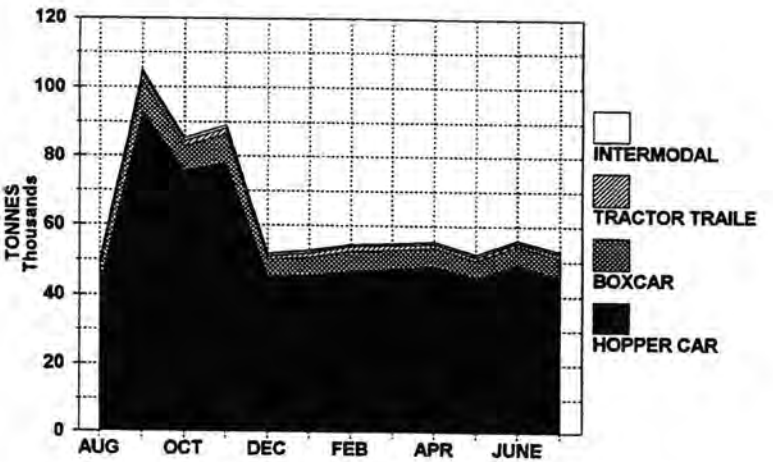
Figure 3 Edible Pulse/Special Crop Shipments by Month and Equipment Type, 1996/97



keep up with this growth. The opening of Delta Port in the summer of 1997 and the introduction of the post Panamax generation of 6,500 TEU

container ships promise to expand the availability and lower the costs of marine containers.

Figure 4 Feed Pulse/Special Crop Shipments by Month and Equipment Type, 1996/97



Conclusions

The exporters survey data show that exporters use a greater variety of equipment to move edible as opposed to feed crops. The largest share of edible crops is packaged on the prairies and shipped on pallets to the ports where they are stuffed into marine containers. Feed exports are moved predominately in bulk using hopper cars.

The pulse/special crop survey data illustrate an important principle of

logistics: A mixed system generally performs better than a pure system. It can be observed that two separate markets exist whose peak shipping periods generally coincide. The greater seasonal demand for equipment in the four months immediately following harvest stretches the ability of the system to perform. By using a variety of transporation modes, pulse/special crops exporters increase the likelihood of reliable service.

Emerging Trends in Western Canadian Grain Transportation

Dr. Barry E. Prentice, Transport Institute University of Manitoba

Introduction

The equipment for handling and shipping grain in bulk has become larger. Covered hopper cars have replaced boxcars, high throughput elevators have replaced small wooden elevators, and tractor-trailers have replaced tandum trucks for farm deliveries. The two aspects of the grain industry that have not improved are the system's reputation for reliability and the harmony of commercial relationships within the supply chain. The transportation experience of the 1996/97 crop year is evidence of the unresolved transportation problem. The current CWB/railways case before the Canadian Transportation Agency epitomizes the level of discord.

Technical change, customer service demands and government policy are forcing the grain industry to come to grips with some long-standing transportation issues. Deregulation, subsidy cuts and privatization have altered the competitive environment, while the real costs of transportation are causing the supply chain to re-engineer its marketing functions. When these structural changes are complete, the logistical system for handling grain in Western Canada will operate much differently than today.

This paper examines the future of exporting grain from Western Canada. The first section addresses the macroeconomic policy changes that are restructuring the agricultural economy of the prairies, and the resulting transition of the supply chain. This is followed by a description of technological changes that will affect the logistics of grain marketing. In the final section, some predictions are made regarding the logistics of exporting grain in the year 2010.

Macroeconomic Policy Changes and Emerging Trends

User-pay provision of services and privatization have characterized the first term of the government. In 1993, the Government of Canada provided over $650 million in direct subsidies for grain transportation, and as much as $350 million of indirect support through infrastructure and services. While some subsidies remain, like the free use of government-owned covered hopper cars, almost $1 billion of cost have been shifted to the private sector.

User-pay policies have been bolstered by the commercialization of infrastructure and privatization of crown corporations. Commercialization removes financial obligations from government for capital and transfers responsibility for operations to the private sector. Creation of the Hudson Bay Railway and transfer of the Port of Churchill to Omni TRAX embodies elements of commercialization, privatization and user-pay policies. Privatization of CN Rail has been accompanied by a quid pro quo to free the management of the railways from burdensome economic regulation. Under the *CTA (1995)*, the railways can accelerate the conveyance or abandonment of branchlines they no longer wish to operate.

Besides cuts in transport subsidies, farm income subsidies have been eliminated. The most significant program cut is GRIP that had annual pay outs of $1 billion at the beginning of the 1990s. Termination of direct and indirect subsidies to agriculture in Western Canada has been offset to some degree by reductions in subsidies internationally and higher commodity prices in 1996/97. As the 1997/98 crop year progresses, the real financial impacts of ending subsidies and economic deregulation are likely to become more apparent.

Commercial enterprises rely on price signals to decide when to expand or contract operations. Economic regulation, subsidies and state-ownership drown out price signals and distort incentives. Changes that would have occurred gradually over 40 or 50 years, are going to be completed within a single decade. Times of rapid change expose the industry to the danger of overreaction. However, unleashing market forces creates opportunities for new logistical approaches to the export of grain.

Rationalization of the Bulk Handling System

The primary elevator system in Western Canada has been contracting slowly for more than three decades. Recent trends in primary elevator numbers are presented in Table 1. Since the 1988/89 crop year, the number of elevators declined from 1,717 to 1,153. Meanwhile, average elevator capacity increased from 4,301 tonnes to 5,728 tonnes (A&AC, 1997). The average size varies by grain company: Manitoba Pool Elevators has the greatest proportion of small elevators (4,202 tonnes), and Parrish and Heimbecker has the largest average elevator size (8,881 tonnes).

Table 1 Western Canada: Licensed Primary Grain Elevators

	August 1, 1987			August 1, 1997		
Primary Elevator Line Company	No. of Elevators	Storage Capacity	Average Capacity	No. of Elevators	Storage Capacity	Average Capacity
Alberta Wheat Pool	305	1,580,990	5,184	179	1,018,190	5,688
Cargill	119	460,090	3,866	66	521,300	7,898
Manitoba Pool Elevators	155	582,060	3,755	120	504,260	4,202
Parrish & Heimbecker	43	262,910	6,114	27	239,780	8,881
Patterson & Sons	55	225,520	4,100	47	208,510	4,436
Pioneer Grain Company	220	938,400	4,265	135	674,660	4,997
Saskatchewan Wheat Pool	531	2,059,440	3,878	374	1,717,970	4,594
United Grain Growers	321	1,258,380	3,920	170	931,760	5,481
Others	21	244,660	11,650	35	788,260	14,975

	August 1, 1987		August 1, 1997			
Total	1,770	7,612,450	4,301	1,153	6,604,690	5,728

Source: A&AC *Biweekly Bulletin*

Horizontal competition is increasing in grain handling because of farmer/community investment and the entrance of multinational grain companies. The "others" category consists of independents, like the Weyburn Terminal, and large international firms that have invested in primary elevators. In addition to Cargill, which has a history of country operations in Western Canada, three high throughput elevators have been constructed by Conagra, and Dreyfus is rumoured to be contemplating such a move. Another U.S. grain company, ADM has recently taken a large equity position in United Grain Growers.

Details of elevator numbers and capacity for different size categories are presented in Table 2. In each province, the bulk of capacity and a significant proportion of the number of elevators are in the zero to 5,000 tonne size category. However, the concentration of capacity in elevators with greater than 15,000 tonne capacity is significant, especially given how few elevators there are. This is especially true in Saskatchewan, where 16 elevators account for 19 percent of total capacity. These numbers reflect the changes that high throughput elevators are having on the primary elevator system.

Table 2 Concentration of Primary Elevator Capacity by Size Category, 1996/97

SIZE (tonnes)	Manitoba *Count*	Saskatchewan *Count*	Alberta *Count*	Western Canada *Count*	Western Canada *% of Total Capacity*
0-5000	157	415	179	752	41.27%
5000-7500	48	150	77	276	25.49%
7500-10000	7	30	36	75	10.02%
10000-15000	3	16	16	36	6.94%
>15000	5	16	9	30	16.28%

Total Number	220	627	317	1170	6,411,176*

*Total capacity in tonnes.

Although the number of elevators has declined, the average size is still small. It does not take great courage to predict that any elevator with storage capacity of less than 7,500 tonnes is living on borrowed time. Even at five turns per year, the largest of these elevators would only load 375 hopper cars annually. Economics cannot justify the employment of one or more grain handlers to load one car per day.

Manitoba Pool Elevators (MPE) is experimenting with a "hub and spoke" system to integrate its wooden elevators (spokes) with its larger concrete facilities. This may succeed if MPE can bundle other services effectively, like farm inputs and custom applications with grain handling at its spokes. In any case, elevator points are becoming more strategic in the delivery of inputs because margins on these products are higher than for grain handling.

Although efforts to retain small elevators may be successful in some cases, most are likely to close. The loss of local elevators will have a significant impact on the average distance from farms to delivery points.

Growth of Agricultural Trucking

Commercial agricultural trucking has been growing for several years. Large farms are relying increasingly on hopper bottom tractor-trailers. Many medium-sized farm operations have purchased grain trailers to earn extra income (Prentice, Kosior and McLeod, 1996). Grain trucking is certain to increase with the end of subsidized rail freight rates, and the abandonment/conveyance of grain dependent rail branch lines.

Restructuring of the handling system is increasing the pressure for longer truck hauls. The large concrete silos that are replacing small wooden elevators are designed to receive tractor-trailers. High throughput elevators can qualify for volume discounts of $3 per tonne by loading 100 car unit trains. Once a tractor-trailer is loaded, the freight charge is less than $1 per additional kilometer. Assuming a load of 20 tonnes, the rail freight discount at the large

elevators could permit elevator operators to draw grain from a 30 to 60-kilometer radius in competition with small elevators.

High throughput elevators and commercial truck hauling have a symbiotic relationship. High throughput elevators need the large trucks to supply sufficient grain to achieve economies of size, and commercial trucking grows more competitive with farmer-owned tandem trucks as the length of haul increases.

Restructuring the Rail System

Changes in the rail systems are being delayed by the pending review of grain transportation in 1999. Rail freight rates for grain are subject to a "rate cap" until the Year 2000. Currently, the rail rates are still based on the WGTA costing, but without the benefit of the subsidy. Following the review, a change may be permitted, but the maximum rate scale for "export grain" could also be extended.

Under the provisions of the *Canada Transportation Act* passed on August 1, 1995, the railways can abandon or convey branch lines with fewer bureaucratic hurdles. The railways are obliged to publish a plan showing those lines for sale, lease, transfer or abandonment over the next three years. Both railways have announced plans to deal with approximately 1,000 miles of this track by 2000. Under the current system however, the savings are clawed back from the regulated freight rate. Consequently, the incentive to prune the system aggressively has been blunted.

Despite the limitations of regulation, the railways have announced more than $1 billion in new investment for the coming year. In both cases a major part of this investment is directed to locomotive power and covered hopper cars. In addition, the railways have been building sidings at high throughput elevator points to handle longer car spots, and investing in port facilities.

A remaining uncertainty of rail transportation is the disposal of the federal government-owned hopper car fleet. The proposal to sell the 13,000 hopper cars to the railways lost support when producers balked at paying higher freight

rates to compensate for this added cost. Settlement of this issue is unlikely to proceed prior to the 1999 review.

Investment in Weight-reducing/Value-increasing Processing
Changing freight rates have provided incentives to invest in value-added processing in Western Canada. During 1996, close to $1 billion of new investment was announced in Manitoba's agricultural processing industries. These facilities include canola crushing, ethanol plants, potato processing, meat packing, and straw-board manufacture (Prentice, Kosior, and McLeod). Except for the straw-board plant, raw material for these facilities will pose a direct competitive threat to the export of unprocessed grain and oilseeds.

Ending grain transportation subsidies was expected to stimulate the livestock industry in Western Canada. The strength of world markets for pork exports and the role of integrated production was less appreciated. Manitoba and Alberta have experienced rapid increases during the past decade, and seem likely to double current production within the next five years. Saskatchewan has been slower to begin expansion, but is following the same path. As the livestock industry expands less feed grains will be available to the export market.

Cultural Shift from Production-oriented to Market-focused Farming
Wheat still accounts for the largest seeded acreage in Western Canada, but the dominance of wheat has been eroded. Farmers have become sensitive to transportation costs and are willing to try a wider range of crops. Expanded acreage of canola, special crops, e.g., feed peas, and forage illustrates the willingness of farmers to invest in products that earn the best profit.

Search for Supply Chain Accountability
The Canadian Wheat Board (CWB) has become the lightning rod for frustration with the limitations of the current marketing system. Some farmers have taken political protest to the extreme of incarceration to publicize their case for marketing freedom (Western Farmers for Justice). More democratic means (Barley vote) have also been used to try to wrest marketing control from the

CWB. These efforts have been rebuffed, but change is proceeding through revision of the legislation that governs the CWB.

Other farm groups have taken a more measured approach to reform with a call for greater "accountability" in the marketing system (Western Canadian Wheat Growers Association). This message has been taken up broadly, and was echoed recently by the President of CN Rail, Paul Tellier, in his view of the "new grain transportation system."

> Accountability. Farmers are accountable for delivering [the right] grain in a timely manner. Railways are accountable for moving [the right] grain according to agreed-upon terms. Shippers are accountable for loading the [right] grain at origin and unloading it at destination. (Tellier, 1997)

The assertion as a goal, of what is commonplace in most logistical systems, speaks volumes about the problems in the current grain handling system. Among the litany of issues begging for resolution, Paul Tellier cites 1) car allocation formulas that are based mainly on historical market shares, 2) a lack of choice on forwarding of CWB grains, 3) deliveries of grain from farms without a known final destination, 4) complex formulas and procedures, and 5) a lack of effective penalties for nonperformance. While far from a ground swell, pressure is building for the CWB to become a port receiver with reliance on contracts to coordinate the supply chain.

Technological Changes

Four major technological changes are affecting the future of the grain industry. Advances in telecommunications and computers are eliminating the advantages of location and time. Biological science is bringing forward a cornucopia of new crop varieties and qualities. Global positioning systems and other applications of satellite technology are creating new opportunities for managing production and marketing. Lastly, innovations in intermodal transportation and economies of size in containerization are reducing the costs of shipping Identity Preserved Grains (IPG).

Information Technology

Information technology is making grading systems obsolete. The economics of grading is based on the savings they can provide for information collection and transmission. When bulk handling was first introduced to the grain industry, negotiations were completed using the telegraph. At that time, users were charged by the word. With a grading system, all the important information could be transmitted in six words or less.[1] Similarly, gathering all the grain into three piles of similar quality greatly reduced the costs of record keeping and transfer of ownership (Prentice, Kosior and Thomson, 1997).

The cost of assembling and transmitting information has fallen so dramatically as to annihilate time and space. With theadvent of the Internet it is as easy to send the contents of an encyclopedia to Australia as it is to send a message across the street. The ease of information collection and transmission promises to reduce transaction costs for international commerce and could revolutionize the marketing of IPG crops.

Producers have already started to use the Internet to market forages and special crops. Services have also emerged, like Agra-Link, that enables trades of feed barley in Western Canada to be made electronically through the Internet. The ability to describe the product accurately is the key requirement for an electronic market to operate on a specifications basis (Prentice and Mulligan, 1996). Already, most oats used for human consumption are sold with no reference to the official grades. This trend will continue as end users become more particular about the exact specifications of the grain they purchase, and information systems make it easier to transmit quality specifications electronically.

Bio-Technology

Advances in crop breeding have delivered new varieties and new crops to Western Canada. Some introductions, such as Linola, are still searching for market success, while field peas are becoming the new Cinderella crop of the 1990s. In addition, herbicide resistant varieties of traditional crops have been introduced and more genetically advanced crops are expected to enter the market pending regulatory approval.

The biggest impact on grain exports may be the ability to tailor the quality attributes to the exact specifications of the buyer. Already some buyers have recognized that all varieties do not react equally in their processes and are willing to pay a premium for IPG crops. The $20 per tonne (1996) quality premium that Warburton's, a British bakery, is willing to pay for three specific varieties of wheat is a well known example of IPG. The contracts are regionally specific as well as variety-specific (Rance, 1997). Similarly, Coors Brewery in the United States has a registered variety of barley grown under contract. These examples may represent smart marketing as much a processing advantage, but the trend to find differentiation through variety specific sourcing will have an impact on grain handling.

Global Positioning Technology

Advances in satellite technology played a pivotal role in the success the U.S. *Desert Storm* campaign. The Global Positioning System (GPS) proved its worth in directing and tracking military logistics in the Gulf War. As these technologies are put to civilian uses, agriculture is a logical market because its activities are spatially dispersed. The ability to monitor farm input application, and test the quality of yield continuously, offers farmers a method of cutting cost and improving the quality of their harvest. Precision farming techniques are still in their infancy, but the promise of using GPS to tailor inputs and track yields is encouraging public and private investment.

Geographic Information Systems (GIS) are being combined with GPS to gather data in agriculture. The ability to track inventories that are dispersed over the length and breadth of the Prairies has important implications for marketing. GPS/GIS could enable the grain industry to employ a true demand pull system of marketing on a Just-In-Time basis.

Thirty years ago, Hodson proposed a solution to Western Canada's grain transportation problem (Taylor, 1966). Better coordination of the rail fleet was viewed as possible, if all information were stored on "one big computer." The computer could be used to track the location of grain inventories and direct the railcars to their best use. Centralized tracking would eliminate duplication of

effort, improve rail car utilization and reduce demands for higher freight rates. Moreover, "ending of the dispute surrounding the use of boxcars that carry grain from the prairies to the ports" would be a benefit in its own right. The system to track and allocate rail cars would require the industry to pool its information. Not surprisingly, the grain industry expressed coolness to the idea of sharing their confidential data. The government voiced interest in the idea, but no funding was put forward to test the concept as a public good. Professor Hodson moved on to other research projects.

Technological changes in information gathering and transmission have improved the economics of Hodson's vision of an integrated logistics system for grain. Computer power has advanced exponentially in the past three decades, while prices have fallen almost as dramatically. Similarly, emergence of the Internet and the deregulation of telephone networks have caused long distance telecommunication costs to plummet. The technical ability to integrate the management of the grain industry supply chain is well within reach, if the will exists to do so.

Containerization and Intermodal Transportation Technology

Advances in containerization have occurred at every link of intermodal transport. The number of container ships doubled in the past ten years, while the size of ships increased by 50 percent. In the 1970s, container ships carried between 1,000 and 1,500 TEUs[2]. The new generation of containerships carry 6,000 to 6,500 TEUs. As a result, costs per container have fallen significantly. New container ships now carry four times the cargo, using the same amount of fuel and with the same crew size, as container ships of the 1970 era. Besides cost reducing technology, competition among the marine carriers is fierce. Rates on the North Atlantic and the Pacific are hitting record lows.

Associated productivity changes have occurred at the ports and the rail intermodal systems. Vancouver's Deltaport can off-load two 6,000 TEU ships simultaneously and load a double-stack container train in eight hours. Since the introduction of double-stack trains in the mid-1980s, container movements have grown at 10 percent annually, and now exceed the volume of "piggy-back" movements in North America. Intermodal transport accounts for about half the

exports of pulse/special crops in Western Canada (Prentice, 1997). This trend is likely to increase as the falling costs of containerization stimulate its use.

Variety is the soft underbelly of the bulk system. As new grains and quality segregations are added, the congestion costs increase geometrically. Unlike the bulk handling system, container shipping can guarantee the identity of grains throughout the logistical system without imposing additional costs for segregation. The defined units and ubiquity of service make containerization ideal for electronic marketing of IPG crops. Moreover, containers hold the potential to develop a true Just-in-time delivery system for grain exports.

Fearless Prognostications for the Year 2010

Predictions that are longer than three years into the future are generally unreliable. Any prediction that is over ten years into the future is little more than "fortune telling", and should be treated as such. In any case, here are some prognostications for the Year 2010, based on emerging trends.

1. Electronic markets: Farmers are going to be more directly involved in marketing their high value crops through an Internet-based system. These products are likely to be Identity Preserved Grains and will be sold on a specifications basis. Farmers may utilize an agent system to guarantee payment and delivery, but will be directly involved in negotiating the terms of the sale. Truck, container, and possibly hopper car freight services will also be marketed through electronic markets.

2. Containerization: The falling costs of container shipping and access to higher margins for specific quality products will encourage more containerization of grain exports. Containers can also double as a form of condominium storage and may be marketed on this basis. By the Year 2010, 25 percent of export grains will be shipped in containers.

3. Bulk system: Over-building of large concrete elevators at some delivery points will lead to conversion, or closure of facilities. The successful locations will derive a significant share of their revenue from input supply sales and custom application.

4. GPS/GIS: Precision farming will increase production, lower costs and become increasingly demanded by buyers who seek exact quality specifications. Despite growth of the livestock industry and domestic processing, technological change will increase production sufficiently to maintain the current levels of grain exports.

5. CWB: Farmers need a marketing agency that can undertake export merchandising work on their behalf. The role of the CWB is changing. How much it will change depends on the skill of the management that emerges following the introduction of its new governance. At the Year 2010, CWB may retain its monopoly on export sales, but cease to be involved in the logistics of originating grain in the bulk system.

Concluding Comments

Supply chain management is a hot topic in the field of international logistics. Increasingly, industry leaders recognize that inefficient supply chains yield inferior returns to their members. Greater competition in the global economy is forcing supply chains to re-engineer and integrate functions. Western Canada must improve the management of its logistical supply chain for handling grain. As 21st Century approaches, supply chain members no longer compete against each other, they now compete against the supply chains of other countries.

Farm prices of grain and other field crops in western Canada are determined by the cost of landing these products at an export customer's door. Canadian supply chains for grain have earned a reputation as unreliable and high cost. A location more distant from saltwater than competitors, and extremes of climate explain part of these problems, but years of distorting subsidies and excess regulation have hampered the effectiveness of the Canadian supply chain.

Deregulation of transportation and the end of subsidies are forcing radical supply chain adjustments. Where years of stability were the rule, dramatic changes are underway in the collection, transportation and marketing of grain. The falling cost of information gathering and transmission will decentralize the buying and selling of grain. This will be reinforced by more economic

container transportation alternatives that will enable small shipments of Identity Preserved Grains to compete with large bulk shipments of "generic" quality.

Transformation of the supply chain will create difficult choices and new challenges for the grain handling and input supply sector, but will also provide opportunities for those who can catch the "right wave."

References

Agriculture and Agri-food Canada. *Biweekly Bulletin.* "Western Canada: Grain Handling and Transportation System", Vol. 10 No. 19.

Prentice, Barry E. *2nd Annual Field on Wheels, Agribusiness Logistics Conference.* "Transportation of Pulse/Special Crops". Winnipeg, MB: University of Manitoba, Transport Institute, November 1997 (forthcoming).

Prentice, Barry E., Jake Kosior and Jim Thomson.. "Re-engineering the Logistics of Canadian Grain Marketing, or Back to the Sacks?" *Canadian Transportation Research Forum.* Proceedings Issue: 32nd Annual Meeting (1997): 722-737.

Prentice, Barry E., Jake Kosior and Bob McLeod. *Agriculture Trucking in Manitoba.* Winnipeg, MB: University of Manitoba, Transport Institute, Research Bulletin No. 16, Sept. 1996 (58 pages).

Prentice, Barry E. and John O. Mulligan. *An Electronic Market for Truckload Freight: Economic Definition, Existing Structure and Missing Prices.* Winnipeg, MB: University of Manitoba, Transport Institute, Research Bulletin [3]No. 15, June 1996.

Prentice, Barry E. and Jack W. Craven. "The Economic Potential for Improving the Canadian Grain Handling System through Containerization", *Canadian Journal of Agricultural Economics.* Proceedings Issue, August 1980, 119-128.

Rance, Laura. "Quality still key in grain business". *Winnipeg Free Press.* March 1, 1997: B12.

Taylor, Robin. "One big computer could end grain transport woes:" Prof. Bernard Hodson" *The Tribune*, August 23, 1966

Tellier, Paul M. "Reforming the grain transportation system". Notes for remarks to the Regina Chamber of Commerce, Regina, Saskatchewan, Sept. 10, 1997.

Endnotes

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1. For example, an offer could include place, grade, price, quantity, delivery date, and sell/buy decision.

2. TEU stands for Twenty-foot Equivalent Unit. ISO containers are built in 20 and 40-foot lengths.

The Challenge of Using International Trade Data to Enhance Transportation Statistics

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ABSTRACT

This paper reports on how Statistics Canada is maximizing the potential of its international trade database to improve transportation statistics. We will describe the methodology used for developing a new trade product, one which expresses all international trade commodities in one uniform weight measurement. This new weight variable for international trade commodities was a key missing link to further enhancements to Statistics Canada's transportation database. We will examine how we might use this new weight information to enhance existing transportation statistics by integrating unit values with reported transportation commodities. We will also describe how we are validating existing transportation databases by reconciling trade and transportation database commodities at the weight level. Finally, we will report on the issue of further record linkages between trade and transportation, similar to those established in the marine trade linkage project of 1989.

1. BACKGROUND

With spiraling growth in international trade, transportation and related companies are increasingly in need of more and better transportation statistics. International trade, the largest component of the current account of the Canadian Balance of Payments, has been growing at a strong and consistent rate annually since 1992. As the transportation segment of Canada's service industry grows, the demand for information on commodity movements by mode of transport is rising. Carriers and companies associated with carriers need current information to help them establish market share and make strategic business decisions. They want to know what commodities are moving between Canada and other countries by month, value, mode, country, and other related characteristics. As a result, Statistics Canada has initiated this project in an attempt to meet the needs of the transportation sector by developing new products and refining existing ones.

In the fall of 1996, Statistics Canada embarked on a joint divisional study to explore how international trade data could be used to produce more useful trade and transportation statistics. The project originated from the 1995 "Transport Canada Data Needs Report" identifying a number of areas for improved modal

statistics. One area recommended for review was the perceived under-utilization of modal data currently in the international trade database. It was theorized that if international trade data could be used to its maximum potential, we could enhance and validate the transportation statistics produced by Statistics Canada.

The study was conducted in two phases. Phase I, completed in March 1997, involved the development of a conversion methodology whereby all non-metric International Trade commodities expressed at the 6 digit Harmonized Commodity Description and Coding System (HS) level would be converted to metric tonnes. A prototype product was developed to demonstrate this estimation strategy, along with a market report identifying potential users and the potential for cost recovery. With the successful completion of Phase I, approval was given to proceed to Phase II with a target date of April 1998 for completion.

2. INTRODUCTION

As observed by Emile Di Sanza in 1987, conceptually," trade and transportation are closely related; international trade statistics reflect the flow of goods from the country of production to the country of consumption, whereas transportation statistics measure the flow of goods from the place of loading to the place of unloading." Despite the close relationship of trade and transportation, two independent data capture and processing systems were developed to meet their respective subject matter mandates. International trade commodity statistics are published monthly by the International Trade Division of Statistics Canada in approximately 5,000 different commodity groups based on the 6 digit HS level. Trade data are tabulated using Revenue Canada Customs administrative records for all imports (Form B3 "Import Customs Control Document") to Canada and all exports (B 13 "Export Declaration") to overseas countries excluding the United States. Canadian exports to the U.S. are captured by the United States Bureau of Census, as part of the Canada/United States bilateral exchange of export trade data, which commenced in 1990.

Each time a commodity is shipped between Canada and a foreign country, a customs record is required to document the numerous trade characteristics of the commodity being shipped. Reported information includes a detailed commodity description, value and mode of transport. Commodities may be reported with or without associated metric weights depending on the commodity being transacted. In many instances, commodity weight and quantity are not reported at all.

The Transportation Division publishes commodity movements by mode of transport at a much higher level of aggregation than its international trade counterpart. For 1996, for example, only 320 rail commodities were available for

all northbound and southbound rail commodity movements. Marine movements for both arrivals and departures were reported for up to 601 commodity classifications. Meanwhile, truck northbound and southbound movements were reported for up to 650 different commodities. Commodity data are published quarterly for marine and truck and annually in the case of rail.
Based on the mode, transportation related administrative records are tabulated and published in metric tonnes for commodities moved internationally.

The lack of metric weights for some reported commodities in the International Trade database combined with the high degree of aggregation of commodities in the Transportation database has limited the capabilities of Statistics Canada to compare the two databases. The potential for improved transportation and trade statistics therefore rests with maximizing additional international trade variables for weight and mode of transport currently reported to Statistics Canada but to date not used. The development of a uniform metric weight for each internationally traded commodity, and how we hope to use this new information to enhance the transportation databases produced by Statistics Canada, will be the central theme of this report. The remainder of this paper will describe the activities undertaken in Phase II of this project. It will address:

- the strategy for producing a new international trade product, reporting all export and import trade at the 6 digit HS level in one uniform metric weight measurement (tonnes) by mode of transport;
- how we intend to use this new trade weight variable to validate and enhance existing transportation databases; and
- the potential for further record linkages for all modes of transport in the Transportation Division, similar to those developed as part of the marine trade linkage project of 1989.

3. CONVERSION OF INTERNATIONAL TRADE TO ONE UNIFORM WEIGHT MEASUREMENT

The mandate of the International Trade Division (ITD) is to publish monthly trade statistics for both exports and imports. The data are drawn from Revenue Canada (Customs) administrative files that are used for applying import/export and tariff regulations. A variety of trade characteristics are reported monthly for each commodity, with the main ones being country, commodity, mode of transport and value. The capture and reporting of weight information by commodity is generally given less priority than value and country data. Weight and quantity information currently reported by ITD depend for the most part on what commodity is being reported. For instance, most bulk commodities e.g. wheat, coal, potash, are reported in metric tonnes. Commodities of a more finished nature tend to be reported in various units of quantity or weight, generally using one of the

international units of measure published in "Imports by Commodity" (65-007-XPB) and listed in Table 1. Many commodities are published with only values, with no weight or quantity data.

Table 1. International Units of Measure

Abbreviation	Meaning
CTM	Carot
MTQ	Cubic metre
DZN	Dozen
GRM	Gram
GRO	Gross
HLT	Hectolitre
KGM	Kilogram
KNS	Kilogram of named substance
KSD	Kilogram air dry
LTR	Litre
LPA	Litres of pure alcohol
NWH	Megawatt
MTR	Metre
TNE	Metric tonne
TSD	Metric tonne air dry
NMB	Number
SET	Number of sets
NAP	Pack
PAR	Pair
CMK	Square centimetre
MTK	Square metre
MIL	Thousand
TMQ	Thousand cubic metre

With the current system used by Revenue Canada Customs to report international trade data, i.e. using the B3 (Imports) and the B13 (Exports to Overseas Countries), there is no requirement for custom brokers to report in one consistent unit of weight measurement. Except for exports to the United States, Canadian exporters and importers are not required to report a shipping weight for each commodity shipped. The requirement is to report an overall gross and net weight for each record, which may include one or multiple commodities on any one form. Value and mode of transport are always captured for each commodity and quantity is frequently captured. Trade data by mode of transport is **published** in value terms only. (See Table 2)

Table 2. International Trade, 1996, Exports and Imports by Mode of Transport and Value

$ Amounts in Billions

Exports	Road	Rail	Water	Air	Other	Total
To U.S.	120.9	50.3	6.3	7.6	24.0	209.1
To Other	4.3	0.4	37.4	8.2	-	50.3
Total	125.3	50.7	43.7	15.8	24.0	259.4

Imports	Road	Rail	Water	Air	Other	Total
To U.S.	125.7	14.0	2.4	14.5	0.9	157.5
To Other	19.6	2.6	36.1	15.3	2.0	75.6
Total	145.3	16.6	38.5	29.8	2.9	233.1

Source: International Trade Division, Statistics Canada

The lack of one consistent weight for all trade commodities has limited both the marketability of trade data as well as our ability to enhance the transportation database.

Methodology for estimation of weights

As indicated earlier, Canada and the United States capture and exchange import trade data as part of a bilateral agreement. On a monthly basis Canada sends to the U.S. data on its imports from the U.S. and, in turn, receives from the U.S. data covering imports from Canada. As both countries record imports using different trade documents, with different requirements, the data elements collected are in some areas not consistent. For instance, data collected by the U.S. on weight information for each commodity by mode is in greater detail and covers all trade. As discussed earlier, the weight and quantity information captured by Revenue Canada depends on the type of commodity. The U.S. reports a shipping weight in kilograms for each individual commodity collected from form 7501, which is used to record all imports into the U.S. from all foreign destinations. Each commodity imported into the U.S. must have a shipping weight entered in kilograms as well as the quantity if relevant. It is the responsibility of the import broker to obtain this information from either the exporter or shipper of trade into the U.S. Since January 1990, Canada has had access to this U.S. weight data information but has not utilized it to its potential.

All U.S. customs documents are processed through an internal edit system to check for consistency. Quantity fields are first validated to ensure that units as reported by the import broker for each commodity are in acceptable units for the

commodity. The shipping weight field is then processed through consistency and statistical edits to ensure that:

- a shipping weight has been entered; and
- the weight of the commodity in relation to the units of quantity and value fall within acceptable parameters.

Only after all commodities are processed through the U.S. internal edit system are records approved and sent to Canada monthly. The relationship derived from this file between quantities, value and shipping weight for each commodity is the cornerstone of our weight conversion methodology in building weight conversion factors. The other fundamental component of the strategy is the Harmonized Coding System (HS), which provides the basis for establishing weight conversion factors. The fact that all commodities reported at the 6 digit HS level for both exports and imports are for the most part considered the same and to possess similar weight characteristics is fundamental to the estimation strategy.

With exports to the U.S. reported at the 10 digit HS level, however, and because a "universal" comparison may only be obtained at the 6 digit level for all trade flows, the strategy requires a roll-up of data on exports to the U.S. to the 6 digit level. Our conversion methodology involves the development of factors for converting international trade commodities to metric tonnes for 6 digit HS codes. Trade commodities reported in non-metric units for imports from all countries including the U.S. as well as exports to all countries excluding the U.S. are converted using one of the following conversion factors:

- quantity to shipping weight (quantity conversion factor); or
- value to shipping weight (value conversion factor).

If quantity information is available, the quantity conversion factor is used. If not, the value conversion factor is used. Exports to the U.S., which already provide shipping weight information and are the source of our conversion factors, are accepted as is.

Example of weight conversion strategy

To demonstrate the weight conversion methodology, we will impute weight information for automobiles with reciprocating piston-type engines displacing over 3000 c.c. (HS commodity 870324). Commodity 870324 is an ideal commodity for demonstration purposes because:

1. it is imported and exported between Canada and all foreign countries; and
2. it is important in terms of value. Exports of 870324 to the U.S., for instance, represent 9% of total value of all July 1996 exports. Imports from the U.S and all other countries account for approximately 2% of total value.

The unit of measure is expressed in number of automobiles (UOM=NMB).

Exports to the U.S. - Commodity 870324 (July 1996)

Mode	QTY	Weight, TNE	Value	SWT./QTY	$/TNE	SWT/Value
Road	23,887	38,827.259	$506,499,772	1.625453	$13,045	0.076658
Rail	38,956	57,002.573	$951,517,736	1.463244	$16,693	0.059907
Total	62,843	95,829.832	$1,458,017,508	1.524901	$15,215	0.065726

Conversion Factors Created in the International Trade Data Library for Exports to the U.S.

Mode	U.S.X UOM.1	U.S.X UOM.2	QTY Conv. Factors	SWT in TNEs/UOM.2	Value Conv. Factor
Road	NMB	...	1.625453	n.a.	0.076658
Rail	NMB	...	1.463244	n.a.	0.059907
Water	...		1.524901	n.a.	0.065726
Air	...		1.524901	n.a.	0.065726
Other	...		1.524901	n.a.	0.065726
Total	NMB		1.524901	n.a.	0.065726

SWT=shipping weight; TNE=metric tonne

Following are examples of conversion results using both the quantity and value conversion factors for each of the three trade flows.

Exports to All Foreign Destinations Excluding the U.S.- Commodity 870324

International Trade Library Data for Exports to the U.S. (HS 870324)

Mode	U.S.X UOM.1	U.S.X UOM.2	QTY Conv. Factor	SWT in TNEs/UOM.2	Value Conv. Factor
Road	NMB	...	1.625453	n.a.	0.076658
Rail	NMB	...	1.463244	n.a.	0.059907
Water	...		1.524901	n.a.	0.065726

Example 1. Shipping Weight Estimated Using the Weight (July 1996) Conversion Factors

Mode	QTY	*Est. Weight, TNE*	Value	Avg. tonne/Qty	Value/TNE (Derived)
Road	24	***39.011***	$640,720	1.625453	$16,424
Rail	199	***291.186***	$4,027,183	1.463244	$13,830
Water	415	***632.834***	$13,349,861	1.524901	$21,095
Total	638	***963.031***	$18,017,764	1.509453	$18,710

International Trade Library Data for Exports to the U.S. (HS 870324)

Mode	U.S.X UOM.1	U.S.X UOM.2	QTY Conv. Factor	SWT in TNEs/UOM.2	Value Conv. Factor
Road	NMB	...	1.625453	n.a.	0.076658
Rail	NMB	...	1.463244	n.a.	0.059907
Water	...		1.524901	n.a.	0.065726

Example 2-Shipping Weight Estimated Using the Value (July 1996) Conversion Factor

Mode	QTY	*Est. WGT.TNE*	Value	Avg. tonne/Qty	Avg. $/SWT-XUS Conversion	Value/TNE
Road	24	***49.116***	$640,720	2.046500	0.076658	$13,045
Rail	199	***241.256***	$4,027,183	1.212342	0.059907	$16,693
Water	415	***877.433***	$13,349,861	2.114297	0.065726	$15,215
Total	638	***1,167.805***	$18,017,764	1.830416	0.065726	

Imports From the United States -Commodity 870324

International Trade Library Data for Exports to the U.S. (HS 870324)

Mode	U.S.X UOM.1	U.S.X UOM.2	QTY. Conv. Factor	SWT in TNEs/UOM.2	Value Conversion Factor
Road	NMB	...	1.625453	n.a.	0.076658
Rail	NMB	...	1.463244	n.a.	0.059907
Air	...		1.524901	n.a.	0.065726

Example 1. Shipping Weight Estimated Using the Weight (July 1996) Conversion Factors

Mode	QTY	*Est. Weight, TNE*	Value	Avg Tonne/Qty	Value/TNE (Derived)
Road	4,882	***7,935.462***	$122,120,074	1.625454	$15,389
Rail	3,369	***4,929.672***	$81,250,362	1.463245	$16,481
Air	1	***1.525***	$61,763	1.524901	$40,500
Total	8,252	***12,866.659***	$203,432,199	1.559218	$15,810

Example 2-Shipping Weight Estimated Using the Value (July 1996) Conversion Factor

Mode	QTY	*Est. Weight, TNE*	Value	Avg. Tonne/Qty	Avg. $/SWT-XUS Conversion	Value/TNE
Road	4,882	***9,361.481***	$122,120,074	1.917551	0.076658	$13,045
Rail	3,369	***4,867.465***	$81,250,362	1.444781	0.059907	$16,693
Air	1	***4.059***	$61,763	4.059000	0.065726	$15,215
Total	8,252	***14,233.005***	$203,432,199	1.724795	0.065726	

Imports From All Foreign Destinations Excluding the U.S -Commodity 870324

International Trade Library Data for Exports to the U.S. (HS 870324)

Mode	U.S.X UOM.1	U.S.X UOM.2	QTY. Conv. Factor	SWT in TNEs/UOM.2	Value Conversion Factor
Road	NMB	...	1.625453	n.a.	0.076658
Rail	NMB	...	1.463244	n.a.	0.059907
Water	...		1.524901	n.a.	0.065726

Example 1-Shipping Weight Estimated Using the Weight (July 1996) Conversion Factors

Mode	QTY	*Est. Weight, TNE*	Value	Avg. tonne/Qty	Value/TNE (Derived)
Road	1,628	***2,646.237***	$24,868,839	1.625453	$15,275
Rail	3,772	***5,519.360***	$49,511,901	1.463245	$13,126
Water	4,812	***7,337.824***	$84,889,043	1.524901	$17,641
Total	10,212	***15,503.421***	$159,269,783	1.518158	$15,596

Example 2-Shipping Weight Estimated Using the Value (July 1996) Conversion Factor

Mode	QTY	*Est. Weight, TNE*	Value	Avg. tonne/Qty	Avg. $/SWT-XUS Conversion	Value/TNE
Road	1,628	***1,906.395***	$24,868,839	1.171005	0.076658	$13,045
Rail	3,772	***2,966.109***	$49,511,901	0.786350	0.059907	$16,693
Water	4,812	***5,579.412***	$84,889,043	1.159479	0.065726	$15,215
Total	10,212	***10,451.916***	$159,269,783	1.023494	0.065726	

Reliability, Data Quality

Our methodology was analyzed by the Business Survey Methods Division (BSMD) of Statistics Canada. Based on this, it has been found to be generally reasonable and sound. At the same time, however, BSMD identified the following concerns:

- whether it might be possible to use quantity and value information together to derive a more accurate weight conversion factor, although this would be more complicated than using only one or the other; and
- whether it might be preferable to use value as the first choice for calculating the conversion factor, rather than quantity.

It was suggested that the methodology might benefit from a more in-depth analysis of the stability of the conversion factors calculated using both quantity and dollar value at a later date. It was also suggested that the assumption that U.S. factors could serve as the basis for the Canadian conversion factors should also be further tested, but that this could only be argued based on subject matter reasons as there are no data to directly support and statistically test this assumption.

3. USING TRADE WEIGHT DATA TO ENHANCE THE EXISTING TRANSPORTATION DATABASE

The potential benefits of using international trade data to improve transportation statistics have been discussed for a number of years. Until now, the lack of consistent weight information for all commodities reported by the International Trade Division has prevented Statistics Canada from making these improvements. With the successful development of a methodology for the conversion of trade to one uniform metric weight, a major hurdle has been crossed. We could now use the international trade database to enhance transportation statistics by:

- adding value amounts to commodities reported by the Transportation Division; and
- validating the transportation database by reconciling commodities by weight for the two divisions.

Achieving this, however, first required the realignment of trade commodities into the appropriate transportation groupings. To do this, concordance tables were developed for 1996 data, linking international trade and transportation commodity descriptions.

Concordance: Trade and Transportation Commodities

For the year 1996, 5,018 HS commodity descriptions at the 6-digit level were used internationally to describe both import and export trade. International Trade reported approximately three-quarters of these as being traded that year between Canada and all foreign countries. Transportation data, on the other hand, are reported according to three different classification systems. Two sub-products of the Standard Commodity Classification (SCC) are used for rail and truck movements while marine data are reported using an aggregation of the Standard Classification of Goods (SCG). Even though rail and truck commodities are both reported using the SCC, the data groupings are not the same: truck data are based directly on the SCC, while rail data are obtained by converting to the SCC the Standard Transportation Commodity Code (STCC) of the Association of American Railroads (AAR). For the year 1996, rail commodities were reported in

320 commodity groups while truck and marine accounted for 650 and 601 respectively.

The SCG based system used to report marine data is an extension of the Harmonized System used internationally to categorize and describe commodities. The aggregation of HS trade commodities to the 601 marine commodities therefore gives an exact concordance. The development of concordances for rail and truck movements is much more difficult, however. Because both modes are reported using the SCC, a system that is not very compatible with the Harmonized System, theoretical concordances are required for many transportation commodities. [1]

To illustrate the difficulty in developing concordance tables for rail and truck the rail commodity "010 Meat, Fresh or Chilled" will be used as an example. An examination of all HS commodities which relate to that code (see table below) shows that most HS commodities match 100% to rail commodity 010. There are some HS commodities, however, which relate to more than one rail commodity group. For example, we know that 020450 "Meat of Goats" falls under both rail commodities 010"Meat Fresh or Chilled" and 012 "Meat Frozen" but do not know by what proportions. For purposes of establishing concordances, therefore, we assume equal proportions. Thus, in the table below, HS commodity **020450** "Meat of Goats" is given a 50% proportion to rail commodity 010, while the remaining 50% is allocated to rail commodity group 012 "Meat Frozen". Where HS commodities fall under three or more rail or truck commodity groupings they are apportioned equally in the same fashion. For example, HS **020890** " Other Meat" is allocated 34% to transportation code 010, 33% to code 012 "Meat, frozen" and 33% to 016 "Fish and marine animals".

Rail Commodity 010 "Meat, Fresh or Chilled"

Transp. Code	4 digit H.S.	6 digit H.S.	Portion %
O10	0201		100%
010		02031	100%
010		020410	100%
010		02042	100%
010		**020450**	**50%**
010	0205		50%
010		020610	100%
010		020630	100%

[1] The Transportation Division plans to migrate truck and rail commodity information to the Harmonized System as soon as resources become available.

010		020680	100%
010		020711	100%
010		020712	100%
010		020713	100%
010		020714	50%
010		020732	100%
010		020733	100%
010		020734	100%
010		020735	100%
010		020736	50%
010		020810	50%
010		020820	50%
010		**020890**	**34%**

Rail Commodity 012 "Meat Frozen"

Transp. Code	4 digit H.S.	6 digit H.S.	Portion %
012	0202		100%
012		02032	100%
012		020430	100%
012		02044	100%
012		**020450**	**50%**
012	0205		50%
012		02062	100%
012		02064	100%
012		020690	100%
012		02072	100%
012		02074	100%
012		020714	50%
012		020736	50%
012		020810	50%
012		020820	50%
012		**020890**	**33%**

Enhancing Transportation Volumes by Adding International Trade Value Amounts

The Transportation Division currently publishes international commodity movements by mode of transport in metric tonnes only (Table 3). Commodities are grouped depending on the mode of transportation i.e. for the 320 rail, 650 truck and 601 marine codes. Users of these databases have indicated that

providing additional information on the value of the goods being moved would substantially enhance the usefulness of our data. This was highlighted in the "Transport Canada Data Needs Report" of 1995, which suggested that better use be made of international trade data to generate unit value per tonne. With the International Trade Division now having weight information for all commodities, we can use the concordance tables to compute and integrate this information in the transportation database.

Valuation of International Trade Commodities:

- Imports are valued F.O.B. (Free on Board), place of direct shipment to Canada. Values exclude freight and insurance costs of bringing the goods to Canada from the point of direct shipment.
- Exports are valued F.O.B. point of exit from Canada to the U.S. and F.O.B. port of exit for trade with overseas countries. Domestic freight charges to the point/port of exit are included in the value.

Table 3. International Commodity Movements, 1996, by Mode of Transport and Tonnages Reported in Thousands

Outbound	Road 650	*Rail (95) 320	Water 601	Air
To U.S.	29.2	46.5	52.6	N/A
To Other	N/A	N/A	121.7	N/A
Total	29.2	46.5	174.3	N/A

Inbound	Road 650	*Rail (95) 320	Water 601	Air
From U.S.	17.8	13.6	36.1	N/A
From Other	N/A	N/A	49.9	N/A
Total	17.8	13.6	86.0	N/A

Source:
-Transportation Division, Statistics Canada. Tonnages are for all transportation codes for each mode of transport.
- Road: For-hire trucking companies domiciled in Canada with annual intercity revenue of $1 million or more.
-Rail: CN and CP including their interlines.
-Marine: A6 Customs documents.

Integration of Trade Values to Transportation Data

For the year 1989, the Transportation Division linked the marine trade database with the International Trade database at the individual record level. Linking the databases allowed the addition of value amounts as well as other trade variables to the transportation database, thus providing new insight into marine commodity

movements. With international trade commodities now including a weight variable for each commodity, we were able to generate value data for marine commodity movements by simply integrating the unit values from the trade data.

Table 4 and the subsequent calculations illustrate the approach to value integration made possible by this, using marine transportation commodity 10 "wheat" as an example. The concordance with HS commodities shows codes 100110 and 100190 as being included in this group.

Table 4. Exports to Overseas Counties, Excluding the U.S., July 1996.

HS code	Description	TNE	$Value	$/TNE
100110	Wheat and Meslin includes Durum	278,213	88,688,744	$318.78
100190	Other Wheat	108,451	34,605,630	$319.09
Total		386,664	123,294,374	***$318.87***

Source: International Trade Division

Concordance: Marine code 10 = HS 100110 "Wheat and Meslin includes Durum",
= HS 100190 "Other"
Total marine volume, Transportation Division = **787,366** metric tonnes
Total marine volume **787,366** tonnes X International Trade value at ***$318.87***/tonne = **$251,106,740**.

With each international trade commodity expressed at the 6-digit level and with concordance tables built linking trade and transportation commodities, we can now proceed with calculating value amounts for each transportation commodity movement.

Reconciling Trade and Transportation Databases

As stated at the outset, international trade and transportation are closely related at a conceptual level. Although the international trade and transportation databases both report commodity movements, what they report and how the data is collected differ considerably. But with international trade commodities now possessing a weight variable in metric tonnes and with concordances built between trade and transportation commodity descriptions, we are now able to measure the differences in what the two databases report using the weight variable.

The objective of the reconciliation exercise is to provide for each database a set of tables by mode of transport, outlining the differences in what each covers for commodities by weight compared to the other database. The reconciliation of the two databases was conducted in two steps. Step I reconciled transportation commodities which are reported in metric tonnes with international trade

commodities which are also reported in some form of metric measurement that can be converted easily to metric tonnes. Thus, commodities already in metric tonnes (TNE) as well as grams (GRM), kilograms (KGM), kilogram of named substance (KNS), kilogram air dry (KSD) and Metric tonne air dry (TSD) were reconciled with trade data. Step II reconciled the remaining transportation commodities with trade commodities requiring conversion to metric tonnes i.e. number (NMB), litre (LTR), pair (PAR) etc (see International Units of Measure in Table 1).

The reconciliation tables provide both Divisions with a tool to help them identify potential undercoverages and thus improve their data. The following is a general overview of the reconciliation process itself.

International Trade

The primary objective of the Canadian International Merchandise Trade Statistical Program is to measure the change in the stock of material resources of the country resulting from the movement of merchandise into or out of Canada. As goods are imported into or exported from Canada, declaration forms are filed with Customs giving such information as description and value of the goods, origin and port of clearance and the mode of transport. Canadian trade statistics are produced monthly and are classified according to the HS system. For the most part, international trade data are considered to be reliable.

For the purpose of our reconciliation exercise, international trade will be examined in terms of trade with the United States and trade with all other countries excluding the U.S. Import trade from all foreign sources is considered to be highly reliable because Canada Customs tends to be more vigilant with respect to goods entering the country than to goods leaving the country. Export trade to the U.S. is also considered highly reliable as this flow of trade is captured by equally vigilant United States customs officials. Export trade to countries other than the United States is considered to be the weakest of the trade flows. As no customs tariffs are collected by Revenue Canada for export trade, Customs officials tend to regard this flow to be a lower priority than import trade.

International trade data are published monthly at the commodity level. Transportation origin and destination commodity movements are available quarterly for marine and truck and annually for rail commodities. We will therefore base our reconciliation on the Transportation Division reporting schedule.

Transportation

The objective of gathering transportation statistics for commodity movements is to measure the total flow of goods from the point of loading to the point of unloading. International cargo movements (origin and destination) are captured by the division using different methodologies depending on the mode. The following is a brief description, for each mode of transport, of how commodities reported in the Transportation Division are captured and how they differ from the International Trade Division.

a. Marine movements

International origin and destination commodity statistics are compiled from data collected on the A6 "General Declaration" and supporting cargo reports supplied to Statistics Canada by Revenue Canada, Customs and Excise. It covers all vessels entering or leaving Canada engaged in international shipping. Departure and arrival data on commodity movements are tabulated monthly by cargo description, weight of cargo, vessel name, vessel agent or Canadian operator and Canadian port of loading.

The reconciliation of the two databases is monthly for the year 1996 and involves the 601 commodity codes used for marine. The data is tabulated by departure and arrival of commodities and is based on the four flows of trade. The following reconciliation tables (5.1 – 5.4) serve as examples for each of the four flows, showing reconciliation figures for the top 5 commodities based on size (largest in terms of overall weight) as published by the Transportation Division.

For the most part, International Trade commodities were reported in metric tonnes. There were, however, some trade commodities requiring the use of the weight conversion methodology (Section 3) to provide weight estimates - ***estimated international trade commodity weights are in bold Italics.***

Table 5.1 Reconciliation: Selected Commodities, Marine, July 1996. "Departures/Exports to the U.S".

Transportation Code and Description	July 96 – Metric Tonnes		
	TD	ITD	(TD-ITD)
32 Salt and pure sodium chloride	301,182	363,057	-61,875
37 Gypsum	489,996	263,715	+226,281
38 Limestone flux	201,919	279,726	-77,807
40 Iron ore and concentrates	1,143,168	1,033,711	+109,457
58 Organic chemicals	144,317	100,536	+43,781

Sub Total (Top 5 T.D. Volume)	2,280,582	2,040,745	+239,837
Total all T.D. Commodities (101)	4,666,645		
% 5 Commodities of Total	48.9%		

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada

Table 5.2 Reconciliation: Selected Commodities, Marine, July 1996. "Departures/Exports to Overseas Countries"

Transportation Code and Description	July 96 – Metric Tonnes		
	TD	ITD	(TD-ITD)
10 Wheat	787,366	584,025	+203,341
33 Sulphur of all kinds	415,624	477,847	-62,223
40 Iron ores and concentrates	1,038,337	1,053,993	-15,656
46 Coal	3,488,562	2,994,211	+494,351
59 Potassium chloride	336,227	415,520	-79,293
Sub Total (Top 5 T.D. Volume)	6,066,116	5,525,596	+540,520
Total all T.D. Commodities (101)	9,454,731		
% 5 Commodities of Total	64.2%		

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada

Table 5.3 Reconciliation: Selected Commodities, Marine, July 1996. "Arrivals/Imports from the U.S."

Transportation Code and Description	July 96 –Metric Tonnes		
	TD	ITD	(TD-ITD)
34 Natural sand of all kinds	117,977	27,052	+90,925
38 Limestone	427,716	230,741	+196,975
40 Iron ores and concentrates	921,180	940,878	-19,698
46 Coal	1,269,570	1,327,324	-57,754
52 Fuel oil Nos. 2 and 3	163,703	****149,795***	13,908
Sub Total (Top 5 T.D. Volume)	2,900,146	2,675,790	+224,356
Total all T.D. Commodities (101)	3,723,666		
% 5 Commodities of Total	77.9%		

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada
*** Estimate based on Value (Conversion Methodology)**

Table 5.4 Reconciliation: Selected Commodities, Marine, July 1996. "Arrivals/Imports from Overseas Countries"

Transportation Code and Description	July 96 – Metric Tonnes		
	TD	ITD	(TD-ITD)
40 Iron ores and concentrates	212,346	51,087	+161,259
42 Aluminum ores, concentrates	305,037	288,026	+17,011
43 Alumina	219,757	219,954	-197
48 Petroleum oils	2,274,877	****2,162,826***	+112,051
49 Gasoline	129,390	****194,188***	-64,798
Sub Total (Top 5 T.D. Volume)	3,141,407	2,916,081	+225,326
Total all T.D. Commodities (101)	4,366,227		
% 5 Commodities of Total	72.0%		

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada
*** Estimate based on (Conversion Methodology):**
48 Petroleum oils-Conversion based on Quantity (MTQ)
49 Gasoline-Conversion based on Value

While both the trade and transportation surveys are intended to be based on a census of customs documents, i.e. B3, B13, A6, A6A, the marine transportation weight data is generally expected to exceed the trade weight data for the following reasons:

- Transportation data include transshipments and in-transit cargoes that originate in the U.S. and are bound for a third country or that originate in a third country and are bound for the U.S.
- International trade for exports to overseas countries excluding the U.S. suffers undercoverage, as many exporters are unaware that they are required to report to Customs. Shipping agents, who file the A6 with Customs, appear to be more reliable in their reporting. The situation is further complicated by Customs reluctance to enforce the filling of the B13 as they collect no revenue from export trade.
- Trade data use a value threshold and do not get many small value shipments. The marine data captures these shipments which are consolidated into larger shipments.

b. Truck shipments

The Transportation Division captures and publishes a wide variety of financial and commodity movement statistics for the trucking industry. The data are captured by dividing the industry into two main components: "for-hire" and "private" carriers. For-hire carriers are engaged in the transportation of freight for compensation.

Private carriers are defined as operators of trucks by a company not principally involved in trucking.

International origin and destination commodity statistics are compiled from the "Quarterly For-Hire Trucking Survey", which targets Canadian domiciled for-hire motor carriers with annual transportation revenues derived from intercity trucking of $1 million or more. The sample survey is generated from approximately 1% of the total number of shipments (probills) filed each quarter for commodities carried by this class of companies. The survey provides estimates of the following intercity commodity movements:

- Metric tonnes transported between Canada and the U.S. (Northbound/Southbound movements)
- Commodity description, based on the Standard Commodity Classification (SCC) System
- Revenue generated from the movement of cargo.

The reconciliation of the transportation For-Hire Trucking Survey to trade data is done quarterly for the year 1996 and involves the 485 truck commodity codes. Truck data are reconciled with northbound and southbound movements by total International Trade exports and imports. Tables 6.1 and 6.2 show figures for the top 5 commodities based on size (largest in terms of overall weight) as reported by the Transportation Division. The comparison of truck metric tonnes reported by both divisions is for the third quarter of 1996.

Table 6.1 Reconciliation: Selected Commodities, Truck, Third Quarter 1996, Southbound/Total Exports

Transportation Code and Description	3rd Quarter 1996				
	TD	ITD EXP.US	ITD EXP.OVS	Total Exp.	(TD-ITD)
33 Wood fabricated materials	1,057,613	-	-	-	-
35 Paper and paperboard	843,452	1,254,386	50,927	1,305,313	-461,861
44 Iron, steel and alloys	592,962	570,695	3,352	574,047	+18,915
47 Non-Metallic Basic	345,658	4,373	-	4,373	+341,285
99 General or Unclassified freight	424,491	-	-	-	-
Sub Total (Top 5 T.D. Volume)	3,264,176	n.a	n.a	n.a	n.a
Total all T.D. Commodities (101)	7,888,051				
% 5 Commodities of Total	41.4%				

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada

Notes:

1. Trade commodity 33 not converted to metric tonnes at the time of writing.

2. No concordance established between Transportation code 99 and International Trade HS codes.

Table 6.2 Reconciliation: Selected Commodities, Truck, Third Quarter 1996, Northbound/Total Imports

Trans. Code (Description)	3rd Quarter 1996				
	TD	ITD IMP.US	ITD IMP.OVS	Total IMP.	(TD-ITD)
07 Fruits and fruit preparations	234,677	264,213	75,781	339,994	-105,317
33 Wood fabricated materials	315,161	-	-	-	-
44 Iron, steel and alloys	402,986	273,607	23,880	297,487	+105,499
58 Road motor vehicles	295,931	-	-	-	-
99 General or Unclassified freight	587,614	-	-	-	-
Sub Total (Top 5 T.D. Volume)	1,836,369	n.a	n.a	n.a	n.a
Total all T.D. Commodities (101)	4,576,494				
% 5 Commodities of Total	40.1%				

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada

Notes:

1. Trade commodity 33 and 58 not converted to metric tonnes at the time of writing.

2. No concordance established between Transportation code 99 and International Trade HS codes

To summarize, while the International Trade series for imports and exports is considered to be a 100% census coverage, the Transportation Division's trucking data are based on sampling. Following are the main factors affecting the reliability of Transportation truck estimates when compared with International Trade data:

- The Quarterly For-Hire Survey Trucking Survey targets only Canadian based for-hire carriers with intercity revenues of $1 million or more. Therefore, shipments delivered by U.S. based carriers, private carriers and smaller for-hire carriers are not included in the trucking origin and destination estimates.
- In some instances, commodity information is unavailable on the probills. This information can sometimes be imputed based on other information; in other instances, where there is no commodity description, goods will be classified as general freight.
- The sample survey is generated from approximately 1% of the total number of shipments (probills) filed each quarter by For-Hire trucking companies.

c. Rail shipments

International origin and destination commodity statistics are compiled by the Canadian Transportation Agency (CTA) and represent an annual census of

waybill records from the two major railways, Canadian National (CN) and Canadian Pacific (CP). Freight interlined with Class II is included while interline duplication between CN and CP is removed by the CTA.

Commodities are reported according to the U.S. Standard Transportation Commodity Description (STCC) and converted to the 320 commodity codes derived from the Standard Classification System (SCC). Intransit movements included in the rail data refer to data movements where both the origin and destination reported are in the U.S.

The reconciliation of the two rail databases is for the year 1996 and involves the 320 rail commodity codes codes. Northbound and southbound rail data are reconciled with total International Trade exports and imports. Tables 7.1 and 7.2 show figures for the top 5 commodities based on size (largest in terms of overall weight) as reported by the Transportation Division. The comparison is for the year 1996.

Table 7.1 Reconciliation: Selected Commodities, Rail, 1996, Southbound/Total Exports

Trans. Code (Description)	Year 1996				
	TD	ITD EXP.US	ITD EXP.OVS	Total Exp.	(TD-ITD)
308 Lumber	5,870,670	-	-	-	-
330 Woodpulp	3,158,362	3,242,564	35,471	3,278,035	-119,673
334 Newsprint paper	2,977,027	3,023,390	10,082	3,033,472	-56,445
416 Potash	5,603,131	5,975,662	-	5,975,662	-372,531
624 Mixed carload freight, n.e.s.	2,421,219	-	-	-	-
Sub Total (Top 5 T.D. Volume)	20,030,409	n.a.	n.a.	n.a.	n.a.
Total all T.D. Commodities (101)	n.a.				
% 5 Commodities of Total	n.a.				

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada

Notes:

1. Trade commodity 308 not converted to metric tonnes at the time of writing.

2. No concordance established between Transportation code 624 and International Trade HS codes

Table 7.2 Reconciliation: Selected Commodities, Rail, 1996, Northbound/Total Imports

Trans. Code (Description)	Year 1996				
	TD	ITD IMP.US	ITD IMP.OVS	Total IMP.	(TD-ITD)
134 Soyabean oil meal	487,482	483,098		483,098	+4,384
204 Copper ores and concentrates	361,823	38,511	1,946	40,457	+321,366
250 Clay	595,574	580,775	88	580,863	+14,711
556 Motor vehicle engines, accessories	575,355	-	-	-	-
624 Mixed carload freight, n.e.s.	2,222,289	-	-	-	-
Sub Total (Top 5 T.D. Volume)	4,242,523	n.a.	n.a.	n.a.	n.a.
Total all T.D. Commodities (101)	n.a.				
% 5 Commodities of Total	n.a.				

Source: Marine Section, Transportation Division/ International Trade Division, Statistics Canada
Notes:
1. Trade commodity 556 not converted to metric tonnes at the time of writing.
2. No concordance established between Transportation code 624 and International Trade HS codes

4. RECORD LINKAGE: TRADE AND TRANSPORTATION DATABASES

Record linkage involves establishing a link between records relating to the same entity, e.g. a specific commodity movement. As Trade and Transportation approach cargo movements from different viewpoints, the merging together of the two sources can provide new insight into the international movement of commodities. In the case of the International Trade and Transportation databases, what needs to be linked are the relevant administrative records which capture each commodity movement. Trade and Transportation databases were successfully linked at the administrative record level for marine movements with customs records for the year 1989. This one-time record linkage project produced a new enhanced transportation database for marine statistics which gave new insight into:

- dollar values with tonnages of commodities shipped,
- Canadian origin and destination commodity movements; and
- the interdependencies among various ports and regions in Canada.

Based on the benefits realized by linking marine movements, therefore, the question arose as to the feasibility of developing linkages for the other modes of transport, i.e. truck, rail and air, with trade data. In an attempt to make better use

of trade data to enhance transportation statistics, we thus examined the feasibility of further linkages for these other modes of transport.

Our examination looked at the three modes of transport, with research targeted at answering two basic questions:

1. Whether the data collected by both divisions are comparable after allowances are made for conceptual and mandate differences. This was never even open to consideration before because so much of trade data was captured in non-metric units of measurement, and because each division used different commodity codes. With the concordance tables built and with trade data in metric tonnes we could now compare what each division reports.
2. Whether the administrative data collected by both divisions are sufficiently similar to allow record linkages. If trade and transportation data were found to be sufficiently similar after analyzing the reconciliation tables, we would then try to identify for these modes what record variables could be used to match transportation records with trade records.

Our research has shown that there is no potential for linking trade and transportation records for truck and rail data, as was done for marine data, for the following reasons:

- For marine movements, trade and transportation data are collected from the same source - Canada Customs documents, while for truck and rail movements, they are collected from completely different sources.
- A census data collection approach is used for both trade and transportation data to track each marine movement. Truck commodity movements, on the other hand, are obtained from a relatively limited sample survey, while rail data are provided at an aggregate annual level by the two major railways.

5. CONCLUSIONS AND OBSERVATIONS

Based on the efforts described in this paper to improve the quality of Statistics Canada's transportation data, we can say the following:

1. A reliable methodology was developed to convert all international trade commodities to one uniform system of weight measurement. International trade data can now be extracted by mode of transport for each commodity traded internationally at the HS 6-digit level in metric tonnes.

2. Value/tonne estimates for all international trade data at the 6-digit HS level are now available. This new value/tonnage information can be integrated

into the transportation origin and destination statistical series without the need for record linkages.

3. International Trade and Transportation databases were reconciled by mode of transport at the individual transportation commodity code level. With trade and transportation data now possessing a weight in metric tonnes for all commodities, we are able to examine commodity movements for the purpose of identifying possible undercoverage of commodities.

4. Concordance tables were developed linking the Harmonized System (HS) to the Standard Commodity Classification System (SCC). If required, the concordance tables for truck and rail can be used in the interim until the new transportation commodity system (SCTG) is implemented in the year 1999.

5. Based on the mandate and methodology associated with the data capture of international truck and rail origin and commodity movements, we conclude that there is no possibility for any systematic record linkage at this time for these modes of transport.

CANADIAN VEHICLE SURVEY: METHODOLOGY

1. Introduction

Canadian transport activity statistics are grossly inadequate due to the lack of any routine measurement of road vehicle activity. Statistics Canada's transportation programme focuses on surveys of carriers, obtaining financial and activity statistics from for-hire trucking, bus operations and some private trucking, but this accounts for only a very small minority of road vehicles. For the majority of road vehicles dominating passenger travel (private cars, light trucks and motorcycles) and freight traffic (many private truck use and local for-hire trucks), no measures of total vehicle-kilometres, passenger-kilometres or tonne-kilometres are available. Among the OECD countries[1], only Canada is unable to provide even any confident estimates of these measures.

Without the measures, we are unable to meet the following simple analytical requirements of transport policy analysis and management:

- estimation of the modal distribution of passengers and freight;
- estimation of risk of accidents and casualties standardized to units of traffic – e.g. per passenger-km and per tonne-km;
- estimation of fuel consumption and emission rates per unit of traffic by class of road vehicles (e.g. for cars, light trucks and heavy trucks) and their characteristics (e.g. weight, engine size, body style);
- monitoring of trends in road traffic, and comparison with those in other modes;
- modelling of trends for forecasting.

[1] International traffic statistics are complied by UNECE in the *Annual Bulletin of Transport Statistics for Europe*. Canada is normally a contributor to the publication, but is unable to provide road traffic measures, and therefore no statistics of total passenger-kilometres nor total tonne-kilometres.

The list of detailed requirements for road traffic data would be much more extensive. This Forum has seen repeated pleas for the data to be improved as part of the national transport statistics programme, to permit more precise research and various commissions of inquiry into transport issues have recommended that improvements be made.[2]

The comprehensive themes in these expressed needs are for the following traffic measures:

- vehicle-km;
- passenger-km;
- tonne-km;

by characteristics of:

- vehicles (construction type, features and equipment);
- users (demographics);
- trips (purpose);
- commodities;
- locations (road type, route, O/D);
- time (hour, day, month).

Obtaining all of these data is a tall order. Experience in traffic measurement and travel surveying worldwide suggests no single method can meet all the needs, and that the required surveys can be very expensive. For example, in order to obtain trip purpose and user demographics for passenger trips, it appears essential to survey users directly; while in order to obtain freight commodities, it appears necessary to survey carriers; and large samples are needed for reliable estimation in both cases. But it does not appear possible to obtain road characteristics reliably from users; nor such transient features of vehicles as weight and equipment condition. It appears in fact that private vehicle owners often find it impossible to report such simple characteristics of vehicles as year of manufacture, or engine size.

Solutions to the needs vary substantially among countries, but there are commonly separate surveys for freight and passenger trips, together with road

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[2] See for example Royal Commission on National Passenger Transportation: *Directions*, Final Report, Ottawa: Supply and Services Canada 1992, and *Competition in Transportation, Policy and Legislation in Review*, National Transportation Act Review Commission, Supply and Services Canada, 1993.

traffic volume counting.[3] These in combination can provide much of the information listed above. Their ability to provide vehicle characteristics and fuel consumption for private light vehicles are seriously limited, however, and their ability to provide truck weights is very questionable.[4]

A review of Canadian needs for road traffic data, and potential solutions, was included in a comprehensive study by Transport Canada of all data needs in 1993.[5] Impetus towards resolving the needs through national surveys was provided subsequently by the major restructuring of federal transport activities, in which it was recognized that direct federal involvement in service delivery implied a greater responsibility for monitoring system performance. A broad requirement to report annually on system activities was included in the *Canada Transportation Act* of 1996 (section 52).

Transport Canada examined the possibilities to meet the road data needs and came to the initial conclusions that:

- it would not be possible financially to meet all the needs immediately so a compromise survey providing as much as possible of the requirements should be designed;
- road traffic volume counting should be left to responsible provincial, territorial and municipal governments; and
- a survey of vehicles using registration files to provide accurate characteristics of the vehicles, then obtaining trip logs from owners, appeared most promising.

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[3] See e.g.: documentation of passenger trip surveys and traffic volume counting, and the recommendations that both are necessary, in OECD, Road Transport Research: *Framework for Consistent Traffic and Accident Statistical Databases*, Paris: OECD, 1988.

[4] Truck gross combination weight proves difficult for carriers to provide in any kind of survey of administrative records, and commodity weight difficult for shippers to provide (viz. the US DOT/Bureau of the Census "Commodity Flow Survey", reported in www.bts.gov). Only direct interception and weighing of vehicles appears able to provide these, as in the Ontario and CCMTA Roadside Trucking Surveys of 1995 (see Harbour, W: "1995 CCMTA National Roadside Survey Project", CTRF Proceedings 1997, 432-444).

[5] Lawson, J: Data Needs Review, Transport Canada, Economic Analysis Directorate, 1993 (available from www.tc.gc.ca under "T-FACTS Info System" , "Research Reports").

In 1996, Transport Canada approached the Transportation Division of Statistics Canada to investigate the feasibility of establishing a new survey program, which would measure motor vehicle use on a regular basis. The Canadian Vehicle Survey (CVS) was proposed to be an annual survey that would cover the entire population of on-road vehicles (commercial, private and those used for both purposes). This survey would provide information on a variety of aspects such as the physical characteristics and structure of the motor vehicle population (including automobiles, commodity carrying trucks and passenger buses), operational and temporal trends in vehicle use and characteristics of the vehicle driver (s).

In order to implement the CVS, a testing strategy was developed. It was first decided to test the content of the trip log by the use of focus groups. Secondly, the content of the telephone interview and parts of the survey process were tested in a small pilot study. Finally a comprehensive pilot test was put in place to test the entire process, estimate the response rates and evaluate the quality of data collected.

In this paper we address the issues relating to the methodology and the challenges presented by the survey. From a methodological perspective, we need to resolve questions like: Do we sample vehicles or households and businesses? What is our survey frame? What information can we get about vehicle use? How do we get it? Will the response rate be sufficient to make this whole exercise worthwhile? In addition, some preliminary results of the small pilot study will be outlined.

2. Sampling Unit

Two approaches could have been used to measure vehicle use: a household/business based survey or a vehicle based survey. In the first approach, households and businesses are contacted and asked for an inventory of their vehicles. One vehicle is selected and then characteristics are measured. Since there are many Statistics Canada household and business surveys, this method gives the opportunity of using existing platforms. The drawbacks of this approach, however, is that these existing surveys have different coverage which could result in under-coverage or double counting of vehicles used for both personal and business activities. Since the major objective of the CVS is to

cover the entire population of on-road vehicles, another approach had been considered.

The second approach is to have the vehicle as the sampling unit. This means creating a sampling frame using the registration file of each province/territory, which would provide a complete coverage of vehicles in Canada. Each vehicle is identified on the file by a Vehicle Identification Number (VIN) as well as other characteristics of the vehicle like the weight. This extra information provides a priori knowledge of the vehicle for the sampling design. Using a vehicle-based approach would also allow international comparability directly with the quinquennial Truck Inventory and Use Survey (TIUS) of the United States. The major disadvantage of this approach is the difficulty of obtaining the files and the integration of registration files from the various provinces/territories.

The second approach was the one chosen for the CVS.

3. Sampling Frame

The sampling frame is defined as the set of units covering all or part of the observed population and enabling access to it. In this case, the sampling frame is constructed from the provincial/territorial motor vehicle registration files.

3.1 Target population

The target population is defined as the group for which the information is required and to which the survey results will apply. For the CVS the population will initially include all active motor vehicles except trailers, motorcycles, off road vehicles like snowmobiles, dune buggies and amphibious vehicles, and special equipment like cranes, street cleaners, snow plows and backhoes.

3.2 Provincial/territorial motor vehicle registration files

The provincial and territorial motor vehicle registration files will be supplied for CVS every three months. These files are a rich source of data themselves. By tabulating them, we get a good picture of the Canadian motor vehicle population and its characteristics (number of cars, trucks, buses, etc.). There are, however, some key problems with utilizing registration files. The main problem is that

each jurisdiction has its own unique file format and variables. It is therefore necessary to reformat the files to a common format. Each time a province institutes a change (new variables, system modifications, etc.), a change will be required to the reformatting programs. The information on the files at times may also be out of date and/or contain errors, which hampers processing.

4. Sampling Design

We will receive registration files each quarter, in order to obtain as up-to-date as possible information on births, deaths and changes to the files. The sample will be selected four times a year. Note also that the four samples will be disjointed - the same vehicle will not be selected more than one time.

4.1 Stratification

There are two main reasons for stratification. Stratification allows us to gain efficiency in the precision of our estimates if we are able to find homogeneous groups of vehicles. Also we can stratify if separate estimates are required for different "domains" of study. The choice of the stratification variables is a compromise between the desire to gain in efficiency (minimize the sampling error) and the desire to have a reasonable sample size.

The basic stratification based on these requirements starts with selected stratification variables with the provincial/territorial boundaries as stratum boundaries. Further, selected stratification variables are: age of vehicle, gross vehicle weight, and vehicle type, since these variables determine to a large extent the number of kilometres traveled. These variables also appear stable over time, which will reduce movements between strata from one survey period to another.

4.2 Sample size allocation

To determine the sample size, we must take into account the cost, operational constraints and the desired precision of the results (standard deviation, coefficients of variation). We also considered the variability of the characteristics in the population and non-response. The greater the difference between population units, the larger the sample size required to achieve specific levels of reliability. Increasing the sample size for non-response does not reduce the bias resulting from the non-response. The size of the bias depends on the

size of the non-response and the difference in characteristics between respondents and non-respondents.

Considering the preceding requirements, the estimated target sample size is expected to be 36,000 vehicles. This sample will be allocated to the jurisdictions in proportion to the square roots of their vehicle population sizes. The square root allocation is a method of increasing the sample sizes for the smaller provinces (when compared with a proportional allocation) without compromising the precision of Canada-level estimates as much as an equal allocation. The allocation to strata within provinces will be again in proportion to the square roots of their vehicle population sizes.

4.3 Sample Selection

The sample (¼ of the annual sample), for the first quarter's surveys, will be selected in November of each year, based on the previous October's clean registration file. Within each stratum, the sample will be selected randomly. The same process will take place for the other quarters.

4.4 Telephone Research

Once the sample has been drawn, telephone numbers are researched since they are not available on the file. Phone software is used and matches are performed by combinations of names and/or address of the owner of the vehicle. For buses and heavy trucks we also match with records on our carrier surveys. In order to increase the matches, the unmatched sample is sent to each regional office of Statistics Canada to try to find telephone numbers using local telephone books and directories. Up to now we have a matching telephone rate of 95%, which is a very good rate.

5. Data Collection

5.1 Information Collected

From an examination of practices of other countries, two types of surveys could be used for this vehicle-based survey. The first one is using a recall technique, where the respondent would be asked about the activity of their vehicle over a past period of time. The data would be obtained on a one-shot basis and the

survey would be conducted as an annual survey. The second technique is the use of a log, where the respondent would be asked to fill in data about the vehicle for a period of time as it takes place. The survey would have to be carried out throughout the year because driving patterns change over the year.

We decided to use logs. We can collect more information and that information is more accurate by this method. The drawback is that low response rates are often associated with logs.

The data will be collected continuously throughout the year with staggered start days. The reporting period for individual vehicle will be either 3 days or 7 days depending on test results.

5.2 Mode of Data Collection

The choice of data collection mode involved balancing a number of competing factors: accuracy and type of information collected, cost per interview, length per interview, response rate and sample size. The data collection for CVS is done by telephone interviews (CATI) and self-completed mail-back trip logs. Since there is likely to be a higher non-response experienced with self-completed mail-back trip logs, we decided to contact the owner of the vehicle by telephone prior to sending them a trip log. This first contact will be done two weeks before the trip log's reference period. Several follow-ups calls will also be made.

Unfortunately telephone numbers can not be found for some owners and no personal contact by telephone can be made with them. In these cases a self-completed mail-back trip log plus a one-page questionnaire, consisting of the main questions asked by phone, will be mailed to them. Follow-up procedures will also be made by mail.

5.2.1 Telephone interview

For all respondents with a telephone number a pre-screen call will be made essentially to verify the vehicle type, which will determine the appropriate log to send them. At the same time, we will ask them some questions about their driving habits, their odometer reading, the number of drivers for that vehicle, etc.. This information will be very useful for modeling non-response, in the

event that they do not fill in the log. In table 1, the main questions are listed by category of information.

The second call, on the first day of the reporting period, will be made to answer any questions, to motivate the respondent to complete the log and to obtain an odometer reading. If the respondent is not reached on the first day, the interviewer will call on the next day.

Table1.Telephone interview questions

Type of information	Examples of questions asked
General information about the vehicle	- What kind of fuel does this vehicle use? - What type of vehicle is this?
Information about how far the vehicle is driven	- Is this vehicle normally driven to work or school? - What would be the distance travelled one way? - What was the total distance driven with this vehicle in the last seven day? - Is this vehicle used every day, week days only, weekends only, a few time a week, very rarely, during certain seasons only or not at all?
General uses of the vehicle	- Is this vehicle used to deliver goods or equipment? - Is this vehicle used for businesses purposes such as delivery, services calls or sales? - Is this vehicle used solely for business or used for both private and business?

Background information on the drivers of the vehicle	- How many different drivers does this vehicle have? - Is there a main driver of this vehicle? - Is the main driver of this vehicle male or female? - What is the age group of the main driver of this vehicle?

5.2.2 Trip log

Surveying vehicles that belong to both households and businesses is quite a challenge since we want a homogeneous process and as few survey instruments as possible in order to keep it simple. We ended up with three versions of the trip log: light, heavy and bus.

These logs were tested in many focus groups all across Canada to identify problems areas, to make recommendations to ensure that the logs were respondent-friendly, that they can be easily understood and accurately completed by respondents, and that the survey's response rate will be maximized.

Most of the questions, listed in the appendix, were reformulated after the focus groups in order to minimize the difficulties that respondents may have in providing answers. We also include, at the back of the log, a section that gives more detailed information about each question asked. The explanations given in that section are summarized in table 2:

Table 2. Trip log questions

Questions	How we use each question
Odometer reading at start and at end of each trip	It is the most important question, allowing us to know the kilometres traveled for each trip, and the total traveled by the vehicle during the survey days. These are essential to calculating the amount of travel in the country each year.
Date/Time each trip started and ended	It tells us when trips start and finish, so we can show, for example, how much travel is on weekdays compared to weekends, in the morning and evening rush-hours compare to the middle of the day, or in the middle of the night.
Origin and destination of each trip	It indicates whether a trip started and finished at home, at work or somewhere else. This should make it easier for them to keep track of the trips when they are filling out the log.
Questions	**How we use each question**
Number of passenger in each age group at the beginning and the end of each trip	It lets us calculate vehicle occupancy. The details of passengers by age-group are primarily for safety analyses because of the particular concerns over safety of infants
Main purpose of each trip	It is important to know why they are travelling by road for people who plan urban land use, or plan public transit, air, bus and bus services. It also lets us know, whether leisure travel is growing faster than commuting, or whether people are travelling longer distance to do their shopping

Driver's characteristics	Driver's sex and age group are asked particularly for computation of accident rates by each group.
Travel on road with posted speed limits of 80km/h or more	It attempts to distinguish between travel on urban streets, and that on highways or in rural conditions. This is an important distinction since safety, fuel consumption and emissions differ greatly between urban streets, and highways or rural conditions.
Fuel purchased, if any, during that trip	The answers are not directly used to try to assess the fuel consumption of the vehicle, but instead to calculate the average amount of fuel bought per day by all the vehicles in the sample. From the daily averages we can estimate annual amounts of fuel used nationally by similar type of vehicles.

The majority of the information in the trip log is collected by asking the respondent to provide information on the trip made by their vehicle. A clear and well understood definition of the word 'trip' was an important discussion. We learned that there is no commonly accepted notion of 'a trip' but the following definition was the favored one - it reduces the burden for people having multiple consecutive trips:

"A trip is defined as your travel from one location to another for a specific purpose such as to or from work. Report a separate trip if there is:

. a change in the main trip purpose
. a stop of more than 30 minutes
. a change in driver "

5.2.3 Follow-ups

Follow-ups will be a key factor in improving the response rate. For the respondents with phone numbers that did not refuse to do the trip log, a third call will be made to verify if they completed the log. If not, we will ask them to report for the following week. If the respondents refuse to complete the log at this point, we will ask them if they will agree to fill in a postcard consisting of three odometer reading and the dates they were taken. This alternative will be effective only for households since businesses may be contacted in the future for

another vehicle and they may directly ask for the postcard instead of the log. There will be a fourth call to ensure that the respondent sends back the trip log or the postcard. Again if the respondents did not complete the log, we will ask them to report for the following week.

For respondents that were not previously contacted by phone, a first reminder will be mailed one week after the last day of the reference period. It will consist of a letter and another trip log to be filled in for the next week. Finally a last reminder will be mailed two weeks after the first follow-up if no log is received. A short questionnaire will then be sent to the respondent asking for an odometer reading.

6. Small pilot test

We conducted a small pilot test for the province of Québec and British Columbia. The objective of this pilot test was to determine where improvements could be made in the survey process. We developed and tested two versions of the telephone interview: a short (version with 6 questions) and a long (version with 20 questions). We also tested a 3-day log and a 7-day log.

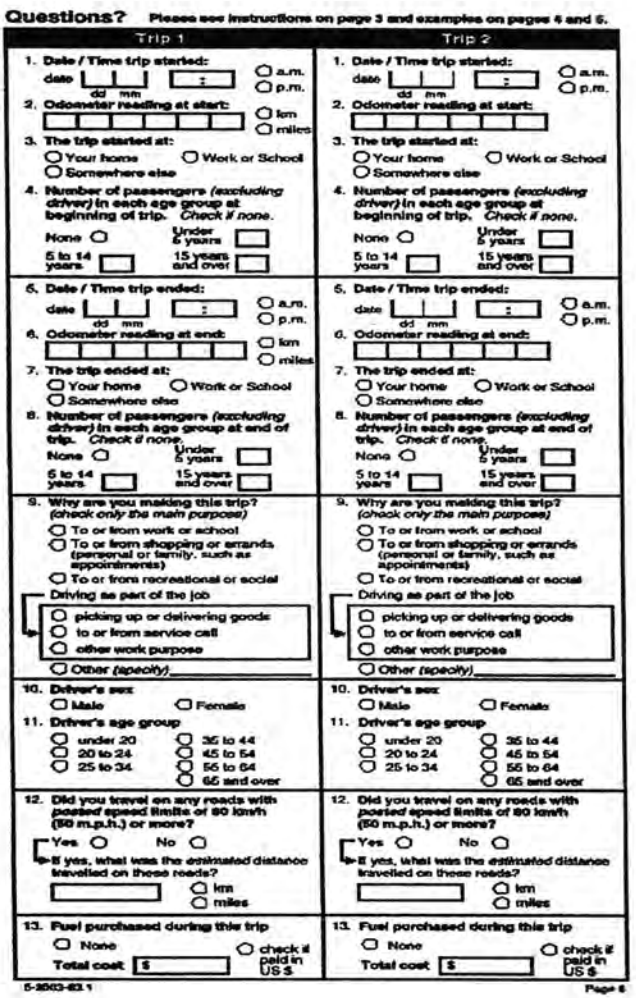
No statistical difference was found between the response rates for the short and long telephone interviews. The other surprising and positive result was that the response rates were similar for the 7-day and 3-day logs. These two lengths will be tested again in the pilot test.

Even though we encountered problems (postal strike, Christmas, ice storm, etc.) throughout the small pilot, we met our main objective - to learn as much as we can in order to carry out a successful comprehensive pilot test.

7. Conclusion

The development of this survey is an on-going process. No doubt, there will be many changes pertaining to all aspects of the survey in the next few months as a result of the comprehensive pilot survey.

Appendix: Trip log questions for the light vehicles



Questions? Please see instructions on page 3 and examples on pages 4 and 5.

Trip 1	Trip 2
1. Date / Time trip started: date dd mm : ○ a.m. ○ p.m.	1. Date / Time trip started: date dd mm : ○ a.m. ○ p.m.
2. Odometer reading at start: ○ km ○ miles	2. Odometer reading at start: ○ km ○ miles
3. The trip started at: ○ Your home ○ Work or School ○ Somewhere else	3. The trip started at: ○ Your home ○ Work or School ○ Somewhere else
4. Number of passengers *(excluding driver)* in each age group at beginning of trip. *Check if none.* None ○ Under 5 years ☐ 5 to 14 years ☐ 15 years and over ☐	4. Number of passengers *(excluding driver)* in each age group at beginning of trip. *Check if none.* None ○ Under 5 years ☐ 5 to 14 years ☐ 15 years and over ☐
5. Date / Time trip ended: date dd mm : ○ a.m. ○ p.m.	5. Date / Time trip ended: date dd mm : ○ a.m. ○ p.m.
6. Odometer reading at end: ○ km ○ miles	6. Odometer reading at end: ○ km ○ miles
7. The trip ended at: ○ Your home ○ Work or School ○ Somewhere else	7. The trip ended at: ○ Your home ○ Work or School ○ Somewhere else
8. Number of passengers *(excluding driver)* in each age group at end of trip. *Check if none.* None ○ Under 5 years ☐ 5 to 14 years ☐ 15 years and over ☐	8. Number of passengers *(excluding driver)* in each age group at end of trip. *Check if none.* None ○ Under 5 years ☐ 5 to 14 years ☐ 15 years and over ☐
9. Why are you making this trip? *(check only the main purpose)* ○ To or from work or school ○ To or from shopping or errands (personal or family, such as appointments) ○ To or from recreational or social Driving as part of the job ○ picking up or delivering goods ○ to or from service call ○ other work purpose ○ Other *(specify)*	9. Why are you making this trip? *(check only the main purpose)* ○ To or from work or school ○ To or from shopping or errands (personal or family, such as appointments) ○ To or from recreational or social Driving as part of the job ○ picking up or delivering goods ○ to or from service call ○ other work purpose ○ Other *(specify)*
10. Driver's sex ○ Male ○ Female	10. Driver's sex ○ Male ○ Female
11. Driver's age group ○ under 20 ○ 20 to 24 ○ 25 to 34 ○ 35 to 44 ○ 45 to 54 ○ 55 to 64 ○ 65 and over	11. Driver's age group ○ under 20 ○ 20 to 24 ○ 25 to 34 ○ 35 to 44 ○ 45 to 54 ○ 55 to 64 ○ 65 and over
12. Did you travel on any roads with *posted* speed limits of 80 km/h (50 m.p.h.) or more? Yes ○ No ○ If yes, what was the *estimated* distance travelled on these roads? ☐ ○ km ○ miles	12. Did you travel on any roads with *posted* speed limits of 80 km/h (50 m.p.h.) or more? Yes ○ No ○ If yes, what was the *estimated* distance travelled on these roads? ☐ ○ km ○ miles
13. Fuel purchased during this trip ○ None Total cost $ ☐ ○ check if paid in US $	13. Fuel purchased during this trip ○ None Total cost $ ☐ ○ check if paid in US $

5-2003-03-1 Page 6

AN OVERVIEW OF THE APPLICATION OF ITS TO COMMERCIAL VEHICLE OPERATIONS IN TEXAS

Dan Middleton
Jeannette Montufar
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AN OVERVIEW OF THE APPLICATION OF ITS TO COMMERCIAL VEHICLE OPERATIONS IN TEXAS

Dan Middleton[1], Jeannette Montufar[2], and Susan Bryant[3]

Introduction

The U.S. Department of Transportation is in the process of deploying several nationwide Intelligent Transportation Systems (ITS) initiatives that may have an impact on commercial vehicle operations (CVO) in the U.S. These initiatives are evolving due to several reasons which include the following: (1) federal, state, and local governments are increasingly being required to do more with limited resources; (2) technology is available to improve safety and efficiency of motor carrier operations; and (3) the motor carrier industry is receptive to improvements that do not compromise safety or efficiency.

One of the items included in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 was the ITS (then IVHS) program. This program was designed to improve mobility and transportation productivity, enhance safety, and decrease the environmental impact of travel through the application of advanced technologies.

In an effort to remain competitive with other states which were already moving ahead with plans to apply ITS to commercial vehicle operations, the Texas Department of Transportation (TxDOT) recognized the need to

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develop a strategic plan for CVO in the state of Texas. The Texas Transportation Institute (TTI) at Texas A&M University was selected to develop this comprehensive plan with the assistance of an advisory team consisting of stakeholders from TxDOT, the Texas Department of Public Safety (DPS), the Federal Highway Administration's Office of Motor Carriers, the National Highway Traffic Safety Administration, Metropolitan Planning Organizations, and motor carriers.

This paper presents preliminary results from the research for the development of the Texas strategic plan for commercial vehicle operations. More specifically, the paper: (1) discusses the National ITS-CVO program; (2) presents information about the trucking activity and commodity movements in Texas, in terms of the quantities and characteristics of vehicles that move on the highways, the area of operation of those vehicles, and the amount of tonnage moved to, from, and within the state; (3) discusses the findings from a carrier survey conducted to investigate important issues of relevance to the development of the strategic plan; and (4) presents areas of potential improvements for commercial vehicle operations in Texas.

The Need for a Commercial Vehicle Strategic Plan for Texas

The Texas Department of Transportation recognized the need for an integrated and coordinated plan for the development of the State's commercial vehicle operations program.

Several characteristics set Texas apart from other states that are also developing CVO strategic plans:

- The size of the state and the distribution of trucking--dispersed over vast areas of land--are factors to consider to effectively use limited enforcement resources.

- The volume of trucks at the 22 border crossings in Texas represents approximately one-half of all trucks crossing the entire U.S.-Mexico border on a daily basis. In addition, Texas has the highest truck volume crossing point along the entire U.S.-Mexico border at Laredo.

- Texas does not utilize ports of entry (POEs) at its state borders, choosing rather to conduct enforcement primarily with roving patrols,

supplemented with a few fixed inspection sites. There are currently 321 DPS officers to patrol and enforce truck size and weight (TS&W) and safety regulations on 36,059 miles of highways in Texas. This mileage includes Interstate highways, U.S. highways, state highways, and Interstate frontage roads [1]. The low ratio of enforcement personnel to highway miles is the reason DPS chooses to operate on a roving basis. This mode of operation is intended to utilize scarce resources to minimize non-compliance. However, this also means that there are relatively few locations suitable for Commercial Vehicle Safety Alliance (CVSA) Level 1 inspections — only 98 for the entire state [2].

- Other agencies in addition to DPS are also trained and authorized to conduct commercial vehicle enforcement of size and weight laws.

A critical step in the ITS-CVO process for Texas occurred with the Commercial Vehicle (COVE) study that was conducted to investigate institutional barriers for a seven-state region [3]. Goals of the Texas State Working Group for this study were to promote CVO regulatory efficiency; to improve motor carrier productivity; and to enhance safety. The COVE study recommended the following: (1) guiding of CVO programs and policies; (2) simplification of CVO rules and regulations; (3) provision of electronic services; and (4) evaluation and implementation of appropriate technology. These recommendations form the foundation of the work performed for the development of a Texas strategic plan for commercial vehicle operations [3].

The strategic plan will recognize and leverage national mandates and opportunities in addition to international activities bearing on freight movement on Texas highways. It will also consider advances in information and transportation technology; streamlining of motor carrier regulatory and administrative procedures and improved safety; and productivity of motor carrier activities in the state.

The National ITS-CVO Program

The National ITS-CVO program is a combination of various initiatives representing the efforts of regions, individual states, the trucking industry, the Federal Government, and other associations and organizations [4]. The main goals and objectives of this program are: (1) to improve commercial

vehicle safety; (2) to increase freight mobility; (3) to improve tax administration and credentials; (4) to improve regulatory compliance; and (5) to reduce environmental and energy impacts [5,6]. Some ITS technologies such as automatic vehicle identification (AVI), weigh-in-motion (WIM), automatic vehicle classification (AVC), automatic vehicle location (AVL), on-board computers (OBC), and smart transponders are already being applied to CVO to streamline administrative procedures and improve the productivity and safety of trucking in the U.S. [4].

Two of the main components of the National ITS-CVO program are the Commercial Vehicle Information Systems and Networks (CVISN), and the Mainstreaming Program. CVISN focuses on exchanging CVO information electronically, while Mainstreaming creates state and regional business plans for the implementation of CVISN [7,8].

The national ITS-CVO program is organized to develop and deploy capabilities in six user service areas: (1) electronic clearance (domestic and international); (2) roadside safety inspections; (3) on-board safety monitoring; (4) administrative processes; (5) fleet and freight administration; and (6) hazardous materials incident response [4,9]. Electronic clearance allows commercial vehicles to travel with minimum or no stopping through ports of entry or weigh stations. Automated roadside safety inspections provide automated information to inspectors to assist them with the inspection process. On-board safety monitoring provides the capability for sensing the safety status of the vehicle, driver, or cargo while traveling at mainline speeds. Administrative processes consist of: (1) electronic purchase of credentials, which allows carriers to automatically apply for permits or for registration; and (2) automated mileage and fuel reporting and auditing, which allows carriers to automatically record total trip miles and fuel purchases for purposes of mileage and fuel tax reports. Fleet and freight administration provides drivers and dispatchers with real-time information about the location and routing of a vehicle. Hazardous materials incident response describes any hazardous materials involved in incidents and defines appropriate countermeasures [4,9].

In the course of the research for the development of the strategic plan, Texas will consider the potential for the application of ITS technologies in these user service areas.

Trucking Activity in Texas

To better understand the implications of trucking in a region, consideration should be given to the quantities and characteristics of vehicles that move on a highway, the area of operation of those vehicles, and the amount of travel. The application of ITS-CVO in a region is largely a function of the need for that application, based on the trucking activity and other relevant factors. This research investigated the current trucking activity in Texas in terms of: (1) characteristics of the truck fleet; (2) truck weights; (3) truck flows; and (4) area of operation of the Texas fleet.

Table 1 details the relative distribution of the different truck types registered in Texas, and compares it to the national fleet. Texas has the third highest truck population in the United States after California and Illinois. The Texas truck fleet represents just over 5 percent of the national fleet (California represents 10 percent and Illinois represents 7 percent). Nearly 60 percent of Texas-registered trucks are single unit trucks, approximately one-third are tractor-semitrailers, 7 percent are truck and trailer combinations, and less than one percent are tractor-double trailers [9].

Table 1 - Total Truck Fleet in Texas

Truck Type	Texas	U.S.
Single Unit	125,896	2,776,004
Truck + Trailer	14,156	181,881
Tractor + Semitrailer	73,391	1,061,255
Tractor + Double Trailer	965	52,031
TOTAL	214,408	4,071,171

Note: Excludes pickups, mini-vans, utility sports, station wagons, trucks or truck-tractors with 4 tires, and trucks pulling 1-axle trailer or 1-axle utility trailer.
Source: U.S. DOT Comprehensive TS&W Study Report No. 2, 1996

More than two-thirds of truck movements in Texas occur at an average gross vehicle weight (GVW) of less than 40,000 pounds, which generally requires no more than three axles. Just over 80 percent of the movements occur at average GVW levels less than 60,000 pounds, which generally require no more than four axles. Almost 100 percent of the movements take place at

average GVW levels less than 80,000 pounds, which generally require no more than five axles. Less than one percent of truck movements occur at weight levels requiring more than five axles [10]. This implies that most trucks operate most of the time at weight levels below the maximum gross vehicle weight limit available to them.

Most of the trucking activity in Texas, in terms of Average Annual Daily Truck Traffic (AADTT), occurs on the following road sections: (1) Interstate 35 between Dallas and San Antonio--approximately 7,000 trucks per day; (2) Interstate 45 between Dallas and Houston--approximately 6,000 trucks per day; (3) Interstate 10 between San Antonio and Houston--proximately 5,000 trucks per day, and east of Houston--7,500 trucks per day; (4) Interstate 20 between El Paso and Dallas--about 3,500 trucks per day, and east of Dallas--5,000 trucks per day; and (6) Interstate 40 east of Dallas--approximately 5,000 trucks per day [10].

Most trucking activity generated by the state stays within Texas. More than three-quarters of the trucks registered in the state drive less than 25 percent of their mileage outside of Texas. One of every 40 trucks drives from 75 to 100 percent of its mileage outside the state. More than 80 percent of all truck trips are within 200 miles of their base location or off the road. Only 1 of 14 trucks operates in the 200 to 500-mile range, and 1 of 17 trucks makes trips that are greater than 500 miles [10]. This indicates that the vast majority of Texas-based trucking is intrastate in nature, and the total trucking activity is mainly local.

In summary, before applying ITS-CVO actions to the state of Texas, the following must be considered: (1) the vast majority of trucks that are registered in Texas are single unit trucks and tractor-semitrailer combinations; (2) more than two-thirds of the movements occur at GVWs less than 40,000 pounds; (3) there are a few selected highways that account for most of the trucking activity in the state; and (4) most of the trucking activity is intrastate and short haul in nature (within 200 miles of home).

Commodity Movements in Texas

Improvements to programs directed at commercial vehicle operations, or the extent to which ITS can be applied to CVO in a region, also depend on the types of commodities that move in that region, the origin-destination patterns

of those commodities, and the quantities of product being moved.

Of all the tonnage that originates in Texas, trucking handles just over one-half; pipeline handles approximately 20 percent; rail handles 15 percent; intermodal operations handle approximately 5 percent; and other modes handle nearly 10 percent. One-third of all ton-miles of movement originating in Texas occur by rail; almost 30 percent take place by truck; 15 percent occur intermodally, and nearly 20 percent of ton-miles of movement take place by other modes [11].

Of the total reported tonnage that originates in Texas and is moved by truck, private trucking accounts for almost 60 percent of this total, and for-hire trucking accounts for the remaining 40 percent (122 million tons). There are six commodities that account for 80 percent of the reported truck-transported tonnage originating in Texas. These commodities are: nonmetallic minerals, petroleum and coal products, food or kindred products, chemicals or allied products, farm products, and lumber or wood products excluding furniture.

Local shipping distances (less than 50 miles) account for 70 percent of all tons moved by truck, and short haul shipping distances (less than 250 miles) account for nearly 90 percent [11].

Intrastate Commodity Movements by Truck

A commodity flow analysis conducted during the course of this research found that of all the reported tonnage that moves intrastate in Texas, approximately 75 to 85 percent moves intra-regionally (meaning that it stays within the region of origin). Of the tonnage that moves intrastate and moves inter-regionally (or between regions), two-thirds are attracted by the Dallas-Fort Worth-Abilene region, and the Houston-Beaumont region. In addition, the same two regions generate just over two-thirds of the intrastate tonnage.

The analysis also found that at a regional level, private trucking dominates commodity movements in Texas, accounting for almost 70 percent of the activity. Private trucks transport mainly petroleum and coal products; nonmetallic minerals; clay, concrete, glass, or stone products; chemicals or allied products; farm products; food or kindred products; and lumber or wood products, excluding furniture. For-hire trucking transports the same commodities with the exception of petroleum and coal products.

The key point about intrastate commodity movements by truck in Texas is that for both private and for-hire trucking, approximately 85 percent of the activity is local (trucks do not leave the region where the tonnage originates). The remaining 15 percent involves trips to major attracting centers like Houston, Dallas-Fort Worth, and San Antonio.

Interstate Commodity Movements by Truck

Interstate commodity movements are of two types: (1) those which originate in Texas and are destined for other states; and (2) those which originate in other states and are destined for Texas. The major destinations for truck-transported tonnage that originates in Texas are: Louisiana, Arkansas, New Mexico, Oklahoma, California, and Kansas. Together, these states attract just over one-half of all the truck-transported interstate tonnage originating in Texas. The major origins for the tonnage that is destined for Texas are: Oklahoma, Louisiana, Arkansas, Tennessee, California, Kansas, and Mississippi. Together, these states generate three-quarters of all the truck-transported interstate tonnage destined for Texas [12].

Figure 1 illustrates tonnage movements by major origin--for tonnage destined for Texas, and by major destination--for tonnage originating in Texas. In the commodity flow analysis, a major destination state was defined as a state which attracted at least 200 trucks per day hauling 25 tons of the truck-transported tonnage originating in Texas. A major origin state was defined as a state that generated at least 200 25-ton trucks per day of tonnage destined for Texas. The 200 25-ton trucks per day were chosen as the cutoff point to avoid small numbers problems when conducting the origin-destination analysis at the regional level.

Texas-Related Carrier Operations

A carrier survey was conducted as part of this study to investigate the following issues of relevance to the development of a Texas strategic plan: (1) motor carrier operations in Texas; (2) motor carrier perception of technology as applied to commercial vehicle operations; (3) the importance of advanced technology in Texas; (4) ways in which carrier operations could be improved by the Texas Department of Transportation, making use of ITS or other methods available to the Department; and (5) motor carrier concerns regarding economic implications of using ITS for their operations in Texas.

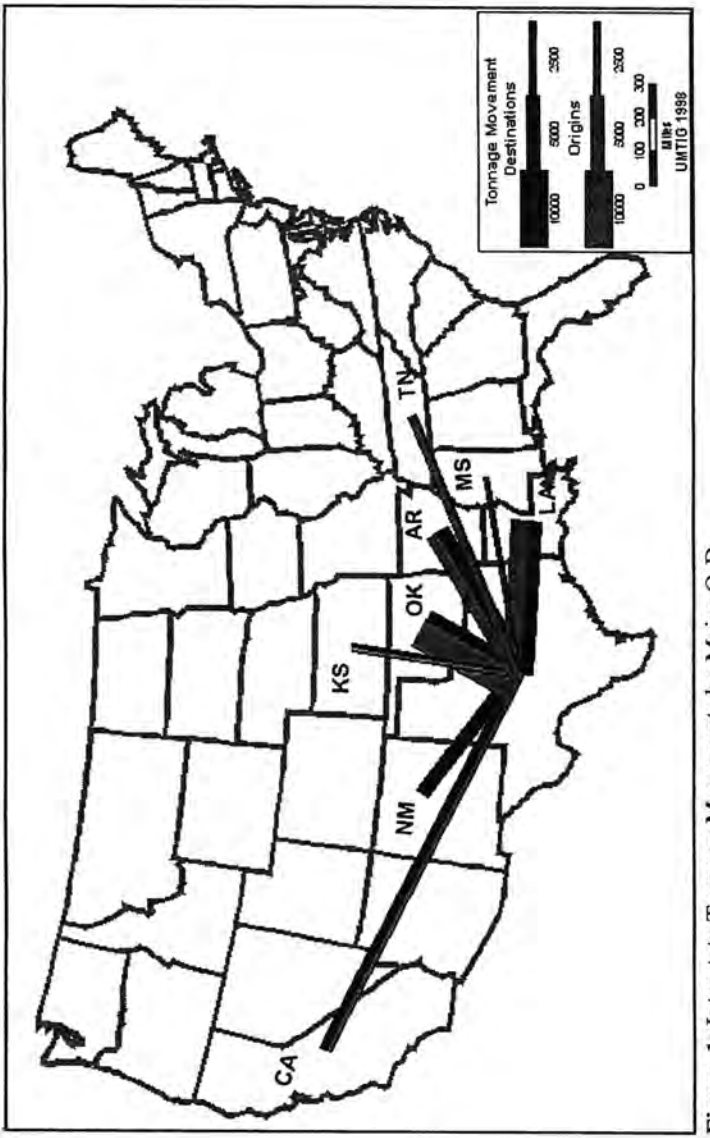


Figure 1: Interstate Tonnage Movements by Major O-D
Source: 1993 Commodity Flow Survey
Mapping by the University of Manitoba Transport Information Group 03/28/98

The selected carriers operate a combined fleet of approximately 35,800 tractors and 92,900 trailers in the U.S., Canada and Mexico. Approximately 15 percent of those tractors and trailers operate either to, from, within, or through the state of Texas.

The majority of carriers surveyed, both private and for-hire, are aware of advanced technologies which can be applied to their operations. This is particularly true for large for-hire carriers, who know about the latest advances in technology, specifically applied to fleet management. However, there is little interest in applying these technologies for purposes other than for fleet management.

Technologies currently being used for fleet management include: (1) satellite systems for equipment tracking, load monitoring, and enhanced communication; (2) cellular telephones; and (3) on-board computers. Other types of technology currently being used by these carriers include electronic toll tags for operations on turnpikes, computer software packages for scheduling and routing, and bar-coding systems for electronic clearance at the U.S.-Canada border. Two of the large truck load carriers are currently considering the possibility of acquiring electronic logging capabilities.

The few carriers that are not currently using any type of advanced technology provided the following reasons: (1) perception of a high implementation cost; (2) the type of operation--the companies operate on fixed-route schedules; (3) changes in technology take place very fast and it is difficult and expensive to keep up to date; and (4) it is difficult for the companies to prove that this type of technology will increase productivity.

Motor carriers also provided their views regarding the importance and need for the use of ITS technology in Texas for purposes of fleet management; administrative procedures, specifically, one-stop shopping; and electronic clearance and enforcement .

There is strong support for the application of advanced technologies for fleet management and for administrative purposes. These carriers believe that technology improves fleet management through better trailer utilization, more efficient loading of trailers, fuel savings, less dispatching personnel, better size and weight compliance, and driver time savings. This results in better transportation rates. On the issue of administrative procedures, the

carriers believe that all information required for registration, permitting, purchase of credentials, and other transactions should be electronically connected to one system that can be accessed by all agencies involved.

Regarding the issue of applying ITS-CVO for electronic clearance and enforcement purposes in Texas, different carriers have different opinions. Just over one-half of the carriers (those that operate most of the time within the state), consider that there is not much potential for the application of ITS for electronic clearance or enforcement purposes in Texas. The main reason provided by these carriers was that trucks that operate in the state spend little time being weighed or inspected. They commented that enforcement practices in Texas are not as strict as in surrounding states, making it difficult to justify investments in technology. In fact, adding technology such as transponders to their trucks was perceived by some as giving DPS even more latitude for enforcement as compared to trucks without transponders. Carriers with time-sensitive cargo agree with the idea of applying advanced technologies for electronic clearance and enforcement.

The carriers that participated in the survey believe that enforcement resources should be focused on non-complying trucking companies and less effort should be spent on the carriers in compliance. They think that it is better to check a few vehicles rather than every vehicle, and it is not cost effective to catch the occasional error of carriers mostly in compliance.

The privacy of data and information collected by advanced technologies is a very sensitive issue. Carriers expressing concerns about this issue believe that the use of technology (ITS) is not a valid reason to increase the amount of information made available to public agencies. They strongly feel that all data should be kept confidential between the carrier and the state regulatory agency. One company expressed opposition to: (1) having a third-party control the information collected; (2) using ITS for tax administration purposes; and (3) using ITS for automatic logging.

Areas of Potential Improvements in CVO in Texas

From meetings with stakeholders, some areas of potential improvements for commercial vehicle operations in Texas have been identified.

There should be increased communication among the agencies involved in commercial vehicle operations (*e.g.*, TxDOT, DPS, and other enforcement agencies). This includes an increased sharing of data and information (*e.g.*, permits, vehicle registration, safety records) electronically stored in one system that is accessible by all agencies. By having this system in place, it would be easier for enforcement officers to target unsafe carriers and reduce redundant enforcement of the same vehicles. This system would also have the potential of offering one-stop shopping for permits and other credentials.

Electronic clearance systems should be implemented at the Texas-Mexico border. TxDOT is participating in the Texas Regional International Border Electronic Crossing (TRIBEX) project. This project is a public-private partnership created for the purpose of demonstrating commercial vehicle intelligent transportation systems technology at international bridges using Dedicated Short Range Communications and other on-board systems, electronic cargo seals, and weigh-in-motion. This project will also support the North American Trade Automation Prototype (NATAP), which includes transponders.

Weigh-in-motion (WIM) devices, coupled with automatic vehicle classifiers (AVCs) could be used by DPS as a non-intrusive method of targeting "hot spots" of commercial vehicle activity. Texas is a relative newcomer in the use of weigh-in-motion for weight enforcement screening. The first installation was opened within the past year on I-35 south of San Antonio. WIM offers productivity gains for the Texas DPS and effectively utilizes scarce resources, especially when strategically located to minimize bypassing opportunities. TxDOT should move ahead with other installations of WIMs as resources become available.

The use of ITS for fleet management and information purposes should be promoted by TxDOT. Motor carriers generally support technologies that improve fleet management for increased productivity, including variable message signs strategically placed in advance of urban areas with timely information regarding traffic conditions or incidents.

In summary, TxDOT should continue its current trend in becoming a more integrated, purposeful department, more externally-oriented towards customers and stakeholders to ensure safety and mobility in Texas.

References

1. Texas Department of Transportation Planning and Programming Division, "1995 Centerline Miles", October 1996. http://www.dot.state.tx.us/rtmodes/pfacts/pfacts.htm#SYSTEMSIZE
2. Texas Department of Public Safety, "Designated Weighing Areas", January 1998.
3. Booz-Allen & Hamilton Inc. et al., "COVE Study Final Report and Implementation Plan, Overcoming CVO Institutional Barriers: Recommended Action", Texas Report, July 1994.
4. Grenzeback Lance, Colman Carol, and Kaliski, John, *Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems: ITS/CVO Program Requirements*, Report Number FHWA-RD-96-126, Cambridge Systematics, Inc., Cambridge, Massachusetts. July 1997.
5. *National ITS Program Plan*, U.S. Department of Transportation/ITS America, First Edition, Washington, D.C., March 1995, p. 186-187.
6. Abbasi, M. F., "Intelligent Transportation Systems Initiatives for Commercial Vehicle Safety Enhancement in the U.S.", *Global Deployment of Advanced Transportation Telematics/ITS: A New Era of Mobility and Safety*, 29th International Symposium on Automotive Technology and Automation pp. 317-325. Florence, Italy, June 1996.
7. *CVISN meant to Improve Information Sharing, Safety*, Venture Newsletter, ITS Washington, University of Washington/Washington State Department of Transportation, Seattle, Washington. July 1997.
8. *The ITS/CVO Mainstreaming Program*, U.S. Department of Transportation, Federal Highway Administration FHWA-JPO-97-012, Washington, D.C., 1996.
9. U.S. DOT Comprehensive Truck Size and Weight Study (Report No. 2), *Analysis of the Truck Inventory and Use Survey from the Truck Size and Weight Perspective for Trucks with Five Axles or More*, February 1996.
10. Montufar, Jeannette, *Trucking and Size and Weight Regulations in the Mid-Continent Corridor*, Master of Science Thesis, Department of Civil Engineering University of Manitoba, November 1996.
11. 1993 Commodity Flow Survey Texas State Report, 1992 Census of Transportation, Communications, and Utilities, July 1996.
12. Analysis of the 1993 Commodity Flow Survey for "Development of a Texas Strategic Plan for Commercial Vehicle Operation", 1998.

Facility Location and Staffing Analysis for TransAlta Utilities

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Headquartered in Calgary, Alberta, TransAlta Utilities (TAU) has been a major supplier of electricity to Albertans since 1911. The company also has interests in gas and electricity distribution, independent generation, energy services and energy marketing. With more than $5 billion in assets, $1.6 billion in revenues, and about 2500 employees, TAU is Canada's largest investor-owned electric utility.

Currently, TAU serves over 340,000 customers in parts of Alberta. Their service area is divided into 3 regions and 19 areas, and they have a total of 57 customer service facilities. Each facility houses between one and four customer service representatives (CSR) and between five and 20 customer service linemen (CSL). The CSR deal with the public (bill payments, complaints, reporting of problems), whereas the CSL respond to customer requests (connections, repairs) and perform other routine duties (substation checks, power line patrol). TAU employs a total of 120 CSR and 270 CSL. Each facility operates relatively independently from one another, although some sharing of resources occurs in cases of emergencies. The existing system was not the result of some "optimal" central planning, but it was put in place in an incremental fashion as the company grew over time.

TAU has recognized that using a decentralized dispatching system and a relatively large number of CSR dispersed over the service area is not the most efficient way to do business, and is planning a dramatic change in the way it does business. The company is consolidating its CSR in a centralized call centre located in Calgary. The call centre would require many fewer operators than the existing system, resulting in significant

savings. As well, a central call center will improve efficiency through centralized dispatching that will remove the arbitrary borders between service areas of the facilities. Finally, the removal of CSR from service facilities negates the need to own and maintain buildings with presentable front offices.

The TAU executives thought that, while they are in the process of changing the nature of customer handling, this was a good time to take a close look at their entire service delivery system. They expressed an interest in approaching the problem analytically, and asked us to design a system from scratch promising an open mind. Specifically, the Network Services Division of TAU wanted us to look into the following questions:

1. how many facilities they should have,
2. where these facilities should be located,
3. how many linemen should be assigned to each facility,
4. how should facilities be clustered into call pools for after-hours service delivery,
5. where the special equipment (bucket and digger trucks) should be located

In the remainder of this paper, we briefly summarize each phase of the project. A more detailed paper is available upon request from the first author.

1. Number of Facilities

Unlike the current facilities, which are open to the public, future facilities will be simply home-bases for the linemen. This is where they meet in the morning, park their trucks, and have coordination meetings. As well, this is where the communication equipment, terrain maps, and repair equipment are kept. Taking this paradigm shift to the extreme, even a small office in the basement of a lineman's house could be considered a facility.

The optimal number of facilities in a distribution system depends on the tradeoff between facility costs and transport costs. As more facilities are added, transport costs go down, and facility costs go up. In our case, the evaluation of transport costs was nontrivial. Hence, we decided to solve the facility location problem for different number of facilities, determine the labor cost for each configuration, and then perform a cost/benefit analysis over different numbers of facilities to determine the minimum cost configuration.

TAU executives wanted us to evaluate a wide range of possibilities, ranging from 40 to 74 facilities. We found that with 40 facilities, the maximum response times would be unacceptably high. At the other extreme, we found that the system was saturated with 74 facilities in the sense that many facilities would be assigned a single lineman, and some of the facilities did not even warrant the assignment of a full-time lineman. Our search was intensified between 55 and 60 facilities. We will return to the question of the number of facilities after we discuss the location and staffing segments.

2. Facility Location Module

For finding the locations of a given number of facilities, we decided to use a popular facility location model, namely the p-median model (Daskin, 1995), where the objective is to select p locations so as to minimize the sum of the weighted travel distances between facilities and demand points.

To use the p-median model, we needed four pieces of data: demand point locations, a measure of demand at each demand point, candidate locations for facilities, and distances between demand points and candidate locations.

Demand point locations:
Although TAU has accurate location records for each of its 340,000 customers, it is not realistic to treat every single customer as a separate demand point in an optimization model. We decided to aggregate customers into clusters based on proximity. About half of the customers are located in the 175 towns and cities of the province. Each of these population center was modeled as a demand point with a weight equal to its number of customers. The other half of TAU's customers are rural customers. TAU has clustered its rural customers into about 900 zones for bookkeeping purposes. We decided to use the same clustering system for demand point aggregation. In total, we modeled 1,043 demand points. We digitized the locations using a desktop geographic information system (ArcView).

A measure of demand at each demand point
To quantify the demand at each point, we created a spreadsheet based on TAU's accounting records. This spreadsheet contains the number of customers (households, street lights, farms, oil wells, factories, etc.) in each town. The demand at each point is assumed to be the sum of all customers in that town.

Candidate locations for facilities

We asked the TAU management for one hundred candidate locations (50 primary, 30 secondary, and 20 tertiary). We performed some simple spatial analysis on these locations and suggested the removal of several of these based on their proximity to more-preferred locations, or poor highway access. After reconsideration, TAU management decided on 74 candidate locations.

Distances between demand points and candidate locations

We assumed rectilinear travel between candidate locations and demand points, simplifying data collection and management. This is a fairly good assumption in Alberta, where there is a near-perfect rural highway grid, with one road going North-South every one mile, and one road going East-West every two miles.

The p-median problem was solved using a greedy pairwise exchange algorithm (Daskin, 1995). We used thirty random starting solutions to increase the probability of finding an optimal solution for a given p. The algorithm was coded in QuickBasic. The best solution for a given number of facilities was exported to ArcView for display. ArcView was used for numerous queries, as well as the displaying of one-hour coverage areas for each facility. To build trust for the model, we also generated a program which allowed the managers to perform "what-if" analysis where they could select an alternate solution, and the program would indicate how good this solution was in comparison to the best one the algorithm found. Furthermore, we generated an animated version of the algorithm, which is used to step through each iteration highlighting the pair of locations under consideration for exchange. These proved to be useful learning tools which are currently used in a distribution management course at the University of Alberta.

3. Staffing Module:

We used two different methods to determine the staffing level at each facility. The first one relies on a detailed simulation of the customer response operations, and the second one is a multiple regression model which predicts the crew size as a function of measurable variables. For most facilities, the two work load estimates computed were very similar to one another, and we decided to take a simple average of these two figures. For our final recommendation, this average was multiplied by 0.8 since about 20% (uniformly) of the current work load of CSL was going to be transferred to a new division within TAU.

For the existing configuration, our estimates showed that some of the facilities were understaffed while some were overstaffed. These results generated some of the liveliest discussions among the area managers. There was general agreement that the model's estimates were closer to the ideal staffing levels than the existing levels. We did not claim that our estimates were based on some hard science, and explained the shortcomings of the models in great detail. While encouraging the managers to criticize the results, we asked that a challenge of an estimate to be based on the data and the assumptions of the models. For example, staff estimates for a few facilities were deemed too low due to an unusually high number of substations or particularly rough terrain in the area. In these cases, the managers adjusted our staffing recommendations.

Simulation:

Responding to customer calls accounts for anywhere from 10% to 30% of CSL time on most days. Hence, the simulation model explains only one part of the daily work load, albeit the most important part from a service quality perspective. It was possible to simulate this part of the operation since TAU had reliable data. Apart from the facility locations, demand zone locations and customer counts, the simulation model also required data on customer call rates, the time spent per repair (service duration), the intra-town travel time (in case there were two or more calls originating from the same demand zone), length of the work day, and travel speed.

The simulation model assigns demand points to the closest facilities to generate service areas and then simulates the operation of a local dispatcher for 100 days. For each day, calls are generated based on the call rates and the number of customers in the service area. The corresponding vehicle routing problem (Lawler et al., 1985) is solved using a savings heuristic accompanied by a 2-opt improvement phase. The number of tours (i.e. linemen) required to service the calls is recorded for each day for each facility, as well as the breakdown of time between travel and service.

The simulation model was programmed in QuickBasic. We generated a demonstration version of the simulation software, which we called "A Day in the Life of TAU." This software displays the service area of a selected facility, generates calls for one day, splits customer locations that could not be serviced by a single lineman into two (or more) customer clusters, designs near-optimal rotes for service, displays the routes graphically, and summarizes the daily work load. It could be run for a

given number of days, and generate a work load histogram for the facility under consideration. Alternately, one could run the program for only one day over all facilities.

Multiple Regression

We knew that CSL spend their time on customer service, line patrol, substation checks, new service hookups, meetings with customers, coordination and safety meetings, breaks, and holidays, and possibly some amount of time is unproductive. If we could develop a causal model to explain the current crew sizes as a function of these activities, we could use this model to estimate the crew sizes for other facility configurations. There were a number of problems with this approach. First, TAU lacked concrete reliable data on how much time was spent on each one of these activities, or how many units of work were accomplished under each category in a given time period. Hence, we had to select independent variables that were easy to quantify based on available data for any configuration. Second, a multiple regression model based on current staffing levels was making the implicit assumption that these levels were consistent, although current staffing levels were arrived at through negotiations between area managers and the central administration over time. Finally, a model that is calibrated using the current system could become useless for evaluating drastically different facility configurations.

Keeping these drawbacks in mind, we decided to implement a model with only three explanatory variables: number of urban customers, number of rural customers, and geographic size of area. We used 'average distance to a customer' as a proxy for the size of the area. The implicit assumption in this model is that the time spent on customers (service, meetings, hookups) will be proportional to the number of customers, and the time spent on facilities (line patrol and substation checks) and travel will be proportional to the size of the area (i.e., lines and substations are uniformly distributed over space). By definition, the unexplained time in the model accounts for time that was not explained by the three variables. It is merely an estimate that minimizes the sum of the squared errors in the model. Part of the unexplained time had a physical interpretation; it was time spent on meetings, breaks, or unproductive time. As we had expected, the correlation coefficient was not very high, but the results (parameter values, and the estimated work loads) seemed to make sense to the managers.

4. Final Configuration:

We now return to the selection of the number of facilities. In addition to the facility locations and staff levels, facility and labor costs are relevant for this decision. TAU gave us estimates for four different facility sizes: one-person facility, two-person facility, small facility (3-4 CSL), large facility (5 or more CSL). Facility costs are independent of locations since the cost of renting or owning and maintaining a facility of a given size is quite similar throughout the province. Labor costs are also independent of locations.

The determination of the final configuration was a highly interactive process. Three TAU managers evaluated several different configurations with 55 through 60 facilities. For a given number of facilities, the managers decided on the final facility locations. In most cases, they accepted the *p*-median solutions. However, in each solution, a few of the facilities were relocated. For example, TAU has no customers in Lethbridge. Hence, the *p*-median solutions do not contain this city, and select the smaller town of Coaldale which has some TAU customers and is only a few miles away from Lethbridge. However, TAU has a large existing facility housing engineering operations in Lethbridge, and the managers decided to swap Coaldale with Lethbridge in all solutions.

For a given set of locations, we used the simulation and regression models to estimate the staff levels. The managers spent a considerable amount of time going through the list of facilities and finalizing their staffing recommendations. In some cases, where they could rationalize a change in our estimates, they modified the allocations.

As a result of the staffing module, a total of 16 facilities were staffed by one or two CSLs, 29 facilities were designated as "small" facilities (3-4 CSLs), and 13 facilities were designated as "large" facilities (5 or more CSLs). The largest facilities (Sherwood Park, Spruce Grove, St. Albert), which are located in urban areas with a fairly high customer counts, were assigned 8 CSLs each. In 34 of the 58 instances, the selected staffing level was the same as the one recommended by the model(s), and in 19 instances it differed by one CSL from the models' recommendation.

5. Design of Call Pools

A call pool as defined by TAU is a group of CSL, one of whom is on-call at all times in a certain area. The only constraint in designing call pools

is that there are at least three CSL in a call pool so that each member of the call pool is on call at most every third night. The goal is to group CSL together so that there is as little travel as possible in responding to after-hours calls.

The output of the location/staffing phase is an input to this problem, which can be posed as a generalized (many-to-one) assignment problem. We designed our own "visual-inspection" heuristic to solve this problem. We started by designating each facility with at least three CSL as a "seed" and assigned the remaining smaller facilities to the closest seed. This gave us a feasible solution. The next step was to visually search the solution for improvements. We identified two ways in which a solution could be improved:

1. group two smaller (one-man and two-man) facilities together to form their own call pool, and
2. split a large call pool into two smaller pools (North-South or East-West).

We gave the managers a list of 10 possible improvements to the initial feasible solution, and left it to them to decide which improvements to accept and what the final number of call pools ought to be.

6. The Specialty Vehicle Location Problem

TAU operates seven bucket trucks and 21 digger trucks mainly for use with street light maintenance and repair. A digger truck can be fitted with a bucket and used as a bucket truck but a bucket truck can not be used in place of a digger. We used two different location models to locate the trucks and worked closely with management testing various configurations and comparing them to the optimal solutions of the models. The models we used were the *p*-median model and the maximal covering model (Daskin, 1995).

We used towns with street lights as the demand points and the number of street lights in each town as a measure of demand. Of the selected facility locations, the ones that had the space to house a bucket or digger truck were identified as candidate locations. In all, there were 30 candidate locations for specialty trucks.

The *p*-median model and the solution algorithm were the same as those used for the facility location phase. The objective of the maximal covering model is to maximize the number of demand points covered for

a given coverage radius using a fixed number of trucks. The *p*-median model located the trucks in the larger population centers, whereas the covering model dispersed the trucks throughout the province. While the solution of the covering model may be appropriate for emergency facility location, it was not a good solution from a total travel distance perspective and a capacity allocation perspective. The managers used the *p*-median solution as a starting point, and asked for some what-if analysis to evaluate the implications of relocating some of the trucks. The changes studied resulted in small increases in the total cost, but resulted in a more even distribution of the work load between the trucks.

8. Concluding Remarks

To close, we briefly summarize the contributions of the project to the final decisions, outline the reasons for the success of the project, and conclude with a brief overview of the project team and the timeline.

Most of the facilities recommended by the *p*-median model were existing facilities. However, some recommendations resulted in changes to the existing system. TAU's decision of closing down two facilities and opening three new facilities was consistent with the location model's recommendations. The contribution of the project in selecting staffing levels may have been more significant than its contribution in selecting facility locations. In most instances, the managers approved staffing levels that were identical (within rounding) to the staffing module's recommendations. As well, it is fair to say that the call pool module and the specialty truck location module have been quite useful in guiding the managers to the final decisions.

The database, and all models reside on a laptop computer that was dedicated to this project. These models may be useful in the future for estimating operating costs to generate bids for possible expansion into new territories. As for the near future, the project helped TAU management design a high-quality and cost-effective service delivery system which should improve TAU's competitive position after the pending deregulation in this sector.

Perhaps the most important contributing factor to the success of the project was the inclusion of several TAU employees in the project team and close collaboration between team members. TAU executives made it clear at the outset that they wanted to actively participate in the process. We had regular biweekly meetings with a group of area managers, and two meetings with a larger group consisting of senior executives and

other TAU employees in charge of other aspects of TAU's reorganization. In all phases of the project, the role of our team was one of providing analysis and numbers, and the decisions were left to TAU managers and executives. A number of models were used, but also a good deal of what-if analysis was employed to quantify the impact of deviations from the model recommendations.

In terms of tools used, we believe that the use of a desktop geographical information system contributed significantly to the success of the project. This tool allowed us to dissect each solution in real time and rationalize the results. It also helped to explain the strengths and weaknesses of the methods used. As well, the step-by-step graphical demonstrations of the location and routing algorithms helped the decision-makers understand the "guts" of the system and built confidence in the process. Finally, the presentation of summary results on a spreadsheet allowed for quick what-if analysis in a familiar environment.

This project was performed from May to December 1997; most of the work was completed in the June-August period. TAU has already announced its reorganization decision. The call center and the new facilities will be in place in 1998. There may be future involvement between TAU and the OR/MS group at the University of Alberta. Possible projects include detailed analysis of workforce levels for future staffing decisions, and design of an intelligent centralized dispatching system.

References:

Daskin, M (1995), *Network and Discrete Location*, Wiley-Interscience Series in Discrete Mathematics and Optimization, J. Wiley & Sons Inc., NY (Chapter 6).

Lawler, E.L., J.K. Lenstra, A.H.G. Rinnooy Kan, and D.B. Shmoys (1985), *The Traveling Salesman Problem: A Guided Tour of Combinatorial Optimization*, Wiley-Interscience Series in Discrete Mathematics and Optimization, J. Wiley & Sons Inc., NY (Chapters 7 and 12).

TRUCKING IN THE PRAIRIE REGION OF NORTH AMERICA: USING GEOGRAPHICAL INFORMATION SYSTEM APPLICATIONS

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INTRODUCTION

Truck transportation in the prairie region of North America is undergoing tremendous growth and change. Principal factors involved are: (1) significant changes in the prairie region agricultural economy, increasingly favoring meat production and specialized crops; (2) changes in truck-rail competition and mode share; (3) changes in the trucking fleet, increasingly utilizing specially-permitted larger and heavier vehicles; (4) large growth in north-south trade, with little change in truck-related trade between eastern and western Canada; (5) changes in the physical highway infrastructure serving western region trucking and certain aspects of the truck size and weight regulatory and enforcement practices relating to it.

Geographical Information Systems (GIS) have the capability of displaying spatial, numerical, and descriptive information in a visual manner. Furthermore, GIS is a set of tools for the higher-order integration of transportation-related data that creates, organizes, and analyzes multi-dimensional databases. The paper demonstrates the process by which truck-related attributes are transformed, interfaced, and combined with geographic data files to create meaningful visual representations of trucking issues in the prairie region.

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The paper presents newly synthesized data and information concerning trucking activity in the prairie region of north central North America. By placing data on a Geographical Information System (GIS) platform, trucking activity is better understood and planning and policy analysis is facilitated on matters such as: (1) transportation network facilities and operations; (2) truck size and weight regulations (TS&W) relating to the defined highway network; (3) truck fleet characteristics; (4) truck flows, vehicle classification studies, and vehicle-miles of travel (VMT) estimates; (5) truck-related commodity flow, origin-destination, and routing data; (6) truck accidents; (7) truck operating weights and dimensional characteristics; and (8) trucking networks and operations involving long combination vehicles (LCV's) and specially-permitted operations

First, the paper presents the development of a GIS-T base-map of the prairie region for use specifically relating to trucking research. A brief discussion of data integrated through GIS-T follows. GIS applications specific to transportation (GIS-T) are demonstrated to determine relative differences between variables and evaluation of impacts of alternative planning and policy strategies. Limitations and problems encountered are reviewed along with suggestions for potential GIS-T applications.

CREATION OF THE GIS-T BASE-MAP

A GIS embodies geographic features that are associated with attribute information. Each geographic feature--point, line, or area--is defined not only by a location in space, but also according to other quantitative or qualitative characteristics. In the transportation system, the highway network consists of links joining nodes that are further described by characteristics such as traffic volumes, highway classification, or pavement type. In the development of a GIS-T base-map, the transportation system network is first defined, followed by the assignment of truck related attribute data to the network.

Geographic Data

Prior to integration of truck attribute data, a geographic representation, or a map database, of the highway system facilities within the prairie region is developed. This map includes the rural highway network, major urban street systems, intermodal locations, bridge structures, weigh scale sites, and other facilities sensitive to trucking operations. The principal

objective of the GIS-T base-map is to create a comprehensive prairie province highway network. The base-map must allow the analysis of trucking in the prairie region as a whole across municipal, provincial, and international boundaries. Therefore, geographic data is collected from numerous jurisdictions within the prairie region.

The seamless integration of centerline maps from different sources is a difficult task. Currently, each province and some urban centers in the study area have developed centerline maps of their highway or street network. However, the maps' formats are specific to each agency's needs and policies results in maps with differing scales, coordinate systems, and attribute referencing techniques. On the other hand, the United States Interstate System and the National Highway System exists as a single geographic file for all states. These differences make the continuous analysis of non-border specific databases impossible.

The integration of urban street and provincial highway spatial data is a common problem. For example, consider the Manitoba Highways and the City of Winnipeg centerline maps. The Manitoba Highways map includes all Provincial Trunk Highways (PTH's) and all Provincial Roads (PR's), but excludes roads in national parks (e.g. PTH 10 through Riding Mountain National Park). This map is linear-referenced in accordance with the Manitoba Highways and Transportation (MHT) control sections. Therefore, a data element such as an accident location, which is specified in terms of its distance from the start of the control section, can be properly positioned on the map. However, linking the accident database, or any other database, to this map cannot be done directly. First, a separate route system must be created. The route system provides the required common geographical referencing mechanism between the map and the database of interest, thereby permitting dynamic segmentation.

Conversely, the City of Winnipeg street centerline map, like most other cities, is a link-node map having no control sections. The spatial structure of the map does not comply with standard requirements of the GIS-T platform for three key reasons. First, the Winnipeg map has a multitude of nodes that fragment street segments between intersections. This makes analysis difficult and inefficient because of the requirement of many link identifiers and descriptors. Second, underpasses and overpasses are defined by nodes. To allow unimpeded routing on an overpass, the overpass link must be node-free. Third, the Winnipeg map is not linear-referenced and therefore does not allow for dynamic segmentation.

Attribute Information

Once the highway system is defined, truck-related attribute information can be associated with the network. Databases used in the analysis of trucking in the prairie region include: (1) the U.S. Truck Inventory and Use Survey (TIUS); (2) the U.S. Highway Cost Allocation Study; (3) the U.S. Commodity Flow Survey (CFS); (4) the Canadian Council of Motor Vehicle Transport Administrators (CCMTA) survey; (5) provincial, territorial, and state truck surveys; (6) on-road surveys of border crossing activity between Alberta-Montana, Saskatchewan-North Dakota, and Manitoba-North Dakota conducted by University of Manitoba students in 1997; (7) Canadian vehicle registration data; (8) special truck flow surveys conducted by individual states, provinces and metropolitan areas in the prairie region; and (9) other research.

In all cases, understanding the structure and content along with strengths and weaknesses of these databases is paramount to: (1) be able to use and interface them; (2) conduct purposeful analyses, draw meaningful conclusions, and provide valid engineering insights; and (3) enable dynamic evaluation by facilitating the simple exchanging and updating of changing attributes.

EXAMPLES OF TRUCK-RELATED GIS-T APPLICATIONS-NORTH CENTRAL PRAIRIE REGION

The goal of the GIS-T base-map is to integrate databases of different formats into a single seamless database. The important feature is that the base-map does not force the modification of any databases, but accommodates each jurisdiction's reporting methods. After the base-map of the prairie region has been developed and truck-related information from many jurisdictions in the prairie region has been synthesized, trucking operations can be analyzed. Using the prairie region GIS-T databases, one can evaluate many policy and planning questions across a continuous highway system spanning across multiple provinces and states.

The practical use of the GIS-T base-map of the prairie regions can be illustrated by showing how the shortest route changes for a truck traveling from Edmonton, Alberta, to Sioux Falls, South Dakota, given a number of successive conditions. First, the shortest path from Edmonton to Sioux Falls for a maximum allowable Gross Vehicle Weight (GVW) of 105,500 pounds year-round can be determined. That route changes with the addition of the condition that the vehicle travel on a route with less than

1000 trucks per day. Then, using the preceding conditions, still another route is generated for an over height vehicle. Any number of conditions from different databases may be stipulated to determine the impact of different regulatory issues.

The following are descriptions of some areas of trucking activity where GIS-T applications can facilitate the analysis of policy questions.

- ***Truck Size and Weight Regulations***

The first, most direct GIS-T application is the spatial distribution of truck related characteristics. GIS techniques can produce a graphical representation that allows a direct visual comparison of one parameter value within a network. For example, color-coded maps are created to show the weight limits and allowable configurations on the highway systems to which they apply. This is a useful method to represent how regulations change from jurisdiction to jurisdiction along the same route. Policy questions relating to weight limit revisions for certain trucks on the highway system can be analyzed so that new areas of discontinuity on the network resulting from that revision can be assessed.

- ***Truck Flows***

GIS-T applications can also create a scaled-symbol or color-coded themes to depict volumes of trucks along the highway system. A truck traffic flow map is created by scaling the traffic flow, measured in Average Annual Truck Traffic (AADTT), along each highway link. This allows an overall comparison of the utilization of the entire highway network and identify routes or areas with a high density of truck traffic.

Relationships between numerous variables can be established by portraying more than one attribute on the network. As an example, exposure-related issues such as truck flows as a function of enforcement locations are evaluated by showing both scaled truck flows and locations of weigh scale sites. The integration of two such databases also permits the query of attribute data for geographic features that meet specific conditions. For instance, links classified as (R)TAC routes with less than 50 trucks per day passing on it can be selected and highlighted in a map.

Also, GIS-T database management functions can cross-tabulate values within the database. Vehicle-miles of travel (VMT) of each highway route and entire prairie region can be calculated by multiplying the link

length by its assigned link AADTT. This is a useful measure of the extent of trucking activity on the length of the highway network.

An even higher order of transportation analysis is the combination of multiple databases through dynamic segmentation. With the creation of a route system of the linear-referenced highway network, databases with different identifiers can be brought together within the same geographic framework. The GIS-T's strip chart can show multiple characteristics of a route and how they vary along the length of the route. A series of graphs is created with one chart for each attribute along the same milepost range of a route. Analyzing the prairies region's highway network in terms of truck accidents, truck flows, and pavement condition rating is an example of interfacing three separate databases. The accident database contains point data linearly referenced to the start and end of control stations. The flow data are link data whose values are not necessarily unique to each control station, but can change at intersections. Likewise, the pavement data can change along links between nodes and along the control section.

- ***Truck Fleet Characteristics***

Truck traffic fleet mix in terms of configurations, body types, and gross vehicle weights can be presented using GIS-T. On-road surveys, weigh-in-motion devices, and automatic vehicle classifiers serve as the source of truck fleet data. Using the GIS chart-theme tools, a series of graphical representations can be developed to visualize how the make-up of the truck fleet changes at different survey locations. Information on truck fleet characteristics reflect not only the governing TS&W regulations in each jurisdiction, but also the likely commodities that are transported along a route.

- ***Routing of Oversize and Overweight Vehicles***

The development of a GIS-T network of the highway system allows routing and shortest path analysis. Given maximum allowable GVW's, heights, and widths, the shortest path, in terms of distance or time, can be determined for a truck with oversize or overweight characteristics. The network can include restrictions such as underpass clearances, bridge widths, hazardous goods routes, and turn restrictions.

Using the same principal, truck travel time contours can depict the relative freight distances to and from activity centers. This is done by routing along the network system to produce an O-D distance matrix for one

origin and many destinations. The O-D matrix is then used to draw travel time contours using Digital Terrain Modeling tools.

- ***Commodity Flows***

Analysis of commodity flow within the region can be done by presenting a desire line diagram. GIS-T desire line diagrams present freight or truck flows between origins and destinations using different bandwidths and patterns. As well, scaled symbol charts can be used to display the percentage of commodities moved to and from major commodity centers.

CLOSING REMARKS

The GIS-T base-map will continue to integrate truck-related data into a seamless database for continuous analysis over a large highway network. GIS-T applications will be accessed, integrated, and demonstrated on a real-time basis during the conference. Further access to basic information presented, along with illustrative examples will be provided by the University of Manitoba Transport Information Group on the Internet at umtig.mgmt.umanitoba.ca.

Open Skies and Open Gates

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1. Introduction

"Forty years ago, air fare between Germany and New York cost 29% of the price of a Mercedes-Benz automobile. Today, it costs no more than 2%" [Thomas Kropp in Ott and Sparaco, 1997]

The recent emphasis on global carrier alliances has created significant comment and concern regarding airline competition throughout the world. Partnership agreements are not a recent innovation in the industry, they date back to the ill-fated Pan Am/W.R. Grace alliance of the 1920's [Shifrin, 1997]. Structural change in the industry environment, both economic and regulatory, has stimulated a trend toward supranational alliances which could have a significant impact on how the industry operates in the future.

The 1944 Chicago Convention established an international aviation framework structured to benefit competitors' as opposed to consumers' interests. It lead to carrier regulation which effectively blocked international mergers, and regulated inter-country competitors. Over time the emphasis of national regulation has changed, leading to:

a) increased inter-country carrier competition through the 1960's and 1970's;
b) rationalization within countries, building hub and spoke routings served by partnerships between regional and national carriers. Thus competition focused on hub versus hub in the 1980's to 1990's;
c) global alliances, the industry response to international merger blockages. These recent alliances create a market where competition is based on alliance versus alliance. [See Sparaco, 1997].

The deregulation of the airline industry in the European Union, and the provision of anti-trust immunity in the United States, has recently provided the impetus for these supranational alliances, including:

since the termination of one leg of their journey is in the same terminal as the next leg originates.

While the exact terms and conditions may differ, in general, members code share so that customers are through ticketed on one carrier code, even though they may change planes and carriers during the journey. Thus all ticketing, boarding passes and baggage handling can be done at the point of origin. Furthermore, the alliance partners benefit by scheduling only sufficient flights to meet demand thus reducing inefficient use of flight equipment, and crew and increasing load factors on each flight. This rationalization reduces costs and releases equipment needed on denser routes or to penetrate new markets.

Code sharing agreements may also be seen as a response to the traveler's desire to remain with the same carrier from home to final destination, perhaps in the belief that this improves the probability of seeing something familiar on the baggage carousel. If both partners show similar flight numbers it becomes difficult to distinguish hybrid itineraries in the timetable. Such code sharing may also increase the prominence of one partner's flights on a reservation system owned by the other.

In this paper a simple stylized model of an air travel network is presented in an attempt to capture part of the impact of the alliance decision as it relates to market and airport access. The model uses a hub airport serving local spokes and a single "trunk" route to an overseas gateway. The gateway is served by a single international carrier that competes for domestic traffic with a 'regional' carrier using smaller aircraft. Each carrier has its own dedicated space at the hub. Initially, the desire for 'same carrier service' excludes the regional airline from providing feeder service to the hub for international travelers. This is relaxed in a second scenario representing code sharing. In the third scenario, code sharing is extended to an alliance between the carriers which permits free sharing of the hub capacity. Results are used to compare the fare structure in each scenario and to estimate the overall social impact of the two types of agreement.

2. The Model

The model consists of a single hub serving three spokes and connected to an easterly gateway airport via a direct link, as shown in Figure 1. Aircraft may operate between spoke-ends as well as to the hub, but gateway service is provided via the hub only. Thus a carrier may offer direct flights from Airport 4 to Airports 1, 2 and 3 but not to Airport 5 (the gateway).

Figure 2

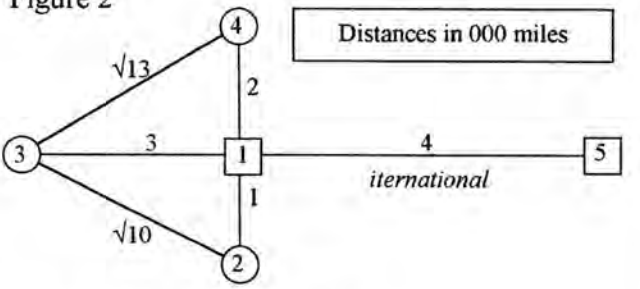


Figure 1: Airports and route distances

Two carriers operate in the system, the international carrier with large aircraft may serve all routes, whereas the regional carrier uses mid-sized aircraft and is precluded from operating on the hub-gateway link (1-5). Capacity at the hub is limited and divided between each carrier, which then has exclusive rights to its portion of the gates and runway slots. For simplicity there are no open gates.

3. Time Periods

The day is divided into four periods as shown in Table 1.

Table 1: time period definitions

TIME PERIOD, t	HOURS
1, peak	07:00 – 09:00
2, off-peak	09:00 - 17:00
3, peak	17:00 – 19:00
4, off-peak	19:00 – 24:00

Two 2-hour slots beginning at 7:00 and 17:00 represent peak demand. Off-peak is captured by the mid-day period (9:00-17:00) and the evening from 19:00 to midnight. Scheduling is assumed to be based on a 24-hour cycle and therefore long flights departing late in the day may generate

arrivals in the morning peak period. To capture the need for crew and equipment repositioning, and the demand for return flights in an analytically convenient way, the schedule is required to be route symmetric. Thus a flight from i to j leaving in time t generates a simultaneous departure from j to i by the same carrier. Symbolically,

$$q(i,j,k,t) = q(j,i,k,t) \; for \; all \; i,j,k,t$$

where q is the number of flights from Airport i to Airport j by carrier k leaving in time period t. If i is the hub airport (1), q(1,j,k,t) is constrained by carrier k's limited space at time t, and by the need for space for the incoming flight from j in a subsequent time period.

4. Demand

Demand is assumed to be for travel between two airports, whether or not directly linked. For example, in Figure 1, passengers demand travel between Airports, 4 and 5 which is supplied by flights from 4 to 1 and from 1 to 5 (and return).

Passenger demand is divided between peak demand and a more elastic off-peak demand which may be identified loosely with business and recreational travel respectively. For each demand type the demand price is proportional to the route distance between home and destination airports. To recognize that non-hub routes are likely to represent travel between smaller cities, demand between the spoke-ends is reduced by a factor of 0.5. Demand for indirect travel, such as between Airports 4 and 5, is divided into demand for the component flights. Both carriers charge the same fare for the same service.

For plausibility demand is further limited as follows:

a) There is no demand for departure after 17:00 (period 4).

b) Travel from Airport 3 to Airport 4 starting during the evening peak (period 3) is assumed to be a 'red-eye' flight which arrives the following morning (period 1). Therefore it is considered to be satisfying off-peak rather than peak demand.

c) Since the gateway airport (5) is assumed to be in a significantly earlier time zone, return flights leaving during hub period 1would involve departures in the small hours of the morning. Hence, to preserve demand symmetry, international departures are limited to periods 2 and 3 (from 9:00 to 17:00).

5. Supply

The supply decision is based on the incremental cost and revenue from operating an aircraft over the specified route. Load factors are assumed constant and each carrier has a single type of aircraft in sufficient quantity to operate all chosen flights. Incremental cost is expressed as a linear function of distance and passenger load for each aircraft type. Aircraft data are shown in Table 2. Cost and capacity data are drawn from the Transport Canada aviation website [undated] and the average load factor, assumed constant at 0.69, is from Velocci [1997].

Table 2: Aircraft load and cost data

aircraft type	pax capacity	average load	cost/mile C$
747-400	398	274.62	18.13508
DC9-10	72	49.68	4.824147

Since the purpose of the model is to examine the effect of very limited cooperation between the two carriers the model was solved under as a Cournot duopoly. Thus each carrier maximizes its contribution on the assumption that its rival's schedule remains unchanged.

6. Solution

Initially the model was solved assuming all hub capacity constraints to be tight, and without non-negativity constraints on the number of flights on each route. From the initial solution, an iterative procedure was used to produce an optimal feasible solution. No attempt was made to impose integer values on the q(i,j,k,t). Strictly partial flights at the hub cannot be interpreted as partial loads since an aircraft uses almost the same hub space regardless of passenger numbers. Since the network is intended to characterize a much larger, more complex system, these flights may be seen as a representative "sampling" of the larger system.

SCENARIO A - Non-cooperation

In the basic scenario each carrier operates independently subject to its own gate constraints and common fares. Passengers from spoke-ends (2,3,4) to the gateway (5) are assumed to attach a high premium to interlining and therefore the demand for the domestic portion of their

travel is applied to the international carrier only. Hub flights by the regional carrier are for terminating passengers only.

SCENARIO B - Code-sharing

Under this scenario each carrier continues to use its own gates exclusively, but the regional carrier is able to supply feeder service to the international link. Access to this demand might be considered as a representation of code sharing between the carriers.

SCENARIO C - Gate Alliance

Through an alliance the regional carrier is able to provide feeder service as in scenario B. In addition, both carriers pool their gate access at the hub.

7. Results

The demand parameters were used to calibrate the model under Scenario A to obtain plausible fare magnitudes. For Scenarios A and B the regional carrier (C2) was limited to 10 of the 35 hourly slots on each of two runways (approximately 29% of the hub capacity). Fares for direct flights are shown in Figure 2. Compound flights have varying fares depending on which legs in which direction take-off during a peak period. It is this connecting traffic demand which produces the reversal of relatives fares between peak and off-peak on flights between the hub and Airports 2 and 4.

Figure 2: Return fares under Scenario A

route	1-2		1-3		1-4	
demand	peak	off-pk	peak	off-pk	peak	off-pk
fare $	125.83	281.45	621.92	381.19	205.95	212.16
route	1-5		2-3		2-4	
demand	peak	off-pk	peak	off-pk	peak	off-pk
fare $	472.79	386.67	506.24	395.46	506.31	375.16
route	3-4					
demand	peak	off-pk				
fare $	1442.37	225.74				

The more even spreading feeder demand in Scenario B provides for a general lowering of fares for hub traffic as shown in Figure 3. Most effected are the routes from Airports 1 and 4 which are close enough to the hub to provide more connections than the more distant Airport 3.

Figure 3: Return fares under Scenario B (code-sharing)

route	1-2		1-3		1-4	
demand	peak	off-pk	peak	off-pk	peak	off-pk
fare $	88.01	269.61	607.09	381.98	133.68	212.49
route	1-5		2-3		2-4	
demand	peak	off-pk	peak	off-pk	peak	off-pk
fare $	470.06	386.67	506.24	395.46	506.31	375.16
route	3-4					
demand	peak	off-pk				
fare $	1442.37	225.74				

While the gate sharing alliance continues this trend in Scenario C, Figure 4 shows a smaller for Airports 2 and 4 but a more marked change for the route from Airport 3. This emphasizes that the important effect here is access to hub airport space rather than to a connecting passenger pool as in Scenario B.

Figure 4: Return fares under Scenario C (gate alliance)

route	1-2		1-3		1-4	
demand	peak	off-pk	peak	off-pk	peak	off-pk
fare $	80.86	250.20	172.34	380.36	172.18	202.87
route	1-5		2-3		2-4	
demand	peak	off-pk	peak	off-pk	peak	off-pk
fare $	485.94	389.19	506.24	395.46	506.31	375.16
route	3-4					
demand	peak	off-pk				
fare $	1442.37	225.74				

As the fares suggest, flight volumes do not change significantly on the non-hub routes. Change is concentrated on the feeder routes as might be expected. The major changes in flight volumes between the three scenarios are shown in Table 3.

Table 3: Percentage change in number of flights on 'spokes'.

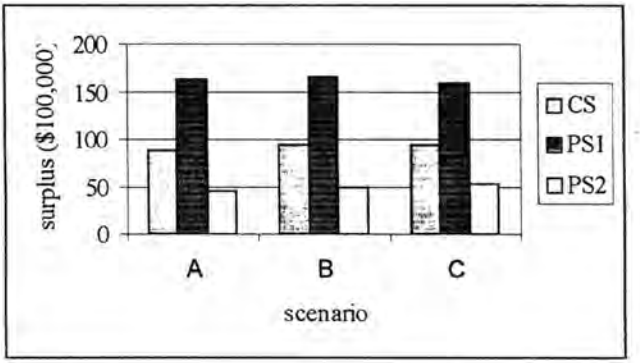
route	1-2				1-3	
demand	peak		off-peak		peak	
carrier	C1	C2	C1	C2	C1	C2
A to B	12	0	4	11	1	33
B to C	3	-20	-18	285	-1	-4
A to C	15	-21	-15	328	0	28

route	1-3		1-5			
demand	off-peak		peak		off-peak	
carrier	C1	C2	C1	C2	C1	C2
A to B	1	-2	2	33	0	0
B to C	-4	7	-2	-12	6	0
A to C	-3	5	0	18	6	0

Figure 5 illustrates the effect of each scenario on passengers and carriers overall. Consumer benefit is measured by Consumer Surplus (CS) and the changes in Producer Surplus are reflected by the contribution (revenue minus incremental cost) for each carrier (PS1 and PS2 for the international and regional carriers respectively). As might be expected the effect of code sharing in this model is to increase apparent Consumer Surplus due to the increased service and lower fares on the feeder routes. There is some small loss to the large carrier from reduced monopoly rent from international passengers and a more noticeable gain to Carrier 2 from the increased access to passengers. This increase in total surplus (CS+PS1+PS2) should be set against the perceived or actual losses to passengers from being unable to discriminate readily between operators on a connecting route.

The regional carrier continues to make gains at the expense of Carrier 1 through improved hub access in Scenario C. Presumably this would form the basis for revenue sharing or other payments in the alliance agreement. Within this model there appears to be little overall effect on Consumer wellbeing from the alliance in spite of the presumed improvement in the allocation of hub resources.

Figure 5: Consumer and Producer Surplus for each scenario



8. Conclusion

As noted in the introduction, airline alliances are neither new nor simple. The present model is an attempt to characterize a small part of this process in a simple fashion. Within this context it is interesting to note to general and not altogether surprising conclusions. Firstly, whatever the consumer problems from code sharing, it appears that the improved access to the passenger market serves to improve the efficiency with which aircraft service is provided to the gain of both customers and society in general. In contrast, the gain in Airport efficiency from joint access through a gate alliance appears to be appropriated entirely by the carriers. It would be interesting to investigate whether this result would be supported in a more complex network.

REFERENCES

Morrocco, J. [1997]. Economics Drives European Linkups. *Aviation Weekly and Space Technology*, Nov.17, 87-88.

Ott, J. and P. Sparaco [1997]. Unique Industry Facets Shape Europe's Alliances. . *Aviation Weekly and Space Technology*, Nov.17, 63-65.

Phillips, E, [1997]. Joint Purchasing Pursued by Alliances. . *Aviation Weekly and Space Technology*, Nov.17, 65-68.

Shifrin, C. [1997]. Proliferating Partnerships Face Increased Scrutiny. *Aviation Weekly and Space Technology*, Nov.17, 54-56.

Sparaco, P. [1997]. New Carrier Relationships Create Legal Complexities in Europe. *Aviation Weekly and Space Technology*, Nov.17, 61-62.

Aircraft Fuel Consumption. [undated]. Transport Canada, http://www.tc.gc.ca/aviation/news/old/fuelcone.htm

Velocci, jr., Anthony L. [1997]. New commercial aircraft demand holding firm, Aviation Weekly and Space Technology, 18 August.

Consumer Attitudes Towards Aviation Regulation: A Comparison of Canadian, American, and Mexican Air Travellers

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I. Introduction

Recent policy initiatives between the governments of Canada and the United States have significant 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. 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 is to create greater international competition between carriers--Canadian and American--which will benefit travellers and, indirectly, create greater stimulants for innovativeness and market responsiveness for the airlines. Extending the liberalized aviation regulatory environment to Mexico is certain to lead to greater competition among the North American partners.

An interesting question this research addresses is: Will Canadian, American, and Mexican air travellers remain loyal to home-country carriers with a move to a deregulated, open market system? This question focuses directly on the extent of country-carrier loyalty--a vital element of competitive advantage which carriers seek to possess. Put another way, will travellers remain "nationally loyal" in the face of changing international air competitors, product offerings, and product attribute trade-offs? To the extent carriers are able to retain "loyal" customers, the ability to compete effectively will be greatly enhanced. If, on the other hand, loyalty is readily traded off for lower fares, better services, and so forth, then the ability to maintain a competitive position in local markets will be diminished.

The marketing literature is replete with examples of firms who have been able to stave off competitors not because they have better prices

or superior products, but because customers like them, are used to them, and remain loyal to them when making choices. Thus, the impact of air liberalization will depend on the ability of national carriers to 1) capture new travellers in new markets, and 2) retain established customers in markets they presently serve.

The empirical portion of the paper makes the point that 'national loyalty' is a significant factor influencing consumers' choice of international air carrier, although price and service attributes tend to dominate preference choices. From samples of Canadian, American, and Mexican travellers, we present choice trade-offs along with attitudes towards economic regulation for the three countries.

In Section two we present a review of the literature concerning the country-of-origin effect and conjoint analysis. Section three develops the logic of our empirical model, the sample used in testing the model, and the study design in carrying out the empirical research. We discuss the findings and implications in section four. In the final section of the paper we discuss the implications of our findings with respect to the industry, government policy makers, and researchers.

II. Conceptual Development

Self Identity Theory

Tajfel (1981) and Turner (1987) have presented compelling arguments and empirical evidence suggesting that individuals operate within various levels of identity as the situation or context in which they function dictates. This line of enquiry has been explored for several decades and has been subsumed under the rubric of Social Identity Theory. Using experimental settings, researchers have acknowledged that groups are formed based on very few similarities and, furthermore, with extended contact the degree of identification among members within the group becomes more pronounced. Thus, we can discuss personal identity, identity with family, ethnic group, religious group, all the way to identification with mankind and the universe. Each level of identity ushers forth a unique set of norms, and behavioral patterns, and expectations for the individual to follow.

One level of identity which we are interested in assessing is that of national identity. We hypothesize that individuals with tendencies to identify strongly with others at the nation level also will possess strong inclinations to make economic decisions which are in the 'national' interest as opposed to basing them on strict individualistic or utilitarian motives. Individuals who tend to identify themselves strongly at at one of the social levels of identity (nation in our case) will tend to view their choices and actions as members of a larger entity. Thus, decisions on economic matters are dependent upon the implications to individual well-being in the strict utilitarian sense, but also in terms of the impact the decision will have upon other members of the relevant social group whom the individual identifies with. This point has found empirical support in experiments dealing with minority group behaviour (Ethier and Deaus 1994), ethnocentrism (Bruning, Lockshin and Lantz 1993), and in consumer behaviour dealing with reference group influence on consumption choices (Bearden, Netemeyer, and Teel 1989).

Country of Origin

An area of study more closely aligned with our research question is referred to as the Country-of-Origin (COO) research. COO has emanated from scholars in marketing and international business and has grown significantly since the early 1970s. Briefly, COO focuses on identifying and describing specific cues consumers respond to in making consumption decisions in situations where local and foreign products compete. Specifically, researchers question whether a Canadian would prefer Canadian-made product relative to a foreign-made product, an American American-made products, a Mexican Mexican-made products, etc. COO has been found to operate in several ways. Consumers employ the COO cue as an additional variable in forming product evaluations (Hong and Wyer 1989). Second, the COO cue establishes a 'halo' effect which alters consumer's attention to product attributes and thus evaluations of product attributes (Han 1989). Third, the COO is conceptualized as a form of country stereotyping which consumers employ when other product-specific is not available (Bilkey and Ness 1982; Hong 1987). The strength of the evidence appears to be with the latter two interpretations (Bruning, 1994).

Consumer Ethnocentrism

Consumer ethnocentrism has been found to be an important factor in international consumption behaviour (Shimp and Sharma (1987). In short, consumer ethnocentrism is a notion which posits that a consumer's patriotic emotions have a significant effect on attitudes and purchase intentions. Consumer ethnocentrism "gives the individual a sense of identity, feeling of belongingness, and...an understanding of what purchase behaviour is acceptable or unacceptable to the ingroup (Shimp and Sharma 1987, p. 280). A relevant manifestation of an ethnocentric consumer's tendencies is a propensity to buy home country goods at a higher price relative to foreign goods of equal quality (Hooley, Shipley, and Krieger 1988). This phenomenon was identified by Heslop and Papadopoulos (1992) who suggested that domestic preference was partly a function of the strength (or weakness) of the nationalism of the people involved. Ethnocentrism has been found to influence quality evaluations (Shimp and Sharma 1987), price (Wall and Heslop 1988), and purchase intention (Han 1988).

In summary, the traditional COO research has focused on identifying the role performed by the country cue in product evaluation and choice. Researchers have been seeking to explain choice preferences without asking the more fundamental question of why, and to what extent, would a consumer form such a preference and behave economically the way he or she behaves? Research in the area of consumer ethnocentrism, however, has focused on a person-specific psychological trait that appears to indirectly impact economic choice behaviour. In this study, we are integrating the social self identity, COO, and consumer ethnocentrism research in developing the logic for airline choice among Canadian, American, and Mexican air travellers. Our argument posits that a preference for local versus foreign products or services is a function of one's strength of national identity which is dependent upon the influence of social identity in defining one's self. The test carried out on the international air carrier market is an attempt to confirm our theoretical views.

III. Methodology

Research Study Objectives

The present paper represents initial reporting of a much larger study undertaken by the research team. 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 six thousand travellers are interviewed between the three countries, (i.e., 2800 Canadians, 2800 Americans, and 600 Mexicans). The present study may be viewed a pilot study of initial results. The overriding objective of the research is to identify the extent to which national loyalty exists for travellers from the three countries, the extent to which these travellers are willing to trade-off national loyalty for economic gain, and the specific attitudes travellers from the three countries hold with regards to economic regulations of air transportation.

Research Instruments

Conjoint analysis is employed in the empirical portion of the study. Widely used in marketing research, the technique represents a consumer side approach to evaluating product attributes, individual characteristics, and situational factors on preferences and choices. The approach in this study is to derive partworth estimates of the several flight-specific attributes and their levels. We then relate the country of carrier partworth estimates to consumer ethnocentrism and attitudinal factors dealing with economic regulation.

The focus of the attribute choice exercise is an hypothetical trip between two points in North America. A total of six flight-specific attributes are presented during the exercise and travellers are asked to rate the importance of each combination of factors on a ten-point scale. Factor-specific part-worth coefficients are determined based on the relative importance of each level of each factor relative to other factor levels presented in the choice situation. The second instrument is a questionnaire which subjects complete concurrently with the conjoint exercise. The questionnaire collects information on personal demographic information and measures attitudes related to national loyalty, consumer ethnocentrism, and aviation regulation. The development and implementation of the instrument is discussed below.

Conjoint Experiment. The instrument for the conjoint exercise involves twenty scenarios with various trip attribute combinations and a rating form for subjects to indicate trip bundle preferences base on a ten-point preference scale. Attributes selected for inclusion in the experiment are suggested by previous research in marketing and transportation (Bruning 1994; Bruning 1993; Bruning and Hu 1984; and Green and Wind 1975). Six trip attributes are selected for use in the experiment: price, in flight service, number of stops, ontime performance, country of carrier, and whether a flyer mileage program is offered. The country of carrier attribute is our proxy for the relative importance of the country of origin (COO) factor in the air carrier selection process. Levels of each of the attributes are identified in Table 1.

Table 1

Conjoint Experimental Attributes and Attribute Levels

	Attribute Level		
Attribute	Low	Moderate	High
Price	$560	$685	$779
In-flight Service	Low	Medium	High
Number of Stops	2 Stops	1 Stop	Non-Stop
On-time Perform	70%	85%	95%
Carrier Country	Mexico	US	Canada
Air miles	No		Yes

The three price levels are selected based on a 2000 mile flight between two points in North America. Pre-tests of the range confirm that subjects identify $560 as the low price, $685 the moderate level price, and $779 the high price. In-flight services are defined as low, moderate, and high based on the travel scenario. Low in-flight service is defined as the

scenario of poor selection of magazines, no newspapers, no meals, too-few attendants for quick service, poor music quality, noisy aircraft, and inhospitable staff. Moderate service is defined as the scenario of at least one interesting magazine, no newspaper, cold sandwich and dessert, satisfactory speed of service, reasonable music quality, aircraft not too noisy, and congenial staff. The high in-flight service is characterized as having a good selection of newspapers and magazines, a hot meal, quick service, clear music and a movie, quiet aircraft, and excellent staff. All other attributes are self-explanatory. Pre-tests of sample subjects indicate that the levels of each of the attributes are appropriate for the study.

The specific attribute level combinations are determined based on a fractional factorial design yielding 20 combinations (Cochran and Cox 1957). Orthogonal arrays are used to determine the appropriate combinations necessary for effectively estimating main effects. Individual ratings based on the ten-point preference scale serve as the dependent variable while the various attribute levels are effect coded (1, 0, -1) independent variables representing the seven travel specific factors and the one country of origin factor. OLS regression is employed to estimate individual as well as aggregate part-worth coefficients associated with each attribute and level.

Survey Questionnaire. A questionnaire is employed to solicit usage, attitudinal, and demographic information from respondents in order to capture nationalism, ethnocentrism and attitudes towards regulation measurements and link them to the country of origin measure. 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 (Chronbach's alpha = .74), sixteen questions concerning consumer ethnocentrism (Chronbach's alpha = .94), and five questions related to attitudes towards regulation. All scales exhibit acceptable levels of internal consistency. The final section of the questionnaire includes items concerning respondents' age, income, gender, and participation in air mileage programs. Data were collected at a major international airport in Halifax, Seattle, and Houston (for the Mexican sample). The research team was not allowed to solicit data from airports in Mexico. consequently, it was decided to interview Mexican residents return to Mexico via flights from Houston. A

convenience sample design was employed to identify and collect information from the sample units. A total of 270 air travellers took part in the conjoint exercise and follow-up survey during a three-month period in 1997.

IV. Results and Discussion

Variable Description

Characteristics of the sample units and key variables employed in the analysis are reported in Table 2. Average age of the respondent falls in the 39-45 range with 15% of respondents frequenting 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 was rated slightly above the mid-point of the seven-point scale. The typical sample respondent travels approximately 3 to 4 times per year, although the percent of international air travel is considerably lower at less than 1 trip per year.

Table 2

Descriptive Statistics for Selected Profiling Variables

Traveller Attribute	Canada	U.S.	Mexico
Age	43	45	39
Gender			
Male	61%	54%	60%
Female	39%	46%	40%
Air Travel Knowledge	4.9	5.0	3.2
Average Annual Trips			
Domestic	3	5	0
International	1	1	2

Conjoint Results

Partworth Coefficients. Table 3 reports the flight attributes and relative importance associated with each attribute level. The two most important factors resulting from the conjoint exercise are Price and Number of Stops. Service and On-Time Performance ranked third and fourth, respectively. Country of Carrier was ranked either fourth or fifth, depending on country-specific sample, among all flight factors. The least influential factor was the existence of Frequent Flyer mileage programs. Price was considered the most important factor for Canadian and Mexican travellers and second-most important factor for Americans followed by On-Time Performance. The results indicate that factors tended to fall into one of three levels of influence: the most important being Price and the Number of Stops, a second level comprised of Performance and In-Flight Service, and a third which includes Country-Of-Origin and Frequent Flyer Programs. The summary statistics from the regression analysis indicate a stable pattern across all three samples. The goodness of fit statistic is moderately high ranging between .456 and .430, and all F-statistics are significant at the $p<.01$ level.

Table 3

Three-Sample Partworth Importance Ratios

Attribute	Canada	US	Mexico
Price	14.3	8.8	12.8
In-Flight Services	27.8	23.8	23.5
Number of Stops	15.9	19.0	17.9
On-Time Perform	14.3	13.3	15.1
Carrier Country	19.8	25.2	19.0
Flyer Programme	7.9	10.0	11.7

Regulatory Attitudes

Several questions were posed to sample travellers that reflected attitudes towards economic regulation in the air sector. Outlined below are the questions and mean response values across the three samples.

Table 4
Mean Responses to Regulatory Questions

	Canada	US	Mexico
Foreign carriers serving _____ communities benefit the nation.	4.58	4.76	5.41
Present regulations limiting foreign airline operations in _____ should not be continued.	3.71	4.31	4.16
Regulations that protect domestic air markets from foreign competition are not beneficial to air travellers.	4.09	5.93	5.81
_____ owned airlines are not competitive without integrating with foreign airlines.	3.15	5.13	5.58
Government policy should allow foreign investors to buy a _____ air carrier even if it means the end of _____ owned airlines.	3.68	3.78	3.49
Mean Item Scores	3.84	4.78	4.89

The results reported in Table 4 represent a snapshot view of several attitudes and attitudinal differences between Canadians, Americans, and Mexicans with respect to aviation regulation. From traveller responses in Halifax, Seattle, and Houston, it appears Canadians tend to hold a more pro-regulatory attitude than do their counterparts in

the U.S. and Mexico. 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 greater degree than Americans and Mexicans. Canadians also felt aviation regulations conveyed more benefits to national air travellers in comparison to Americans and Mexicans. Americans and Mexicans felt national carriers would benefit through integration with other carriers while Canadians were not so confident of this statement. Finally, when threatened with the demise of a national carrier, Canadians were less willing to allow foreign ownership compared to Americans and Mexicans, although the difference was statistically insignificant.

V. Conclusions

The analyses indicate that the three North American samples differ along a number of dimensions with respect to national loyalty to own-country carrier and to attitudes toward protective regulations. Canadians rate price as the most important factor in their decision to fly with a particular carrier; however, they also possess the strongest loyalty to own-country carrier (14.3%). Americans, while indicating price and the number of stops as most important flight related factors, nonetheless, indicate the lowest degree of own-country carrier loyalty (8.8%). Mexicans rank price as the most important factor and own-country carrier loyalty is between Canada and the US levels (12.8%). Taken together, the data suggest a relatively strong pro-national and protectionist response from the Canadian sample in comparison to that of the Americans and the Mexicans. Does Canadian, American, and Mexican aviation regulatory policy reflect consumer sentiments? Has the market been effectively "polled" prior to development of national policies affecting the sector? These are vital questions which our research hopes to answer in further analyses of the data.

References

Bearden, W.O.; Netemeyer, R.G.; and Teel, J.E. (1989). "Measurement of Consumer Susceptability to Social Influence," Journal of Consumer Research, 15:473-481.

Bilkey, W.J. and Ness, E. (1982). "Country of Origin Effect on Product Evaluation,"Journal of International Business Studies, 13:89-99.

Bruning, E.R. and Hu, M.Y. (1984). "Misperceptions of Airline Services and the Degree of Prior Experience," Logistics and Transportation Review, 20:213-222.

Bruning, E.R.; Lockshin, L.S.; and Lantz, G.E. (1993). "A Conjoint Analysis of Factors Affecting Intentions of Canadian Consumers to Shop in U.S. Retail Centres," Proceedings, Administrative Science Association of Canada, Lake Louise, Alberta,

Ethier, K.A. and Deaux, K. (1994). "Negotiating Social Identity When Contexts Change: Maintaining Identification and Responding to Threat," Journal of Personality and Social Psychology, 67:243-251.

Green, P.E. and Wind, Y. (1975). "A New Way to Measure Consumers' Judgements," Harvard Business Review, July-August: 107-117.

Han, C.M. (1989). "Country Image: Halo or Summary Construct?" Journal of Marketing Research, 26:222-229.

Han, C.M. (1988). "The Role of Consumer Patriotism in the Choice of Domestic Versus Foreign Products," Journal of Advertising Research, 28:25-32.

Heslop, L.A. and Papadopoulos, N. (1992). "But Who Knows Where or When? Reflections on the Images", in Product Country Images, N. Papadopoulos and L. Heslop, eds. USA: Hawthorn Press.

Hong, S.T. and Wyer, R.S. (1989). "Effects of Country-of-Origin and Product Attribute Information on Product "Evaluation: An Information Processing Perspective," Journal of Consumer Research, 16:175-187.

Hooley, G.; Shipley, D. and Krieger, N. (1988). "A Method for Modelling Consumer Perceptions of Country of Origin," International Marketing Review, 5:67-76.

Shimp, T. and Sharma, S. (1987). "Consumer Ethnocentrism: Constructiona and Validation of the CETSCALE," Journal of Marketing Research, 24:280-289.

Tajfel, H. (1981). Human Groups and Social Categories. Cambridge, England: Cambridge University Press.

Turner, J.C. (1987). Rediscovering the Social Group: A Self-Categorization Theory. Oxford, England: Basil Blackwell.

Success of New Non-Stop Services in the Aviation Transborder Market

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Introduction

Since 1994, several factors have combined to change transborder air carrier passenger services. In particular, passengers have been offered more non-stop flights between Canada and the U.S. For example, passengers flying between Toronto and St. Louis may now fly non-stop rather than having to make a connection at Detroit or Chicago.[1]

These changes have occurred for several reasons, including an easing of access restrictions for air carriers flying between Canada and the United States (an outcome of the 1995 Canada-US "Open Skies Agreement"), the introduction of more cost efficient jets, trade patterns (NAFTA) and economic growth.

Since "Open Skies", the carrier offering the most new non-stop transborder service has been Air Canada. In a press release dated February 23, 1998, Air Canada stated:

> *"The airline's trump card in the Open Skies market is its versatile fleet including: the Canadair Regional Jet, the Airbus A320 and the Airbus A319. Together, these aircraft are perfectly suited to meeting the needs of customers and allow Air Canada to bypass U.S. hubs in favour of rapid and frequent non-stop services ."*

The paper examines transborder activity between major Canadian and U.S. cities where non-stop jet services started during the study period and where hub connections have been bypassed. The study uses a non-random selection of city pairs and excludes holiday markets where charter competition would have existed. City pairs served by regional carriers were also excluded.

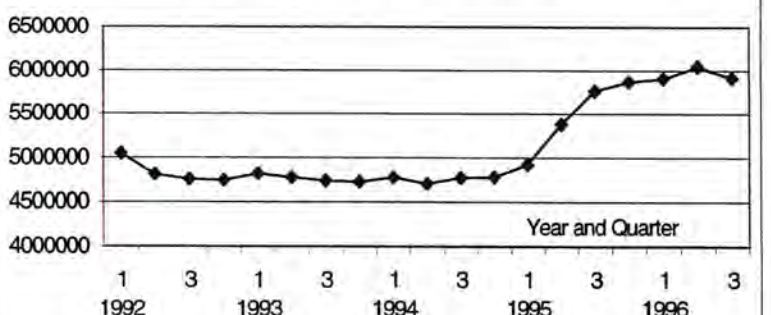
The research outlined in this paper utilizes scheduled passenger data from Statistics Canada's transborder Origin and Destination survey. Data from this survey are published in "Air Passenger Origin and Destination, Canada-United States Report" (Catalogue 51-205 XPB). Data from the third quarter of 1996 are compared with the third quarter of 1995. An analysis of the preceding year is also included. The other primary data source is "Transport Canada Aircraft Movement Statistics", TP 577, produced by Statistics Canada.

Canadian cities which were initially targeted for inclusion in the study were Halifax, Quebec, Montreal (Dorval), Toronto (Lester Pearson International Airport), Ottawa, Winnipeg, Calgary, Edmonton and Vancouver. Only those city pairs that experienced new non-stop transborder services were included in this study. [2] Eleven city pairs were chosen for review in the main study period, 1995-96. [3]

Changes in Traffic Patterns

Figure 1 shows the total estimated number of seats[4] flown between Canada and the U.S. by scheduled carriers with jet aircraft between 1992 and 1997. The graph shows that there has been a significant increase, especially since 1995.

Figure 1
Total Estimated Seats Flown on Transborder Markets by Scheduled Carriers With Jet Aircraft



Source: Transport Canada Aircraft Movement Statistics, TP577
Produced by Statistics Canada

Table 1[5] shows the estimated number of seats flown on the eleven transborder city pairs, where new non-stop services began during the main study period. During the third quarter of 1995, activity levels were negligible on these city pairs.

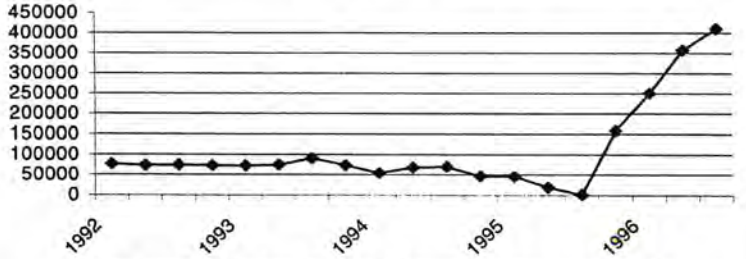
TABLE 1
ESTIMATED NUMBER OF SEATS FOR
11 CITY PAIRS WITH NEW NON-STOP SERVICES
BETWEEN THE 3RD QUARTERS OF 1995 & 1996

City Pair	Est. Seats 3rd Quarter 1996	Carrier(s) Offering New Non-Stop Services
Toronto – Kansas City	11 300	Air Canada
Toronto – Denver	47 553	Air Canada
Toronto – St. Louis	68 800	Air Canada, TWA
Toronto – Nashville	25 100	Air Canada
Toronto – Minneapolis/St. Paul	33 036	Air Canada
Vancouver – Salt Lake City	62 381	Delta
Vancouver – Denver	21 250	United
Vancouver – Atlanta	33 120	Delta
Vancouver – New York (JFK)	34 298	American
Vancouver – Detroit	26 420	Northwest
Calgary – Houston	47 084	Air Canada
Total	410 342	

Source: Transport Canada Aircraft Movement Statistics, TP577
Produced by Statistics Canada

Figure 2 shows the estimated number of seats flown for the eleven city pairs (from Table 1) during the period 1992 to 1997. The figure shows a noticeable increase in activity between the third quarters of 1995 and 1996.

Figure 2
Estimated Seats Flown on 11 City Pair Transborder Markets
By Scheduled Carriers With Jet Aircraft
New Services



Source: Transport Canada Aircraft Movements Statistics, TP577
Produced by Statistics Canada

Table 2 shows, for the eleven city pairs, the phenomenal growth in activity for those air carriers that offered new non-stop services. At the same time, traffic on connecting services dropped by 36%. Six percent of the total market continued to be carried on direct services that had at least one stop.

TABLE 2
COMPARISON OF 3rd QTR PASSENGER VOLUMES FOR 11 CITY PAIRS WITH NEW NON-STOP SERVICES

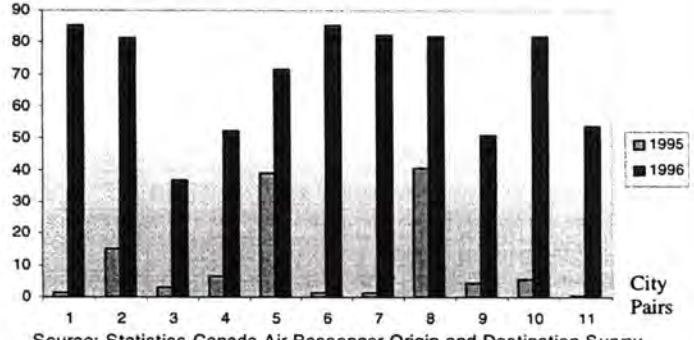
	1995	1996	CHANGE	
Number of Passengers Flown:			**Volume**	**%**
Direct by carriers that offered the new non-stop service (* On certain city pairs, these carriers would have offered some direct services with at least one stop in 1995.)	1 500	105 440	103 940	6929
Direct by other carriers (with at least one stop)	8 950	9 390	440	5
By carriers offering only connecting service	79 940	51 450	-28 490	-36
Total	90 390	166 280	75 890	84
Market Share in Percent:				
Direct by carriers that offered the new non-stop service (* see note above)	2	63		
Direct by other carriers (with at least one stop)	10	6		
By carriers offering only connecting service	88	31		
Total	100	100		

Source: Statistics Canada Air Passenger Origin and Destination Canada-United States
Cat. 51-205-XPB

Not all of the eleven city pairs studied were similar in terms of the proportion of direct versus connecting passenger traffic. Figure 3 shows the changes in the percentage of direct traffic.

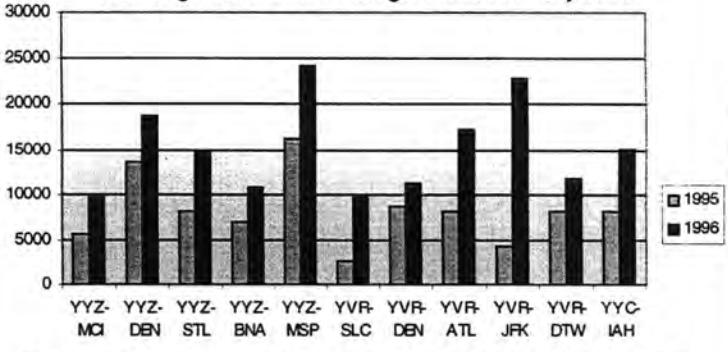
Figure 4 shows the increase in total Origin-Destination traffic at the eleven city pairs between 1995 and 1996 (third quarters). As can be seen, growth has been significant.

Figure 3
Proportion of Direct Passenger Traffic at 11 City Pairs



Source: Statistics Canada Air Passenger Origin and Destination Survey
Note that city pairs in this figure are coded to assure data confidentiality.

Figure 4
Total Origin-Destination Passenger Traffic at 11 City Pairs



YYZ - Pearson International Airport, Toronto; YVR Vancouver; YYC Calgary; MCI Kansas; DEN Denver; STL St. Louis; BNA Nashville; MSP Minneapolis; SLC Salt Lake City; ATL Atlanta; JFK John F. Kennedy New York; DTW Detroit; IAH Houston

Source: Statistics Canada Air Passenger Origin and Destination Survey

City Pairs With No New Non-Stops Added During The Study Period

The preceding tables and figures show that significant growth has occurred for those city pairs in which new non-stop services were added during the study period. In comparison, this section will review city pairs where services remained relatively constant. Table 3 shows activity levels for nineteen such city pairs.

TABLE 3
ESTIMATED NUMBER OF SEATS FOR 19 CITY PAIRS WITH NON STOP SERVICES IN BOTH THE 3RD QUARTERS OF 1995 AND 1996

City Pair	1995	1996	% Chg.	Carrier(s)
Toronto – Atlanta	125 221	122 353	-2	Air Canada, Delta
Toronto – Boston	144 925	129 727	-10	Air Canada, USAir
Toronto – Detroit	167 524	182 721	9	Northwest
Toronto – Houston	54 500	47 553	-13	Air Canada
Toronto – Los Angeles	126 000	110 499	-12	Air Canada
Toronto – New York (LGA)	468 573	407 433	-13	AC, American, Canadian
Toronto – Milwaukee	27 692	27 956	1	MidWest Express
Toronto – Chicago	418 970	456 368	9	AC, AA, CP, UA *
Toronto – San Francisco	124 026	114 799	-7	Air Canada, United
Montreal – Washington (DCA)	64 707	61 469	-5	Air Canada, USAir
Montreal – Detroit	114 217	109 559	-4	Northwest
Montreal – Los Angeles	26 936	24 245	-10	Air Canada
Montreal – Chicago	181 633	168 812	-7	Air Canada, American
Montreal – Pittsburgh	39 274	41 976	7	USAir
Vancouver – Dallas	67 803	69 336	2	American
Vancouver – Chicago	118 516	104 522	-12	Canadian, United
Ottawa – Washington (IAD)	26 450	23 850	-10	Air Canada
Calgary – Dallas	76 450	68 574	-10	American
Calgary – San Francisco	49 905	47 566	-5	Air Canada, United
Halifax – Detroit	42 320	40 825	-4	Northwest
Total	2 465 642	2 360 143	-4	

Source: Transport Canada Aircraft Movement Statistics, TP577
Produced by Statistics Canada

* AC – Air Canada; CP – Canadian; AA – American Airlines; UA United Airlines

Table 4 shows that the total scheduled transborder market increased by 19% over the review period. The table also shows that for the nineteen city pairs (from Table 3) where no new services were added, the number of passengers carried grew six percent. As shown previously, the growth rate for the eleven city pairs with new non-stop services was 84 percent.

The table also shows that the size of the transborder market where new services occurred is small relative to the overall transborder market.

TABLE 4
COMPARISON OF 3RD QUARTER SCHEDULE PASSENGER MARKET SIZE

	1995	1996	Change	% Change
Total Transborder Market	2 884 370	3 426 310	541 940	19
11 City Pairs With New Non-Stop Services	90 390	166 280	75 890	84
19 City Pairs (Table 3) With No New Non-Stop Services	745 480	792 290	46 810	6
Other City Pairs	2 048 500	2 467 740	419 240	21

Market Share (in Percent)		
New Service City Pairs	3	5
No New Service City Pairs	26	23
Other City Pairs	71	72

Source: Statistics Canada Air Passenger Origin and Destination Canada-United States Report Cat. 51-205-XPB

Comparison of 1994 and 1995

An analysis of 14 city pairs that initiated new services between the third quarter of 1994 and the third quarter of 1995 yielded data with generally similar results to the city pairs which received new services between the third quarters of 1995 and 1996. Table 5 shows that Origin-Destination traffic increased significantly and direct traffic represented the majority of the market in the latter year. While traffic between these city pairs increased by 88%, the overall Canada – U.S. Origin-Destination traffic

increased by 19% in the third quarter of 1995, compared to the third quarter of 1994.

TABLE 5
COMPARISON OF 3RD QUARTER PASSENGER VOLUMES FOR 14 CITY PAIRS

Number of Passengers Flown:	1994	1995	Change	
			Volume	%
Direct by carriers that offered the new non-stop service (* On certain city pairs, these carriers would have offered some direct services with at least one stop in 1994.)	31 510	138 990	107 480	341
Direct by other carriers (with at least one stop)	1 820	2 830	1 010	56
By carriers offering only connecting service	60 300	34 380	- 25 920	-43
Total	93 630	176 200	82 570	88
Market Share in Percent:				
Direct by carriers that offered the new non-stop service (* see note above)	34	79		
Direct by other carriers (with at least one stop)	2	2		
By carriers offering only connecting service	64	20		
Total	100	100		

Source: Statistics Canada Air Passenger Origin and Destination Canada-United States Cat. 51-205-XPB

Observations

It is apparent that traffic was stimulated by the introduction of new non-stop services. Between the third quarters of 1995 and 1996, overall traffic increased by 84% in markets where non-stop services were introduced. In markets that already had non-stop jet services and where no new services were introduced, traffic increased by only 6%. While there was increased passenger traffic that flew direct on city pairs that had new non-stop services, there was a decrease in connecting traffic on these city pairs. Similar results were observed during the preceding year.

The preceding analysis shows that the air carriers have been successful in identifying markets that can support new non-stop services. Nevertheless, some passengers will continue to choose flights that connect at intermediate points. Convenience factors such as frequency of service and scheduling are the main reasons. Another reason is that some passengers may wish to acquire reward program points and will choose to use an air carrier despite the need to make a connection. Finally, some passengers may prefer larger jet aircraft and may decline to fly on smaller turboprop aircraft or the relatively small (50 seat) Regional Jet such as those used by Air Canada and Comair on lighter density non-stop flights.

Other Findings

A) Effect of New Services: Toronto-Montreal and Toronto-Ottawa

Passengers wishing to travel from Ottawa or Montreal to the United States where there are no available non-stop services to the U.S. may use Toronto as the connecting airport to the U.S. With the introduction of new non-stop transborder flights, the passenger may have one less stop or connection to make in 1996 than in 1995. Table 6 indicates that the number of passengers flying between Montreal or Ottawa, to the cities noted, has increased at a substantially higher growth rate than the market in general. There are several factors that could explain these increases. However, the reduced connections, as a result of new non-stop services out of Toronto have undoubtedly had an impact.

TABLE 6
OTTAWA/MONTREAL TRANSBORDER PASSENGER TRAFFIC TO/FROM U.S. CITIES THAT RECEIVED NEW SERVICES TO/FROM TORONTO

United States City	Canadian City	3rd Qtr 1995	3rd Qtr 1996	% Change
Kansas City, Denver, St. Louis, Nashville and Minneapolis/St. Paul	Ottawa	4 550	8 420	85.1
	Montreal	21 680	28 580	31.8
	Total	26 230	37 000	41.1
Rest of the U.S. Market	Ottawa	93 570	133 890	43.1
	Montreal	513 040	540 470	5.3
	Total	606 610	674 360	11.2

Source: Statistics Canada Air Passenger Origin and Destination Canada-United States Report Cat. 51-205-XPB

B) Gateway Patterns

TABLE 7
PROPORTION OF TOTAL TRANSBORDER PASSENGERS WHOSE U.S. GATEWAY WAS THEIR U.S. ORIGIN OR DESTINATION (THIRD QUARTER 1996)

Passengers on a transborder flight	3 427 720
Passengers with no U.S. connection	1 984 700
Percentage without a U.S. connection	57.9

Source: Statistics Canada Air Passenger Origin and Destination Canada-United States Report Cat. 51-205-XPB

Table 7 shows that in the third quarter of 1996, slightly less than half of transborder passengers connected in the U.S. This is approximately the same proportion as in several preceding years.

Table 8 splits the data according to the nationality (Canadian or U.S.) of the carrier on the transborder leg. The table shows that 91 percent of the passengers travelling on Canadian air carriers reached their final destination without a U.S. connection. Only 38 percent of passengers flying on U.S. flag carriers reached their destination without a connection.

TABLE 8
PROPORTION OF TOTAL TRANSBORDER PASSENGERS WHOSE U.S. GATEWAY WAS THEIR U.S. ORIGIN OR DESTINATION (THIRD QUARTER 1996)

	Canadian Carriers	U.S. Carriers
Passengers on a transborder flight	1 284 410	2 143 310
Passengers with no U.S. connection	1 171 980	812 720
Percentage (no U.S. connection)	91%	38%

Source: Source: Statistics Canada Air Passenger Origin and Destination Canada-United States Report Cat. 51-205-XPB

The data show that it is the nature of flights by Canadian carriers to end at the U.S. gateway, while most of the passengers on U.S. carriers go beyond

the gateway. With Air Canada offering the bulk of the new transborder services in recent years, and offering these services on nonstop flights, this pattern is unlikely to change.

Conclusion

It appears obvious that adding new nonstop services has stimulated traffic and pulled passengers from connecting flights to direct flights in great numbers. The number of new non-stop routes has increased steadily since the third quarter of 1996. This trend could ultimately cause U.S. hub and spoke carriers to reconsider their frequencies or capacity on the transborder legs. [6] Changes in the future will also depend upon the changes in trade patterns and economic growth in Canada and the United States.

***

Note: The views and opinions expressed in this paper are those of the authors and do not necessarily reflect those of Statistics Canada.

The authors would like to thank Rolf Hakka of the Aviation Statistics Centre, Statistics Canada, for his valuable contribution to this paper.

The authors retain all responsibility for any errors.

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[1] Direct passengers include those who fly non-stop between city pairs and those who travel on multiple stage services that stop in other cities without the passenger deplaning until reaching the final destination. Passengers who deplane and enplane again at intermediate stops to reach their destination are considered to be connecting passengers.

[2] Services that did not exist in the third quarter of 1995 but began in the next year are referred to as "new", although they may have existed in prior years (e.g. 1994).

[3] Table 1 contains a list of the eleven city pairs.

[4] In Tables 1 and 3, the number of seats is calculated by multiplying an estimated number of seats per aircraft by flight frequency.

[5] The city pair Toronto - Washington was excluded from Tables 1 and 2. Although a new service began between Toronto and Dulles International Airport, there were two existing non-stop services offered by regional carriers in 1995 that ceased in 1996. Also, at Washington National, there were two existing services in both 1995 and 1996.

For city pairs involving New York or Washington (both with 2 major airports) there was an additional complexity. In Tables 1 and 2, JFK airport in New York was chosen for analysis. However, in 1995, there was substantial Origin-Destination traffic between Vancouver and New York's Laguardia Airport. Vancouver – Laguardia traffic was studied to ensure that

there were no significant changes in the volume of traffic in 1996. If reductions in traffic to Laguardia had occurred, it could be assumed that passengers had switched to JFK from Laguardia because of non-stop flights to JFK. However, this switching did not occur.

[6] This study did not specifically focus on the effect on bypassed U.S. hubs. However, the assumption could be made that carriers that previously connected passengers through U.S. hubs have suffered some losses. For example, in the third quarter of 1996, there were approximately 79,000 Origin-Destination passengers between Toronto and the new nonstop U.S. points: St. Louis, Denver, Kansas, Nashville and Minneapolis. According to ICAO, the annual traffic by flight stage (the flow between cities) between Toronto and Chicago in 1996, by American Airlines and United Airlines (for whom Chicago is a hub) was 740,000. The 1995 Origin-Destination data show that the third quarter accounted for 28 percent of the year's traffic, amounting to approximately 208,000 passengers. For these carriers, the opportunity to carry 79,000 passengers through their hub and spoke system is important.

An example that can be used to show the impact on the domestic portion of the U.S. hub and spoke system is Chicago - St. Louis. In the third quarter of 1996, there were nearly 15,000 Origin-Destination passengers who travelled between Toronto and St. Louis. During the same quarter, there were 324,000 passengers on the Chicago – St. Louis flight stage. The loss in opportunity to carry the 15,000 passengers on the U.S. leg is not as significant as in the previous example. U.S. air carriers may not be as concerned with the effect of these losses on the U.S. domestic leg, given the size of the U.S. domestic market.

Canada's East Coast Container Ports, Do they Compete With or Complement One Another in the Race for North American Container Traffic?

Introduction:

International shipping is a highly competitive industry, especially the shipping of containers. Shipping lines are constantly trying to increase productivity by reducing costs and by attracting larger volumes of containers. In response to spiraling container freight rates, the lines have been driven to increase economies of scale. These economies are expected to be achieved through larger ships and fewer, more efficient port calls. Larger ships and client demands for frequent service have encouraged innovative alliances and pooling agreements among lines to maximize the use of this larger capacity.

Ports competing for this container traffic stand to gain or lose – big time. Old carrier-port relationships are threatened as alliance partners seek the most efficient ports for their combined service. Ports that are constrained by depth, navigation channels, turning basins or landside acreage may be reduced to spoke or secondary port status. Ports that have been naturally blessed with limitless depths, marine and landside space, must race to develop the port and inland infrastructure required to accommodate the mega-ships and their massive container volumes. Even if a port and its inland partners make the sizable investments necessary, there is no guarantee that the mega-ships will call.[1]

Must ports compete for this traffic or acquiesce to declining volumes? Such a scenario in Canadian terms could see the deep water port of Halifax thrive, while the inland port of Montreal declines.

The writer's hypothesis is that while container mega-ships will indeed call at North American ports, the Port of Montreal will continue to succeed, essentially because it is a niche port in the ocean container market and can therefore resist the trend. Halifax, on the other hand, could become a big winner if mega-ships become a dominant factor in the ocean container market by going with the trend – however, it faces some high stakes investment decisions that are not without risk. This hypothesis will be

evaluated through a review of academic literature and an analysis of statistics that will contrast the container operations of the two ports.

This report uses container data from two sources, Statistics Canada's marine international Origin/Destination (O/D) database and Journal of Commerce P.I.E.R.S. data (provided by the Maritime Administration of the US Department of Transport). The unit of measure is the Twenty-foot Equivalent Unit (TEU) for containers with cargo or the full TEU (i.e., no empty containers). The data cover a ten-year period from 1987 to 1996. There are limitations with the comparability of these data – P.I.E.R.S. data use country of export/import while the Statistics Canada data use the country of the port of loading/unloading. To derive TEUs by world region from the Statistics Canada data, the TEUs loaded/unloaded at Canadian ports by ship calling at more than one world region were apportioned using the containerized tonnage shipped to or received from each region. These limitations are not expected to have much impact on the analysis.

Containers, Customers and Economies of Scale

The ports' quest for increasing container volumes is directed more at shipping lines than individual shippers. The measure of a container port's success may be the number of containers handled, but they achieve that success by first attracting lines and then encouraging those lines to increase their container activity through programs such as volume pricing and marketing activities that promote both the port and the shipping lines.

Shipping lines choose their ports based on a number of factors including proximity to markets, physical characteristics, availability of inland transportation, port charges, and reliability of port services such as stevedoring. The port selection must also fit well with the carrier's overall strategy including the markets and trade routes served.

Carriers in turn offer their customers a package of cost and service attributes that include the reliability and efficiencies achievable based on the selected port or ports and service delivery options.

Studies of the ocean container market indicate that it is neither stagnant nor homogenous. Shippers' requirements change over time and the market can be segmented both geographically and by class of customer (e.g., freight forwarders, large shippers, small shippers, and consignees) in terms of the cost/service attributes.[2]

While cost is always a consideration, it need not be a determining factor in carrier choice, particularly when customers perceive little cost difference among carriers. Carriers can differentiate their services and attract customers with such non-cost factors as service reliability, frequency and after sales service (e.g., accuracy of documentation, quality of telephone help). Indeed a 1995 poll by Containerisation International found the number three requirement on shippers' top 10 list was port of coverage and the sequence of calls preceding the shipper's destination.

Segmentable markets and non-cost carrier selection criteria suggest that pursuing a lowest-cost service strategy may make a carrier vulnerable to competitors that can identify and exploit niche markets, or that can expand and diversify their product lines (i.e., combinations of cost and service options) to appeal to a wider customer base. Shipping lines may achieve such diversification in their product lines by adding new services[3] or through mergers and strategic alliances. This may be one reason why 1996 was a record year for mergers and alliances, another reason is the cost savings that are possible when resources are combined. [4]

Taking a scale economy approach to cost reduction may also have risks. The concept of scale economies for shipping is generally accepted as sound economic theory. Larger ships are built at a lower cost per gross registered ton (GRT) than smaller ships and have lower running costs per GRT. Indeed, Drewry Shipping Consultants recently estimated that the annual operating and voyage costs of a 6000 TEU super-post-Panamax ship are 21% less per TEU slot than those of a optimized 4000 TEU Panamax container ship.[5] However, the larger ships normally gain their unit cost advantages by increasing overall capital cost, with ships of 6000 TEU capacity costing up to $100 million according to Drewry.

Shipping lines may compensate for this higher capital by purchasing fewer ships thus limiting service frequency even though overall service capacity may increase. Such lines may lose customers due to the lower service frequency and have to discount rates to attract other customers. Lower than expected revenues result in an inability to service a bloated debt load and can lead to the demise of the shipping line[6].

Ship size is not the only factor that affects the economics of container ship services. Lim (1994)[7] in comparing the revenues and expenses of different size container vessels could find no empirical evidence of unit cost decreases on a TEU-mile basis for larger size ships because non-cost related factors conspired to eliminate their scale economies. Factors such

as route characteristics, prevailing freight rates, load factors and operating days can affect the economics of container shipping and are independent of ship size. Even for vessels operating on the same route, differences in the ships' purchase prices may bias unit costs (TEU-mile) in favour of a smaller vessel. Introducing larger container ships on some routes may also exacerbate over tonnage and increase downward pressures on freight rates for all ships that ply those routes.

Still the trend to larger container vessels continues unabated. The number of existing container ships and ships on order with over 2500 TEU capacity grew by 55.9% from November 1, 1990 to November 1, 1994, while ships with less than 2500 TEU capacity increased just 16.0%. Slot capacity provided by these larger ships increased by 73.0% in the same period, suggesting that the growth has been in ships much larger than 2500 TEUs.[8] The growth has really been phenomenal in ships of 3250 to 4249 TEU capacity which went from 68 ships in service at the end of 1991 to 170 ships by the end of 1996. Ships over 4250 TEU capacity increased from 8 to 66 ships in service during the same period.[9] However, while the growth rate for large container ships (2500+ TEUs) may be increasing faster than for medium sized container ships (1000-2499 TEUs), there are more of the latter and shipyards build more medium sized ships each year than mega-ships[10]. This suggests that larger ships do not meet all the market needs envisaged by carriers.

In Europe, this trend to larger ships has indeed had an impact, setting in motion a trend to coastal port locations with inland urban ports either losing container volumes or relocating most of their own container handling capacity downstream to new coastal port locations. The new coastal port locations save transit time, particularly for larger ships as they do not have to await locks or high water to navigate confined channels.

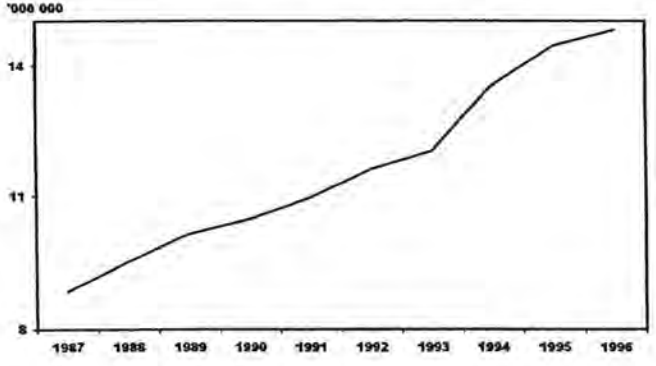
Hamburg and Antwerp, however, have resisted the trend to coastal port locations with container volumes that have risen from 2.2 million TEUs and 1.8 million TEUs, respectively, in 1991 to 2.9 million TEUs and 2.3 million TEUs in 1995[11]. Antwerp's success has been attributed to a strong concentration of port based industries and extensive transport links with the hinterland, while Hamburg is a cargo transshipment centre with Free Port status and strong trading links with the Far East.[12] Unlike other upstream European ports, Hamburg and Antwerp are geo-politically constrained from opening coastal port operations and are therefore likely to continue to resist such change.

In summary, the literature suggests that while the global trend to larger container ships is well established, such ships are not an industry panacea. Shipping lines that choose to use the larger ships must continue to balance the customer's demand for frequent service with the increase in unit capacity (TEU slots per ship) while maintaining compensatory freight rates. Lines are attempting this through mergers, alliances and service extensions. Mid-sized container ships have a role in enabling lines to differentiate their service by calling with greater frequencies and at ports not easily accessible to the larger ships. Maersk Lines' initiation of direct weekly service from Northern Europe to Montreal, in alliance with Sea-Land Services and P&O Nedlloyd, particularly demonstrates this concept, as Maersk often leads in the race for mega-ships.

The North American Ocean Container Shipping Market

In 1996, North American ports (excluding Mexico and Alaska) handled 14.5 Million full TEUs (i.e., containers with cargo) in trade with overseas ports. In the decade 1987 to 1996, this market has grown at an average annual rate of 5.9%. In terms of world regions, Asia and Oceania was by far the most important origin/destination (O/D) with 56.1% of the full TEUs in 1996, followed by Europe with 24.1%.

Full TEUs to/from Overseas Ports and Countries
(1987-1996, Millions of TEUs)



Ports on the Pacific coast, which handled 80.9% of the full TEUs originating in or destined to Asia and Oceania, accounted for 49.1% of the total traffic. Atlantic coast ports handled 44.4% of the full TEUs because

they dominated the traffic to and from Europe and South and Central America. Ports on the Gulf Coast handled almost all of the remaining TEUs as Great Lakes ports handled just 410 TEUs from/to overseas ports in 1996.

From 1987 to 1996, growth rates for container traffic varied significantly among world regions. Traffic to/from South and Central America and the Middle East and Africa led the world regions with average annual growth rates of 12.1% and 9.7%, respectively. Europe had the lowest average annual growth rate at 3.3%, while container traffic to/from Asia and Oceania grew at an average annual rate of 5.6%.

Millions of Full TEUs Handled at North American Ports by World Region of Origin/Destination in 1996				
	North American Coast			
World Region	Atlantic	Pacific	Gulf	Total
Asia and Oceania	1.51	6.59	0.04	8.14
Europe	2.81	0.28	0.41	3.50
South and Central America*	1.69	0.22	0.42	2.34
Middle East and Africa	0.42	0.04	0.07	0.53
North America N.E.S.	0.01	--	--	0.01
Total	6.44	7.13	0.95	14.52

*Includes Mexico

Canadian ports handled 10.0% of the full TEUs handled by North American ports in 1996. However, the proportion by world region varied widely, ranging from 2.1% of the rapidly growing South and Central American market to 24.6% of the more slowly growing European market. Canada's share of the markets for Asia and Oceania, and Middle East and Africa were 6.2% and 5.9%, respectively.

Canada's eastern ports (Montreal, Halifax and others) were particularly active in the European market, handling 30.1% of the full TEUs exchanged between Europe and North America's Atlantic Coast in 1996.

Comparing Canada's East Coast Ports to U.S. East Coast Ports

The decade 1987 to 1996 saw 74% growth in the number of full TEUs handled by ports on the Atlantic Coast of North America from ports overseas (i.e., excludes Canada-U.S. traffic). However, the growth rates varied significantly among ports from –25% for Baltimore, Maryland, to 2493% for the port of Wilmington, Delaware.

The growth rates for Canada's two main Atlantic ports also varied significantly with full TEUs for this overseas market increasing 60% at Montreal and decreasing 9% at Halifax. (Including Canada-US traffic, Halifax's total TEUs (full and empty) increased 7% during this period with strong growth in traffic with US ports.) In 1996, the two ports ranked third and nineth among ports on the Atlantic Coast of North America in terms of TEUs.

Full TEUs Handled at Atlantic Coast Ports in 1996 and 1987 with Overseas Ports/Countries of Origin/Destinations			
Port	TEUs 1996	TEUs 1987	Increase from '87 to '96
NY/NJ	1 530 622.3	1 143 924.0	34%
Charleston, S.C.	800 050.9	379 746.6	111%
Montreal, P.Q.	745 760.4	465 223.0	60%
Miami FL	503 858.1	190 610.7	164%
Norfolk, VA	680 175.5	310 353.5	119%
Savannah, GA	455 695.3	284 423.1	60%
Port Everglades, FL	422 153.1	123 261.9	242%
Baltimore, MD	275 815.5	368 624.0	-25%
Halifax, N.S.	229 857.8	252 181.0	-9%
Jacksonville, FL	185 403.5	78 336.9	137%
Other Canada	40 519.1	23 245.9	74%
Other U.S.A.	585 791.9	313 204.3	87%
Total	6 570 985.9	4 019 705.7	64%

The factors that determine a container port's potential include: natural endowments (navigating and landside access and space); man-made endowments (docks, cranes, intermodal infrastructure); human factors (labour harmony and productivity, legislative environment, port tariffs and fees); and perhaps most importantly location. Location determines the port's market potential given the other necessary endowments.

In theory, the Canadian ports could compete for all North American container traffic with an Atlantic Coast O/D. However, it is more instructive to compare these ports against those ports that are more likely to compete within the same markets. To identify these competitors, it is useful to consider the markets that could be well served by the two Canadian ports based on their locations.

The world's busiest container ports are all well situated in terms of centrality and intermediacy. Centrality is the port's location near a strong traffic-generating local or immediate hinterland, while intermediacy is its location along the path between two pairs of distantly located traffic-generating regions[13]. However, these concepts, particularly centrality, are very much affected by scale.

For example, Halifax's immediate hinterland could be restricted to just Halifax county or extended by good intermodal connections to include the Atlantic provinces and the New England states. Montreal's hinterland could be similarly restricted to metropolitan Montreal or extended to include Ontario, Quebec and the U.S. Census Region known as the Middle Atlantic (New York, Pennsylvania and New Jersey). The resulting markets have vastly different consumption and production levels (i.e, traffic-generating potential).

For Halifax, the extended market would have a 23-fold increase in population and a 96-fold increase in the value of manufacturing shipments. For Montreal, there would be a 10-fold increase in population and a 26-fold increase in the value of manufacturing shipments. For these extended hinterlands, the Canadian ports must compete with: NY/NJ (NY/NJ), which resides within the US Middle Atlantic; Baltimore, which resides on Middle Atlantic's border; and Norfolk, which has been an effective competitor with Baltimore for this traffic. Halifax and Montreal could also compete with one another for containers in the New England, Middle Atlantic, Ontario, and Quebec markets.

The Impact of Extending the Ports' Hinterlands		
Halifax port:	Manufacturing shipments 1994 (US $ Billion)	Population 1996 ('000)
Halifax county	1.7	343.0
Nova Scotia	4.8	909.3
Atlantic Canada	12.7	2,333.8
Atlantic Canada and New England States	168.0	7,774.9
Port of Montreal:	Manufacturing shipments 1994 (US $ Billion)	Population 1996 ('000)
Montreal	24.9	3,326.5
Quebec	74.9	7,138.8
Quebec and Ontario	237.7	17,892.4
Quebec, Ontario and US Middle Atlantic	638.9	34,631.1
Sources: Statistics Canada's 1996 Census and Annual Survey of Manufacturers. US Bureau of Census Population Estimates Program (SU-96-11) and Annual Census of Manufacturing		

To assess the Canadian ports' potential in terms of intermediacy, it is necessary to consider the pairings of traffic-generating regions in North American and world regions overseas. The main North American region of interest to the Canadian ports, is the U.S. Census East North Central Region (Wisconsin, Michigan, Illinois, Indiana and Ohio). The traffic-generation potential of this region is huge with its population of 23.9 million in 1996 and manufacturing shipments of $US 815.2 billion in

1994. Both Canadian ports have excellent rail connections to this important market.

The most important world regions for the Canadian ports are Europe, which in 1996 accounted for 97% of Montreal's overseas container traffic, and Europe and Asia and Oceania, which together accounted for 88% of Halifax's overseas container traffic.

Montreal is the leading Atlantic coast gateway for full containers of European O/D, followed by NY/NJ. NY/NJ leads for the world regions of Asia and Oceania and the Middle East and Africa. Halifax is the fifth busiest port based on the 1996 data, for the Asia and Oceania region and the sixth busiest for the European region. The Central and South American market, which accounts for less than 1% of the full TEUs handled by Montreal and Halifax is dominated by Port Everglades and Miami, Florida, perhaps due to their southern location relative to the North American heartland.

Shares of Full TEUs Handled at Atlantic Coast Ports in 1996 by Region of Origin/Destination

Port	Europe	Middle East & Africa	Asia & Oceania	Central & South America	North America NES	Total
NY/NJ	24.3%	32.4%	34.3%	11.4%	0.1%	23.8%
Charleston, S.C.	12.9%	16.6%	18.5%	5.2%	0.0%	12.4%
Montreal, P.Q.	25.8%	3.7%	0.1%	0.1%	0.0%	11.6%
Miami FL	13.6%	14.2%	10.5%	4.7%	0.3%	10.6%
Norfolk, VA	2.2%	1.6%	5.5%	20.8%	0.0%	7.8%
Savannah, GA	3.6%	13.7%	15.4%	3.9%	0.0%	7.1%
Port Everglades, FL	1.7%	0.5%	0.1%	21.9%	0.0%	6.6%
Baltimore, MD	4.7%	8.3%	3.7%	3.0%	0.0%	4.3%
Halifax, N.S.	4.1%	3.4%	5.8%	0.6%	97.8%	3.6%
Jacksonville, FL	0.9%	0.1%	0.7%	8.8%	0.0%	2.9%
Other U.S.A.	0.2%	0.1%	0.0%	1.2%	0.8%	0.4%
Other Canada	6.1%	5.3%	5.5%	18.3%	1.0%	9.1%
	100%	100%	100%	100%	100%	100%

From 1987 to 1996, the Canadian ports' performance in the European and the Asia and Oceania markets compared to the three main US ports competitors has been mixed. Montreal has surged ahead in the European

market with an increase of 62% over the decade and has replaced NY/NJ as the number one port on the North Atlantic. Halifax has lost some ground in both the European and the Asia and Oceania markets, which continues to be dominated by NY/NJ. Norfolk has made significant gains in all markets and has overtaken Halifax in the Asia and Oceania market. It has more than doubled the full TEUs of European O/D over the decade and handled almost half the European volume handled by Montreal in 1996. Baltimore has lost significant ground in both the European and the Asia and Oceania markets.

Full TEUs by World Region for Canadian Ports Relative to Main U.S. Competitors ('000 TEUs)				
Yr. - Port	Europe	Middle East & Africa	Asia & Oceania	South & Central America
96 - NY/ NJ	683.8	135.6	517.9	193.3
87 - NY/NJ	551.3	53.2	441.1	92.3
Increase 96/87	**24%**	**155%**	**17%**	**97%**
96 - Montreal	726.7	15.7	1.1	2.3
87 - Montreal	449.4	3.5	2.3	1.0
Increase 96/87	**62%**	**347%**	**-54%**	**128%**
96 – Norfolk, VA	381.4	59.4	159.4	80.0
87 - Norfolk, VA	188.9	17.9	88.2	15.4
Increase 96/87	**102%**	**232%**	**81%**	**421%**
96 – Baltimore, MD	133.6	34.7	56.2	51.3
87 - Baltimore, MD	218.8	34.0	86.5	29.3
Increase 96/87	**-39%**	**2%**	**-35%**	**75%**
96 – Halifax	115.2	14.3	87.6	10.4
87 - Halifax	137.9	7.9	100.4	3.6
Increase 96/87	**-16%**	**81%**	**-13%**	**188%**

NY/NJ, the Canadian port's largest competitor, has seen its full TEUs to/from overseas countries climb 34% over the decade. NY/NJ has a large local market, which according to one study, accounted for 68.1% of the TEUs handled by the port in 1994. The other main inland markets served by NY/NJ in that year were the Mid Atlantic (11.9% of TEUs), the Great Lakes area (8.0%) and New England (7.6%).[14] Despite such a vibrant local market, the port complained to the U.S. Maritime Administration of containers diverted to Canada due to shippers' desire to circumvent U.S. regulations (e.g., filing of ocean rates) and lower port tariffs.[15]

However, NY/NJ's main concern with Canadian competition appears to have been its own draft limitations. The port's main channels (Kill van Kull, Newark Bay and Elizabeth Channel) have a limiting depth of 40 feet which causes ships such as Maersk's 4000 TEU M-class vessels to top-up or lighten their loads at Halifax or Norfolk.[16] Despite contaminated

dredge spoils, the port recently received approval and federal funding for 65% of the US$621 million cost to dredge the channels to 45 feet.[17] This may stem some of the diversion of containers through Canadian ports which NY/NJ estimates at 100,000 containers a year. In fairness to Canadian ports, it should be noted that the diversion of containers is not uni-directional. P.I.E.R.S. 1996 data show that the port of NY/NJ handled over 84,000 TEUs of Canadian origin/destination in trade with counties overseas. Other US Atlantic ports handled a further 31,000 TEUs.

Canadian ports have traditionally been seen as low-cost alternatives to the U.S. ports. However, they do have significant locational advantages over the U.S. ports. Halifax is on the Great Circle route and is the closest North American port to Northern Europe (e.g., Antwerp, Rotterdam), with an ocean-distance advantage of 1150 kilometres over NY/NJ the closest of its U.S. competitors. The opening of the Sarnia tunnel in 1995 has given Halifax direct access to the U.S. Midwest. This resulted in a 40% gain in the number of containers carried by the tunnel's owner, Canadian National, between Halifax and the U.S. in 1997 over 1996.[18] The port's 60-foot channel depths are the deepest on the Atlantic coast. Only two other Atlantic ports, Baltimore and Norfolk have the 50-foot channels necessary to accommodate a fully ladened 6000 TEU container ship.

Montreal, with its location 1,600 kilometres inland, has the closest rail access to the U.S. Midwest. The port has strengthened this locational advantage by enhancing its multi-modal connections with dockside rail access for the two railways, Canadian National (CN) and Canadian Pacific (CP), that serve the port. Continuous improvements in the intermodal connections have reduced rail times from Montreal to 10 hours for Toronto, 25 hours for Detroit and slightly more than 30 hours for Chicago. Double-stack service has been available for the CP route from Montreal since May 1994. Montreal has also benefited from the Sarnia tunnel as CN has offered high-cubed double-stack service from Montreal to the U.S. Midwest since 1995.

The locational advantages of the Canadian vis-à-vis the U.S. Midwest may be considered long-term strategic advantages. However, other advantages such as depths, lower port tariffs and the shipping lines' ability to offer confidential ocean rates may be affected by the counter-actions of U.S. ports, such as NY/NJ's dredging program and attempts to cut costs.[19] If the Canadian ports are to compete with U.S. ports they must continue to maintain their advantages in these other, less permanent areas, as indeed they have in the past. The U.S. ports, particularly NY/NJ will

continue to have the advantage when it come to the size of their immediate port hinterlands, which Canadian ports would likely have access to only as low cost service providers.

Comparing Montreal and Halifax

As container ports, Halifax and Montreal can aptly be described as a study in contrasts. The contrast starts with the most obvious difference, vessel size and how vessel size has changed over the decade 1987-1996. As expected, the ships calling at Halifax tend to be larger than those calling at Montreal. In 1996 ships over 2000 TEUs represented 68% of the vessel calls at Halifax for ships transporting containers, 80% of the total TEU capacity and 75% of the TEUs handled by the port. For Montreal ships over 2000 TEUs had just 28% of the vessel calls, 45% of the TEU capacity and 45% of the TEUs handled by the port.

Distributions of Container Activity by Vessel Size in TEU Capacity for Halifax and Montreal (1987 & 1996)				
Halifax - 1987	<1000	1000-1999	2000-3249	3250+
Share of vessel calls	27%	36%	37%	0%
Share of TEU Capacity	8%	39%	53%	0%
Share of TEUs loaded/unloaded	10%	37%	52%	0%
Halifax - 1996				
Share of vessel calls	23%	9%	54%	14%
Share of TEU Capacity	4%	7%	65%	25%
Share of TEUs loaded/unloaded	10%	6%	66%	19%
Montreal - 1987				
Share of vessel calls	74%	24%	2%	0%
Share of TEU Capacity	64%	28%	9%	0%
Share of TEUs loaded/unloaded	42%	58%	1%	0%
Montreal - 1996				
Share of vessel calls	37%	36%	28%	0%
Share of TEU Capacity	19%	36%	45%	0%
Share of TEUs loaded/unloaded	21%	34%	45%	0%

While the shift to larger vessels from 1987 to 1996 is quite apparent in both ports, it is interesting to note that the proportion of TEUs loaded and unloaded by the smaller ships (<1000 TEUs) in Halifax was unchanged from 1987 to 1996. The trend to larger ships seems to have more impact on the ships in the 1000-1999 TEU bracket which lost considerable share

in terms of vessel calls, total capacity and TEU volumes to the larger vessels (2000 TEU and above). In Montreal, both the small and mid-sized (1000-1999 TEU) vessels lost share to the larger ships, however there appears to have been a cap in vessel size at about 2500 TEUs.

The larger ships calling at Halifax load/unload a lower percentage of their container capacity than the ships calling at Montreal. On average, the container ships calling at Montreal in 1996 unloaded containers amounting to 73% of their container capacity and then loaded 81% of their capacity before leaving port. In Halifax, the percentage of capacity used was 11% for unloaded containers and 11.9% for loaded containers. This is consistent with Montreal's role as the single North American port of call for some lines on the North Atlantic trade route. By contrast Halifax is one of a number of ports-of-call for ships offering North Atlantic and Round-the-World services. The smaller ships that use Halifax appear to be engaged in supply of St. Pierre and Miquelon and spoke services to US ports.

Montreal's role in the North Atlantic also seems to have had an impact on the number of empty containers that are handled at the port. Empty containers accounted for 8.7% and 17.7%, respectively, of the total containers for Montreal and Halifax in 1996. At both ports there was a significant disparity between the rate of empty containers outbound (Halifax 2.4%, Montreal 2.5%) and inbound (Halifax 33.8%, Montreal 15.5%), suggesting that there is a significant amount of container repositioning for the inbound trades.

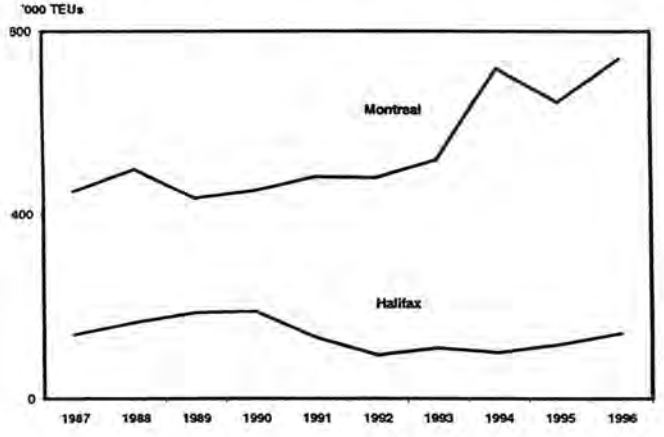
For the decade 1987 to 1996, both Montreal and Halifax experienced average annual growth rates around 4% in the total tonnage of containerized cargo (including cargo to/from the U.S.). However the pattern of growth varied significantly between the two ports. Whereas Montreal's containerized cargo grew each year since 1989, Halifax's containerized cargo tonnages have fluctuated considerably with peak years in 1990 and 1996.

It is evident from this foregoing discussion that the ports do not compete for exactly the same kind of container ship traffic. However, this is only part of the story as the real concern is whether or not the ports and their respective lines or services, compete for the same containers. One would expect that they do compete for at least some containers with a European O/D, particularly since the ports' hinterland markets are likely to overlap

(i.e., both ports attempt to serve New England, US Middle Atlantic, US Midwest, Ontario, Quebec and Atlantic Canada).

Three data series could be used to consider this question: total TEUs (full and empty) handled by the ports; tonnage of containerized cargo; or, full containers with a European O/D. The first data series is affected by empty containers which were allocated based on tonnage of containerized cargo by world regions and is therefore suspect. The second data series has some double counting of containerized cargo for Halifax in the years prior to 1994. A correlation analysis of the full TEUs with a European O/D was therefore undertaken.

Full TEUs with a European Origin/Destination for Halifax and Montreal



The analysis found a correlation coefficient of ρ=-0.44 for full TEUs with an European O/D for the ports of Halifax and Montreal over the decade 1987 to 1996. This could suggests that there has been some competition between the two ports for North Atlantic container traffic as a gain at one port may be accompanied by a loss in the other port. However, it also suggests that competition between the two ports is less important to the success of either port than are other factors. Such factors as the economic climate in Canada and its trading partners and competition with U.S. ports appear to have more influence on the success of the ports of Halifax and Montreal. The opening of the Sarnia tunnel could increase the competition between the ports for containers with a US Midwest O/D.

Conclusions

The increasing size of container ships has had an impact on Canada's two main Atlantic coast ports. Halifax and Montreal have both seen their containerized freight arrive and depart in larger ships over the decade 1987-1996, as shipping lines attempt to reduce costs through scale-economies. Halifax has been able to accommodate much larger ships than Montreal. However, while there appears to be some competition for containerized cargo between these ports, the competition appears to be directed more at U.S. Atlantic coast ports. The large size of U.S. markets make them very attractive in an era of free trade and Canadian ports are well sited to compete within these markets.

The continuation of the trend to larger ships does not necessarily imply that there will be a loss of traffic at Montreal in favour of Halifax or other deep-water U.S. ports. Montreal appears to have developed a niche-market with lines that specialize in direct service to Europe that use the port as their sole North American port of call. These services appear to have generated a growing volume of traffic for the port in the past and this seems likely to continue in the future. The success of such services appear to be based on giving the customer (e.g., shippers, freight forwarders) a wider set of options to move their freight. A 1996 survey by Containerisation International revealed that shippers want a say in the selection of shipping conferences and the routing of their cargo[20] and Montreal's inland location near major markets will likely continue to give it an advantage in competing for these customers.

Halifax seems to have a competitive advantage due to its location on the Great Circle route and its deep waters. Using this advantage to attract mega-containerships (6000+TEUs) will depend on its ability to make a sizeable investment in cranes for post-panamax ships, which individually cost about $20 million. This is not without risk, as NY/NJ will continue to be a major competitor with its recently approved dredging program. Norfolk is also able to offer deep draft and has improved its competitive position over the past decade. In the future, Halifax may continue to play a role as a port where container ships top-up (i.e., load to capacity) before heading overseas, or lighten-up (i.e., unload containers to reduce draft) before heading to other North American ports with draft limitations such as NY/NJ. With the investment in cranes, there could be potential for Halifax to become a major centre for post-panamax ships from Asia and Oceania when these ships are introduced to the Suez express services. However, this potential needs to be investigated.

[1] In August 27,1996, K. Barry Olsen, President of Maersk Canada Inc., told the Canadian Ports and Harbours Association that if Halifax port did not invest in post-panamax gantry cranes - jumbo, post panamax container ships would not visit the port. However, he gave no commitment the ships would call at Halifax if the investment were made.

[2] Brooks, M.R. (1995), Understanding the ocean container market – a seven country study. *Maritime Policy Management*, **22**(1), 39-49.

[3] For example Maresk's decision to add direct service to Montreal.

[4] Tirschwell, P. (1998). Mergers reshape shipping. Journal of Commerce. 5 January 1998. P8.

[5] Damas, P. (1996) Big...bigger...super-post-Panamax. American Shipper **38** (11) 61.

[6] Lim, S-M. (1996) Round-the-world service: the rise of Evergreen and the fall of U.S. Lines. *Maritime Policy & Management*, **23**(2), 119-144.

[7] Lim, S-M. (1994). Economies of container ship size. *Maritime Policy & Management*, **21**(2), 149-160.

[8] Containerisation International Yearbook. (1991 and 1995). Table 3.

[9] Lloyd's Shipping Economist (1997). Poorer prospects for larger vessels. **19**(11) 12-15.

[10] Based on a comparison of the numbers in reference 9 and the article "Large tonnage hits small containerships". Lloyds Shipping Economist **19** (5) 12-15.

[11] Containerisation Annual Yearbook. 1997.

[12] Baird, A.J. (1996). Containerisation and the decline of the upstream urban port in Europe. *Maritime Policy & Management*, **23**(2), 145-156.

[13] Fleming, D.K. (1997). World container port rankings. *Maritime Policy & Management*, **24**(2), 175-181.

[14] Ashar, A. (1997) Impact of Dredging New York Harbour. Transportation Quarterly **51**(1) 45-62.

[15] America Shipper. Canadian ports gain in transatlantic. March 1997, 66-67

[16] Containerisation International. Dredgement day approaches **29**(7) 78-79

[17] Canadian Sailings. 23 February 1998, 37

[18] Peters, T. (1998) Port of Halifax posts strong container growth. Canadian Sailings. 12 January, 1998 p5.

[19] Canadian Sailings. 26, January 1998 p5.

[20] Containerisation International. Shippers know best. **29**(11) 67-70

A TIME FOR CHANGE
AN INTERNATIONALLY COMPETITIVE CANADIAN FLAG? PRAGMATIC REFORM OF THE CANADA SHIPPING ACT IS THE ANSWER[1]

Jonathan Seymour

Summary

Prior to 1991, Vancouver had no international shipowners, no ship managers and few time-charter operators. It is now home to a more diverse and vibrant marine community, as a result of changes made to the federal Income Tax Act in 1991, the so-called *International Maritime Centre (IMC) amendments*. It is possible to view the IMC initiative as an end in itself. Alternatively, it can be viewed as the first step in a three-step process with the potential to create a significant Canadian presence in deep-sea shipping based on competency, competitiveness and quality. Reform of the Canada Shipping Act (CSA) can provide the next two steps. Done well, this will result in significant benefits to Canada. A first class national register that is genuinely competitive, the creation of employment and business opportunities for Canadians, a rejuvenated marine training system and a world-class, professional marine infrastructure better able to service the needs of the Canadian exporter.

Canadian ships are controlled by the CSA and its regulations. Second only in size and complexity to the Income Tax Act, it owes its genesis to the British Merchant Shipping Act of 1894 and the era of sail. Late in 1996, Transport Canada embarked on a three-year project to reform the CSA. The first legislative product of this work is Bill C-15, which has as its primary objective up-dating Part I of the existing Act. It received second reading in the House of Commons in March 1998. A second bill is anticipated early in 1999 dealing with the remainder.

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[1] The mandate of the not-for-profit society International Maritime Centre – Vancouver, includes *"the provision of advice and input to the federal and provincial governments regarding the legislative and regulatory framework required to enhance the development of the international shipping sector in Canada generally, and in British Columbia in particular"*.

For Canada, this creates an opportunity. Canada already has in place the first of a number of essential elements, a tax-and duty-free regime for international shipping at the corporate level. The others are possible through the remainder of the current CSA reform process.

1. The Essential Elements

Three primary elements dictate whether or not a country can achieve competitiveness in international shipping: tax-free status at the corporate level, a flexible manning regime, and the application of ship safety standards that are genuinely international. The IMC amendments to the Income Tax Act provided Canada with the first of these three elements. The current reform process for the Canada Shipping Act can provide the remaining two.

All that is required is a clear policy direction and the realization that Canadians have the capacity and the willingness to compete internationally - providing their efforts are not hobbled by overly-prescriptive, out-of-date regulation.

2. Background

Between 1945 and 1950, the Canadian government disposed of the large merchant fleet it had built up during the war years. Canadians had no interest in buying these ships, so they were sold to foreign interests. Over the next 40 years, recriminations and demands for government subsidies or cargo reservation schemes dogged every discussion on a possible Canadian deep-sea presence. In 1984, responding to repeated calls for action, the federal government appointed a task force under the chairmanship of Professor Gunnar Sletmo. It reported in 1985[2], and rejected any government intervention to establish and support a core deep-sea Canadian fleet. The representatives of the seafarer unions on the task force did not agree and tabled a minority report.

Since 1985, a number of things have changed both within the international and Canadian environments. Canada is no longer a high-cost country when it comes to the supply of qualified labour. Canadian senior officers take positions on foreign ships, where the prevailing wages are often

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[2] Gunnar Sletmo, Task Force on Deep-Sea Shipping, Final Report to the Minister of Transport, April 1985

better than domestic pay. Canadian junior officers who do not seek out positions on foreign ships can easily spend 15 or more years accumulating enough watch-keeping time to sit their examinations for senior certificates, because of the lack of opportunity in Canada's domestic trade.

Canadian marine schools, such as the Pacific Marine Training Campus (PMTC) of the BC Institute of Technology, have difficulty offering a full range of courses because they cannot get enough students, so they are threatened with closure. The career path, once obvious to Canadian mariners through service on the Lakes or the coast, is no longer an expedient one. As a result, Canada's ability to produce suitably qualified seafarers for the many Canadian shore-based jobs requiring professional sea-going qualifications has been seriously curtailed.

Meantime, there is a significant and growing shortage of qualified seafarers worldwide. In a recent speech[3], Barbara Fletcher, director of the London-based Institute of Chartered Shipbrokers estimated this shortage could reach 45,000 by the year 2002. She also pointed out the impact this would have on the future recruitment of shore-based personnel with sea-going experience. One result is a sharp rise in the number employment advertisements in the marine press in Europe and Asia. A second is upward pressure on wages offered to skilled personnel internationally.

Part of the backdrop to the Sletmo task force was the UNCTAD code. A cargo preference system, advocated by the United Nations Convention on Trade and Development (UNCTAD), it sought to divide cargoes between national carriers on a 40/40/20 basis; i.e. 40% for the country of origin, 40% for the country of destination and 20% for cross-traders. The UNCTAD proposal was opposed by the OECD countries.

Another part of this same backdrop was the prevalence of subsidy schemes. The US system was the most obvious, where Construction Differential Subsidies (CDS) and Operating Differential Subsidies (ODS) were used as policy tools intended to preserve a high-cost merchant marine as the country's *fourth arm* of defence.

The UNCTAD code is now a footnote in the progress towards free trade in goods and services, and even in the USA, most direct subsidies to the shipping industry are being terminated.

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[3] Seatrade Week Newsfront, November 21, 1997 pp 14, *et al*

3. CSA Reform

Late in 1996, Transport Canada embarked on a three-year project to reform the CSA. The first legislative product of this work is Bill C-15, which has as its primary objective up-dating Part I of the existing Act. It received second reading in the House of Commons in March 1998. A second bill is anticipated early in 1999 to deal with the remainder of the Act; the personnel sections (Part II, et al), the technical/ship safety sections (Part V, et al) plus a number of miscellaneous items. In the meantime, Transport Canada's reform team is engaging in extensive consultations with stakeholders.

Under the current regulatory regime, Canadians cannot be competitive in international shipping using Canadian ships, Canadian seafarers and Canadian management. This is largely because, without a Canadian-flag deep-sea presence, the Canada Shipping Act and its regulations have grown on a largely *ad hoc* basis to meet the needs of the domestic industry. In spite of being an active player in the international organizations that seek to harmonize shipping regulation worldwide, Canada's record of implementing IMO and ILO conventions has been hesitant. Canada is, of course, entitled to regulate its domestic trade to meet the special requirements of its operators. When it comes to its international regime, however, Canada does a number of things to ensure that internationally traded ships do not willingly use the Canadian-flag.

3.1 Ship Construction and Equipment

With respect to ship construction and equipment, Canada's approach imposes an extra cost burden – one that can be avoided by maintaining foreign registry. Transport Canada regards a foreign ship trading between (say) Vancouver and Alaska using the Inside Passage as a safe ship if it complies with the internationally acceptable standards of its existing flag state. If the same ship plying the same route now seeks to become Canadian, it must comply with a number of uniquely Canadian standards in addition to the normal international requirements. In addition, it is required to comply with these standards as if it is a brand new ship, irrespective of its actual age. The resulting reconstruction and re-equipment project is invariably so onerous and expensive that Canadian flag is ruled out.

3.2 Manning and Certification

The manning of Canadian ships and the certification of seafarers is the second major area where the Canada Shipping Act eliminates deep-sea opportunities for Canadians. Every successful and competent deep-sea registry permits partial foreign manning and accepts specified foreign certificates of competency as equivalent to its own. This is not the case in Canada.

The prohibition is not a direct one, however. A mariner serving on board a Canadian ship in a certificated position must hold a Canadian certificate. A Canadian certificate is only issued to a Canadian citizen or permanent resident. Certificates issued by other countries may be considered equivalent to Canadian certificates, subject to a reciprocal arrangement. There are no such reciprocal arrangements and no intention of entering into any. Consequently, on a typical, frugally-manned ship, every job would be reserved for a Canadian[4].

Proposals[5] have lodged with Transport Canada recommending mixed manning and a degree of reciprocal recognition of certificates. These proposals contain a number of safeguards; in addition, they would not apply to Canada's coasting trade. The Coasting Trade Act would continue to reserve Canada's domestic trade for Canadian ships that are required by the Immigration Act to be manned entirely by Canadians.

3.3 The Total Package

Figure 1 summarizes the primary legislative and regulatory components for Canadian ships engaged in international traffic:

- Figure 1a contains those that would remain unchanged under these proposals.
- Figure 1b summarizes those components where change has been recommended, and indicates the scope of change requested.

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4 IMC – Vancouver, correspondence with Transport Canada – Marine Safety Transport Canada, Manning Regulations and Crewing Regulations, July 1997

5 R C E Kitching, Canada Shipping Act Reform, Marine Certification and Manning, September 1997

FIGURE 1a. CSA REFORM: THE AGGREGATE PICTURE – PRESENT AND PROPOSED

	present	proposed
Coasting Trade Act	• domestic trade reserved for Canadian duty-paid ships • absent a Canadian duty-paid ship, a coasting license may be issued to a non-duty-paid Canadian ship, subject to duty and immigration provisions • absent a Canadian ship, a coasting license may be issued to a foreign ship, subject to duty, inspection and immigration provisions	unchanged
Immigration Act	• positions on all ships in the domestic trade reserved for Canadians • employment authorizations not required for foreign nationals employed on foreign-registered ships engaged predominantly in international trade • employment authorizations not required for foreign nationals employed on a foreign-owned Canadian ship engaged predominantly in international trade	unchanged
Customs Tariff	• ships imported into the domestic trade subject to 25% duty • ships imported from USA subject to residual duty under CUSTA • partial remission available 1/120th per month	unchanged
Customs Tariff	• duty removed for ships engaged in international trade operated from a Canadian base	unchanged

Income Tax Act	• a foreign corporation will not be deemed a resident of Canada if it
	  • is incorporated offshore
	  • is a *bona fide* operator of ships
	  • that are engaged in international traffic
		unchanged

Income Tax Act	• a foreign resident is exempt from taxation on Canadian-sourced international shipping income	unchanged

FIGURE 1b. CSA REFORM: THE AGGREGATE PICTURE – PRESENT AND PROPOSED

present		proposed	
Canada Shipping Act	• a Canadian ship may be owned by a British Commonwealth individual or corporation	Bill C-15 CSA Reform I	• a Canadian ship may be owned by a foreign corporation but must be substantively managed from Canada
Canada Shipping Act	• licensed jobs on Canadian ships reserved for holders of Canadian licenses • Canadian licenses only held by Canadians • reciprocity provisions exist but none authorized	CSA Reform II	• senior positions on Canadian ships engaged in international traffic reserved for Canadians • other licensed positions open to foreign nationals holding a reciprocally-recognized license • reciprocal agreements pursued as a matter of policy
Canada Shipping Act	• foreign students at a Canadian marine school cannot be awarded Canadian licenses or any other internationally recognized qualification	CSA Reform II	• foreign students at Canadian marine schools may sit for and be awarded an internationally recognized qualification (not necessarily a Canadian license)
Canada Labour Code	• applicable to all Canadian ships	CSA Reform II	• ?? ILO conventions to apply to all personnel employed on foreign contracts on Canadian ships engaged exclusively in international traffic??
Canada Shipping Act	• Canadian ship construction/equipment *add-ons* • registration requires compliance with Canadian standards for a brand new ship	CSA Reform II	• eliminate Canadian ship construction/equipment *add-ons* • entry into register requires compliance with international standards for a ship of its age

4. Experience Elsewhere

The current reform of the Canada Shipping Act permits both drafters and regulators the opportunity to adopt a competitive regime and remove the barriers that currently prevent or hinder Canadian seafarers from finding employment and Canadian shipping entrepreneurs from developing business opportunities.

Today's success stories are the Netherlands[6], Norway[7] and Singapore. In each case their merchant fleets and their international shipping communities are expanding. They have in common no corporate taxation on shipping income earned offshore, flexible manning arrangements and/or payroll tax adjustments, plus the application of international standards per convention combined with the agencies able to monitor and enforce compliance. The Netherlands has been so successful in repatriating Dutch operators and attracting foreign shipping groups that the available pool of ship officers has been temporarily exhausted. Recently, some 40 ships have been refused registration because of a shortage of qualified Dutch seafarers[8].

The Dutch experience is particularly noteworthy for other reasons. First, it was motivated by a shore-based personnel crisis. Because of its strategic location and its extensive navigable river and canal systems the marine infrastructure of the Netherlands is regarded as a vital national interest. Germany's largest continental port is Rotterdam, not Hamburg or Bremen. The Netherlands recognized its need for a large pool of professionals to keep this infrastructure functioning - managers, navigators and engineers with extensive sea-going experience and qualifications. But, with a sharply declining deep-sea fleet, the established career path that had previously supplied seasoned mariners to run the maritime infrastructure was fast being dismantled. Second, the Dutch adopted a highly structured approach to solving this problem. The

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6 Lloyd's Shipping Economist, Government helps revitalize Dutch fleet, August 1996
Lloyd's List, Dutch initiative boosts register, November 16, 1996
Lloyd's List, Dutch dream team wide awake, December 9, 1997
Lloyd's List, Flag law change leads to expansion, January 13, 1998

7 Lloyd's List, State pledges on tax reform bring back confidence, October 30, 1996
Lloyd's List, Return of the golden age, November 22, 1996
Seatrade Review, In the mood, October 1997

8 Seatrade Week Newsfront, Crewing, November 28, 1997

objectives were clearly defined, the policy framework was comprehensive and inclusive, and pragmatic use was made of a wide range of tools to create a competitive environment able to generate the demand for mariners at sea and the means to train them.

5. The International Shipping Environment

The international shipping environment is changing significantly. In the world of maritime safety, 1998 is a pivotal year. It marks the implementation of two very significant international agreements - the International Safety Management Code (ISM), part of the Safety of Life at Sea Convention (SOLAS) and the new Standards of Training, Certification and Watchkeeping for Seafarers Convention (STCW95). Adoption of these two conventions by every major flag-state, combined with almost universal port state control, is expected to undermine the ability of sub-standard ships to continue trading[9].

6. The IMC amendments

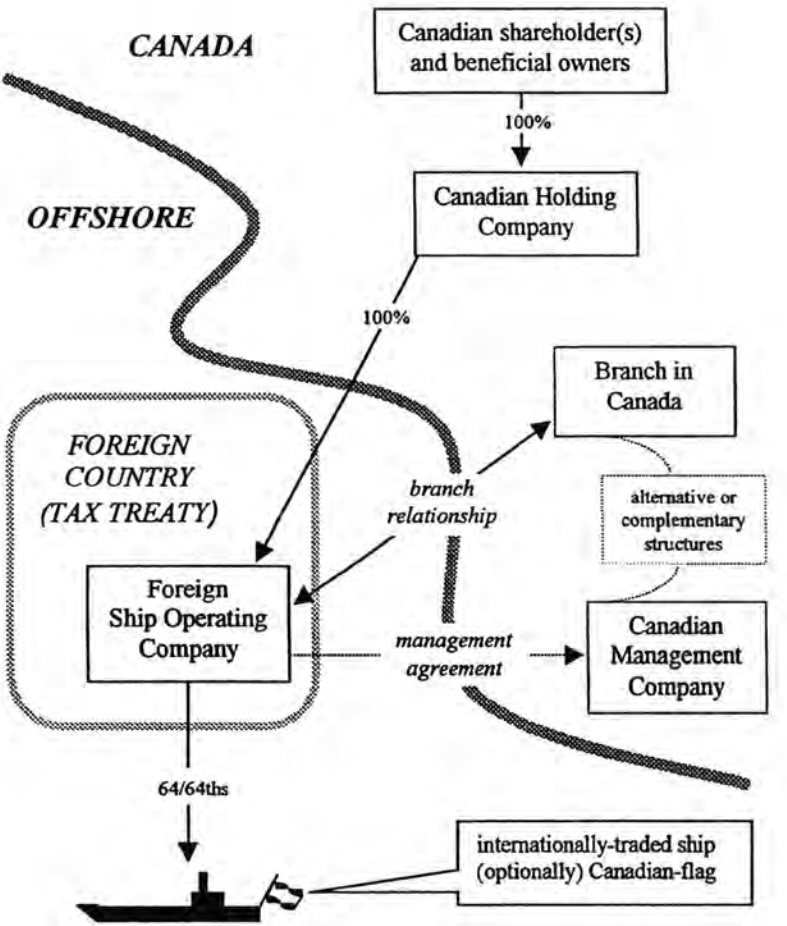
There is an opportunity here for Canada. Canada already has in place the first of the three essential elements, a tax-free regime for international shipping at the corporate level. This was implemented by the 1991 changes to the Income Tax Act - sometimes referred to as the international maritime centre (IMC) amendments. The relevant clauses in the Act are included in full in Appendix 1, and a flow chart designed to help interested parties understand how the IMC amendments actually work is provided in Appendix 2.

These provisions, in combination with the foreign ownership sections of the Canada Shipping Act plus the Customs Tariff, allow a Canadian ship to operate free of Canadian income tax and import duty – providing it is used exclusively in international traffic. Among other things, Bill C-15 maintains and improves the existing foreign ownership provisions in the Canada Shipping Act by requiring the ship to be managed in Canada. Figure 2 shows how an international shipping group beneficially-owned in Canada can be structured to use the IMC amendments and (optionally) deploy a Canadian ship in international traffic.

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[9] Transport Canada, Tightening the Net: Canada signs Joint Ministerial Declaration on Port State Control, March 25, 1998

FIGURE 2. THE IMC INITIATIVE
POSSIBLE GROUP STRUCTURE(S)
INCLUDING BILL C-15 OPTIONAL REGISTRATION PROVISIONS



The other essential elements, the manning regime and the adoption of international technical standards, can both be achieved within the current Canada Shipping Act reform process – given the policy direction and will to do so. The potential result? A first class national register that is competitive; the creation of employment and business opportunities for Canadians; and a vibrant, world-class marine training system. Because Canada has virtually no Canadian-flag ships trading deep-sea, the proposal contains no obvious negatives. Two groups have voiced concerns. The exporters and the seafarer unions.

7. Potential Opposition

7.1 Exporters

Historically, exporters have opposed every previous Canadian flag proposal. This was because every proposal was underwritten – either explicitly or implicitly – by cargo reservation and/or government subsidies. Canadian exporters, who have always had access to competitive international shipping, are unprepared to see their products priced out of overseas markets by the higher freight rates required to support uncompetitive national-flag ships. The current proposal is different because it involves only enabling legislation. A Canadian ship will only be used if it is competitive. Neither cargo reservation nor subsidies are involved. The benefits of the proposal have been recognized by the Western Canadian Shippers' Coalition[10], a broadly based group of exporters.

7.2 Seafarer Unions

Some union officials have suggested this proposal threatens existing Canadian jobs[11]. Except for forays into the contiguous US waters, Canadian ships only trade in Canada's domestic or coasting trade. Union (and non-union) jobs for Canadian seafarers on Canadian ships are only found in Canada's coasting trade. There are many legislated barriers to entry. Foreign ships (and non-duty paid Canadian ships) are prohibited from Canada's coasting trade if a duty-paid Canadian ship is available.

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10 Western Canadian Shippers' Coalition, R J Renwick, letter to B Streeter, Director General, Marine Safety, Transport Canada

11 ILWU local 400, A Engler, letter to the editor, Westcoast Shipping, February 1998
ILWU local 400, A Engler and IMC – Vancouver, J Seymour, miscellaneous correspondence 1998

And, even if a coasting license is granted under the Coasting Trade Act, duty must be paid under the Customs Tariff and the ship will be inspected to ensure full compliance with Canada's domestic safety standards. Also, under the Immigration Act, Canadians must fill every position on board every ship in the coasting trade. A foreigner may only work on board if a validated employment authorization has been issued, in other words if no suitably qualified Canadian is available.

Nothing will change in Canada's domestic trade under this proposal. Canadian seafarer's jobs are not threatened. The result will be additional jobs for Canadian seafarers outside Canada's coasting trade. Few countries have such a clear division between their domestic and deep-sea shipping scenarios. With its domestic trade protected and its deep-sea trade virtually non-existent, any Canadian activity in the deep-sea sector represents an economic expansion. No vested interests are challenged.

8. Conclusions

In aggregate, these proposals allow a foreign subsidiary of a Canadian company to:

- own a Canadian ship engaged exclusively in international trade,
- manage the ship in Canada,
- man the ship wholly or partially with Canadians,
- comply with international ship construction and safety standards, and
- operate free of Canadian income tax and duty.

In other words, Canada would have the capacity to meet all three of the essential elements previously mentioned.

Vancouver's International Maritime Centre initiative is a success story[12]. Before 1991, Vancouver had no international shipowners, no ship managers and few time-charter operators. Now it has a more diverse and vibrant marine community.

It is possible to view the IMC initiative as an end in itself. Alternatively, it can be viewed as the first step in a three-step process with the potential to create a significant Canadian presence deep-sea shipping based on competency, competitiveness and quality.

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[12] International Maritime Centre – Vancouver, Economic Benefits, 1996 Lloyd's Shipping Economist, The new centre for maritime excellence, September 1997

Reform of the Canada Shipping Act can provide the next two steps – a flexible manning regime and the adoption of genuinely international standards. Done well, this will result in significant benefits to Canada. Job opportunities at sea, job opportunities on shore, a quality marine training establishment, economic growth, more personal income plus a world-class professional marine infrastructure better able to service the needs of the Canadian exporter.

APPENDIX 1. INCOME TAX ACT: RELEVANT SECTIONS

81. Amounts not included in income.

(1) There shall not be included in computing the income of a taxpayer for the taxation year...

(c) Ship or aircraft of non-residents. – the income for the year of a non-resident person earned in Canada from the operation of a ship or aircraft in international traffic, if the country where the person resides grants substantially similar relief for the year to a person resident in Canada;.....

250(6) Residence of international shipping corporation

[The following text includes the wording covering wholly-owned subsidiaries contained in Bill C-28 at s.241. Bill C-28 received second reading on February 4, 1998. These technical amendments to 250(6) have been applied to the 1995 tax year onwards.]

For the purposes of this Act, a corporation that was incorporated or otherwise formed under the laws of a country other than Canada or of a state, province or other political subdivision of such a country shall be deemed to be a resident in that country throughout a taxation year and not be resident in Canada at any time in the year, where

(a) the corporation

(i) has as its principal business in the year the operation of ships that are used primarily in transporting passengers or goods in international traffic (determined on the assumption that the corporation is non-resident and that, except where paragraph (c) of the definition "international traffic" in subsection 248(1) applies, any port or other place on the Great Lakes or St. Lawrence River is in Canada), or

(ii) holds throughout the year shares of one or more corporations, each of which

(A) is a subsidiary wholly-owned corporation of the corporation as defined by subsection 87(1.4), and

(B) is deemed by this subsection to be resident in a country other than Canada throughout the year,

and at no time in the year is the total of the cost amounts to the corporation of all those shares less than 50% of the total of the cost amounts to it of all its property;

(b) all or substantially all of the corporation's gross revenue for the year consists of

(i) gross revenue from the operation of ships in transporting passengers or goods in that international traffic,

(ii) dividends from one or more other corporations each of which

(A) is a subsidiary wholly-owned corporation of the corporation, as defined by subsection 87(1.4), and

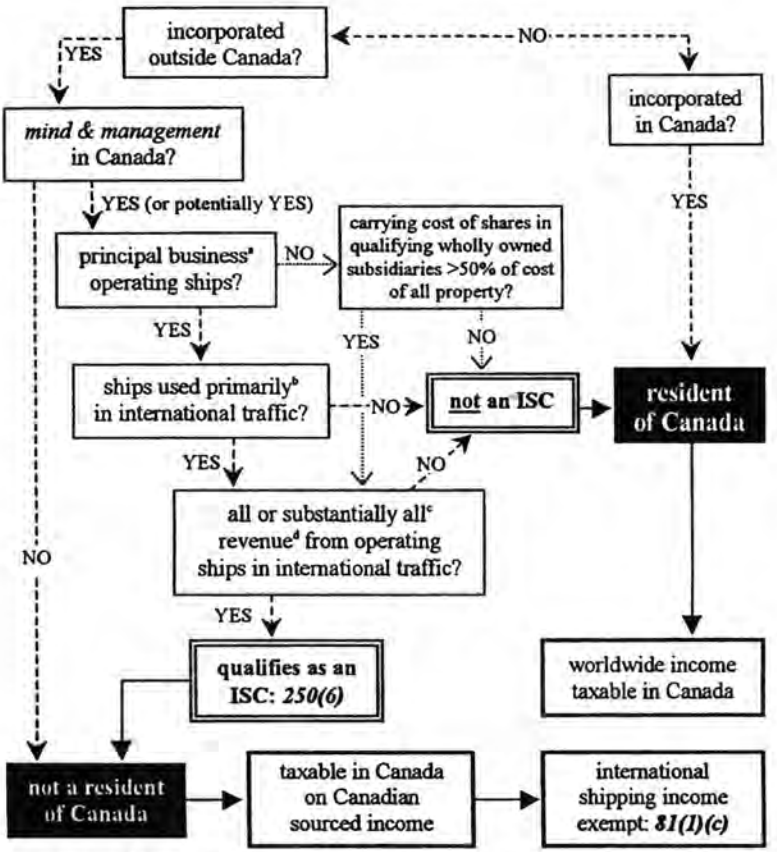
(B) is deemed by this subsection to be resident in a country other than Canada throughout each of its taxation years that began after February 1991 and before the last time at which it paid any of those dividends, or

(iii) a combination of amounts described in subparagraph (I) or (ii); and

(c) the corporation has not been granted articles of continuance in Canada before the end of the year.

Appendix 2 is a flow chart designed to help interested parties to understand 250(6) and its relationship to 81(1)(c).

APPENDIX 2. THE INTERNATIONAL SHIPPING CORPORATION
THE APPLICATION OF SECTIONS 250(6) AND 81(1)(c)



a principal business could be construed as >50%
b used primarily could be construed as >50%
c all or substantially all could be construed as >90%
d revenue includes dividends from qualifying wholly-owned subsidiary ISCs

1. A foreign incorporated company engaged in the operation of ships in international traffic, having its mind-and-management in Canada and meeting the prescribed tests, will qualify as an International Shipping Corporation (ISC) under section 250(6) of Canada's Income Tax Act and will be treated as a non-resident of Canada.
2. A non-resident company with international shipping income from traffic to or from Canada is exempt from tax on this Canadian sourced income under section 81(1)(c).

A BIDDING SYSTEM FOR PORT PRICING OPTIMIZATION

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Abstract. Based on their operation features, transportation/ logistics companies may respond differently to port pricing. Some may be willing to pay more than current charges for some specific time windows while others may consider current charges too high. On the other hand, port authority may be more profitable by using a competitive pricing scheme which matches the transportation/logistics companies' operation features better. This paper, in order to unite the operation cost, competition and profit of port authority, designs a bidding system between port authority and transportation/logistics companies. Under this system, port authority can announce prices for various time windows while companies can bid prices for specific time windows according to their operation basis. Based on given biding prices, a quadratic 0-1 programming model, maximizing the total profit to the port authority, is developed and solved. The solution to this model gives an optimal assignment of vessels to berths. By use of the sensitive analysis method presented, the system can provide with some guiding information, say, at what price a specific time window could be available under current bidding prices. Then, the companies can change their bidding prices and, the system gives out a new assignment.... as so on, till an equilibrium is reached. This system is coded in C++ and demonstrated on a sample port.

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Key words. Port pricing, bidding system, scheduling, optimization, sensitivity analysis .

1. INTRODUCTION

It is common for port authorities to charge for berthing or anchoring service. Existing pricing policies do not sufficiently mirror the operation features of port authorities as well as of transportation/logistics companies. Some companies may be willing to pay more than current charges for some specific time windows while current charges may be considered high to some other companies. In other words, companies may differently value specific time windows. This results from that companies may have different operation features which, in this paper, include transportation networks, trip connections, scheduled time tables, time-dependent demands, operation costs, time-value of vessels and the goods carried, etc. For example, in order to connect to next trip in time or avoid costs caused by delays, some companies may be willing to pay higher prices to have their vessels be served (e.g. loading, unloading, etc.) earlier. On the other hand, in peak periods, the time windows in which vessels expected to be served may overlap. This causes a competition environment among transportation companies. Thus, there may exist a more flexible but more complicate pricing scheme which not only matches operation features of transportation companies, but also make the port authority more profitable.

In next section, the relationship among operation features and value of time window is analyzed and then the guidance to bidding prices is conducted. For given prices, a quadratic 0-1 programming model, which schedules the service for vessels with maximizing the total profit of the port authority, is developed in Section 3. An algorithm for this model is given in Appendix A. Section 5 presents a sensitive analysis method which provides with such information that, under current bidding prices, at what price a specific time window will be available. This is important for transportation companies in competition. In Section 6 the system is run and analyzed on a sample port.

2. VALUE OF TIME WINDOW AND COMPETITIVE PRICING

It is obvious that being served in different time window a vessel contributes differently to its company. In this paper, we estimate this contribution in "value of time window".

According to the operation features, for every vessel, there is always a time window which is mostly beneficial to the company. We call this time window the "expected time window". Suppose the company gets benefit of E [1] if the vessel is served in its expected time window, then, the value for other time windows can be expressed as

value of time window t = E - cost of trip connections' changes or delay/advance - loss of time-dependent demands - loss due to goods delay - operation cost during the delayed period - other cost/loss due to delay/advance + benefits due to advance.

If denote a time window by its starting time, then, the value of time window is a function of time t, as shown in Fig.1.

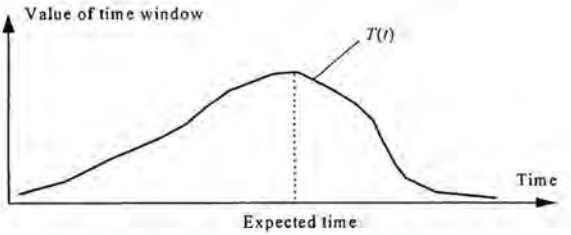


Fig.1. Value function of time window for a vessel

Given the value function of time window for a vessel, the company can determine the highest prices it should pay for various time windows. These prices can be considered as the ceilings of bidding prices.

Practically, there may be competition in port service paying. This occurs when more than one vessel expect the same time window. On the other hand, in terms of port's maximum profit, the vessel with the highest bidding price may not necessarily scheduled at its expected time window (we will see this in computational results of a sample port in Section 6).

[1] The estimation of E is another significant issue. We will discuss this in another paper.

So, port pricing is composition of competition (for expected time windows at appropriate prices) and optimization (for maximum profit to the port authority).

3. MATHEMATICAL MODEL

First of all, let's divide the planning period (e.g. one week or one month) into time slots with the same time span. The length of the time slot can be from 1 hour to several days, depending on the distribution of time vessels need for services. The principle is that every vessel (approximately) occupies an integer number of time slots for served. For example, if 4, 12, 16 and 36 hours are, respectively, the time needed by 4 vessels for service, then, the length of time slot can be set to 4 hours.

On the other hand, the bidding price should be for the whole service period, but not only for a single time slot. In this paper, for convenience in expression, a bidding price at time t refers to the price that the vessel starts to be served at time t. Thus, similar to the function of time window value, we get a function, $P(t)$, of bidding prices.

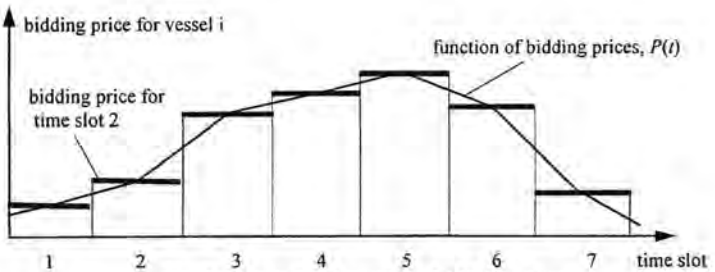


Fig.2. Discretization of the bidding price

Furthermore, we need to discretize function $P(t)$ according to the time slots, as shown in Fig.2. Now we get the bidding prices for various time slots.

Definitions:

(i) The service for a vessel is called to be composed of k sessions if this service lasts for k time slots, as shown in Fig.3.

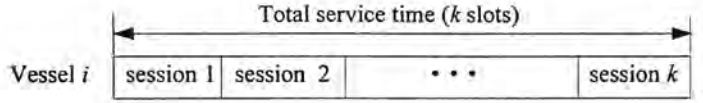


Fig. 3. Illustration of vessel service

(ii) A vessel is called to be assigned at time slot j if it starts to be served at time slot j.

Notations:

N_v = the number of vessels to be assigned.
T_i = the number of time slots vessel i needs for service.
n_t = the number of time slots of the planning period.
p_{kj} = bidding price of vessel k for slot j.

For mathematical formulation we index the vessel sessions and time slots consecutively, as shown in Fig.4. Denote by I, J the total sessions and total slots respectively.

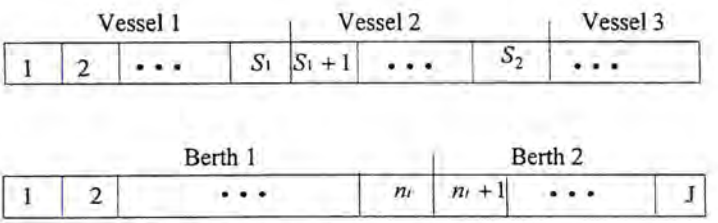


Fig.4. Sessions of vessels and slots of Berths

Define

$$x_{ij} = \begin{cases} 1, & \text{if session } i \text{ is scheduled at slot } j, \\ 0, & \text{otherwise.} \end{cases}$$

3.1 Constraints

(a) Every slot cannot be assigned more than 1 time, i.e. a berth cannot served more than 1 vessel in the same time. So,

$$\sum_{i=1}^{I} x_{ij} \le 1, \quad j = 1, 2, \ldots, J \,. \tag{1}$$

(b) Every vessel cannot be assigned more than 1 time (those can not assigned in this planning period will be moved to next period). So,

$$\sum_{j=1}^{J} x_{ij} \le 1, \quad i = S_{k-1} + 1, \quad k = 1, 2, \ldots, N_v \,. \tag{2}$$

where, $i = S_{k-1} + 1$ is the first session of vessel k. Since next constraint confines the session orders, here we only need to consider the first sessions of vessels.

(c) The first session of a vessel should be scheduled before other sessions of the same vessel, and they are inseparable, so,

$$\begin{aligned} x_{ij} = x_{i+l,j+l}, \quad & i = S_{k-1} + 1; \quad l = 1,2,\ldots T_k - 1; \\ & k = 1,2,\ldots,N_v; \quad j = 1,2,\ldots,J-l \,. \end{aligned} \tag{3}$$

3.2 Objective Function

The object is to maximize the total profit to the port authority, i.e.

$$\text{maximize} \quad R = \sum_{k=1,i=S_{k-1}+1}^{N_v} \sum_{j=1}^{J} p_{kj} x_{ij} \tag{4}$$

By introducing a positive number, M, which is large enough, the model can be written as

(I)

$$\max f(x) = \sum_{k=1,i=S_{k-1}+1}^{N_v} \sum_{j=1}^{J} p_{kj} x_{ij} + M \sum_{k=1,i=S_{k-1}+1}^{N_v} (1 - \sum_{j=1}^{J} x_{ij} - y_k)^2$$

$$+ M \sum_{k=1,i=S_{k-1}+1}^{N_v} \sum_{l=1}^{T_k} \sum_{j=1}^{J-l} (x_{ij} - x_{i+l,j+l})^2 \,, \tag{5}$$

$$\text{s.t.} \sum_{i=1}^{I} x_{ij} \le 1, \ j = 1, 2, \ldots, J \ ; \tag{6}$$

$$x_{ij}, y_k \in \{0,1\}, \ i = 1, \ldots, I; \ j = 1, \ldots, J; \ k = 1, \ldots, N_v . \tag{7}$$

In model (I), constraints (2) and (3) are transferred into the objective function as punishing terms. The purpose of doing so is to get the special structure of the model, which is helpful for algorithm design.

4. SOLUTION TO THE MODEL

Model (I) is a quadratic 0-1 program with special structure. We ever got similar model in studying real-time flight scheduling (Cao & Kanafani, 1997a). As shown in [1], the solution to this model can be easily obtained by solving its relaxation problem (i.e. replace constraint (7) with $x_{ij}, y_k \ge 0$). The algorithm developed in [2] for the relaxation problem is expressed in Appendix A.

5. SENSITIVE ANALYSIS

Denote the maximum profit under current prices by f^*. Suppose one vessel, say v, needs to pay price of q for specific time slot, say t. let $x_{vt} = 1$ and denote the vector consists of remaining decision variables by $\bar{x}$, then the total profit can be written as

$$\bar{f}(\bar{x}) = f(\bar{x}) + q . \tag{11}$$

Replace objective function (5) with $f(\bar{x})$ and solve the resulting program, denote the maximum profit by $\bar{f}^*$. So, to guarantee vessel v to be assigned at time slot t (the total profit should not lees than f^*), vessel v should pay

$$q \ge f^* - \bar{f}^* \tag{12}$$

6. ANALYSIS OF A SAMPLE PORT

A sample port is constructed with following features: (a) there are 2 berths; (b) there are 40 vessels to be served in the planning period; (c) the minimum bidding price of any time slot is 200; (d) there is no difference between the two berths, i.e., every vessel bids the same price for a specific time window of Berth 1 as that for the same time window of Berth 2. Appendix B summarizes the bidding prices for one of the berths.

The Optimal solution is shown in Tab.1.

Tab.1. The optimal schedule under the primary bidding prices

Berth\Schedule	Scheduled Service Order
Berth 1	20, 35, 30, 22, 33, 36, 32, 16, 39, 25, 5, 11, 12, 1, 3, 26, 2, 4, 38, 7
Berth 2	6, 31, 15, 10, 14, 21, 19, 17, 24, 29, 34, 9, 8, 37, 28, 18, 40, 13, 27, 23
	Total profit = 25124.00

Now, by using the sensitive analysis method in Section 5, the system can provide the transportation companies with some information guiding the bidding prices. Follows are two examples.

(i) Vessel 3 is currently scheduled at Slot 15 other than its expected Slot 16. If the company wants Vessel 3 to be scheduled at Slot 16, suppose it needs to pay the price of q. Resolving the model we get the total profit is 24606+q. So, to ensure the total profit to be greater than 25124, the company should pay q>518 (25124-24606). Tab.2 is the new schedule with $p_{3,16} = 519$, the lowest price Vessel 3 has to pay for Slot 16. Similarly, Vessel 25 has to pay 471 for Slot 3, its expected slot, as shown in Tab.3.

Tab.2. The optimal schedule with $p_{3,16} = 519$

Berth\Schedule	Scheduled Service Order
Berth 1	20, 35, 30, 22, 33, 36, 32, 16, 39, 25, 5, 11, 12, 1, 26, 3, 2, 4, 38, 7
Berth 2	6, 31, 15, 10, 14, 21, 19, 17, 24, 29, 34, 9, 8, 37, 28, 18, 40, 13, 27, 23
	Total profit = 25125.00

Tab.3. The optimal schedule with $p_{25,3} = 471$

Berth\Schedule	Scheduled Service Order
Berth 1	20, 35, 25, 22, 33, 36, 32, 16, 39, 30, 5, 11, 12, 1, 3, 26, 2, 4, 38, 7
Berth 2	6, 31, 15, 10, 14, 21, 19, 17, 24, 29, 34, 9, 8, 37, 28, 18, 40, 13, 27, 23
	Total profit = 25125.00

(ii) Transportation companies can also request price guidance for a specific period (containing several slots). Fig.5 shows the guidance for prices bidding (called guiding prices, the lowest ones the company has to pay for the corresponding time slots) compared with the previously bidding prices of Vessel 25. An interesting thing is that the guiding prices for Slot 1, 2 and 4 are higher than that for Slot 3, the expected slot. This results from the competition.

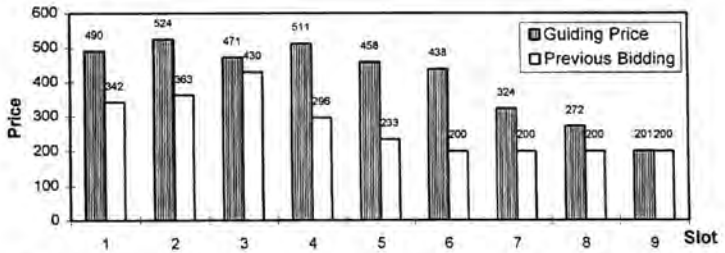


Fig.5. Comparison of guiding prices and previous bidding prices of Vessel 25

REFERENCES

1. Cao, Jia-Ming & Adib Kanafani (1997a). "Real-time decision support for integration of airline flight cancellations and delays, Part I: Mathematical formulation", *Transportation Planning and Technology*, (UK) Vol. 20, No.3, 183-199.
2. Cao, Jia-Ming & Adib Kanafani (1997b). "Real-time decision support for integration of airline flight cancellations and delays, Part II: Algorithm and computational experiments", *Transportation Planning and Technology*, (UK) Vol.20, No.3, 201-217.

APPENDIX A. Algorithm for the Relaxation Problem of Model [1]

For convenience, rewrite the relaxation problem of Model (**I**) in following general form:

(II)

$$\max\ \varphi(x) = c^{\mathrm{T}}x + x^{\mathrm{T}}Dx\ , \tag{9}$$

$$\text{s.t. } x \in Q =: \{x \mid Ax \le e,\ x \ge 0\}\ , \tag{10}$$

where, $c, x \in R^n$, $e = (1,1,\ldots,1)^{\mathrm{T}} \in R^m$, $D \in R^{n\times n}$ is a symmetric matrix, and

$$A = \begin{bmatrix} 1 & 1 & \ldots & 1 & 0 & 0 & \cdot & \cdot & \cdot & 0 \\ 0 & 0 & \ldots & 0 & 1 & 1 & \ldots & 1 & 0 & \cdot & \cdot & \cdot & 0 \\ & & & & & & \cdot & & & & & & \\ & & & & & & & \cdot & & & & & \\ & & & & & & & & \cdot & & & & \\ 0 & 0 & \cdot & \cdot & \cdot & 0 & 1 & 1 & \ldots & 1 \end{bmatrix}.$$

Now the algorithm for Model (**II**) can be expressed as follows:

1. Generate a feasible solution $x^{(0)} \in Q$ and set $p \leftarrow 1$.

2. If $g(x^{(p-1)}) = 0$, then, go to 4; otherwise, solve following linear programming,

(LP)

$$\max\ y(x) = g^{\mathrm{T}}(x^{(p-1)})x\ , \tag{11}$$

$$\text{s.t.}\quad x \in Q\ , \tag{12}$$

and, denote the optimal solution by x^*. If $x^* = x^{(p-1)}$, then, go to 4; otherwise, go to 3.

3. Construct $\overline{x} = (\overline{x_1}, \overline{x_2}, \ldots, \overline{x_n})^{\mathrm{T}}$ such that

$$\overline{x_j} = x_j^{(p-1)} + \lambda_k (x_j^* - x_j^{(p-1)}),\ \text{for } j \in I_k\ \ (\lambda_k \in [0,1])\ , \tag{13}$$

and solve

$$\max_{0\le\lambda\le e} \xi(\lambda) = \varphi(\bar{x}), \quad (\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_m)^T, \ e = (1, 1, \ldots, 1)^T), \tag{14}$$

denote the optimal solution by λ^*. If $\lambda^* = 0$, go to 4; otherwise, let

$$x_j^{(p)} = x_j^{(p-1)} + \lambda_k^* (x_j^* - x_j^{(p-1)}) \ \text{ for } j \in I_k, \tag{15}$$

and set $p \leftarrow p+1$, return to 2.

4. Stop. $x^{(p-1)}$ is a local maximum of (**II**).

APPENDIX B. Bidding prices of vessels for various time slots

Vess.\Slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	200	200	200	200	226	260	292	313	374	419	443	474	498	565	438	319	246	200	200	200
2	200	200	200	200	200	200	200	200	200	200	200	203	260	317	364	394	433	382	299	200
3	200	200	200	200	200	200	200	200	204	252	278	310	335	403	456	518	465	349	242	200
4	200	200	200	200	200	203	250	279	345	392	418	450	504	559	605	634	672	734	587	450
5	465	488	528	596	640	660	684	729	775	811	859	755	691	634	519	423	294	232	200	200
6	541	444	392	257	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
7	200	200	200	200	200	200	200	200	200	200	200	200	233	278	317	343	379	439	503	558
8	405	445	466	494	544	567	593	639	686	751	787	854	899	790	676	583	459	407	322	204
9	216	276	308	371	413	460	500	525	559	617	678	701	587	532	422	336	227	200	200	200
10	706	738	783	825	678	620	563	440	318	229	200	200	200	200	200	200	200	200	200	200
11	225	275	330	378	411	453	490	513	546	604	665	688	611	528	464	366	233	200	200	200
12	200	204	262	311	373	269	200	200	200	200	200	200	200	200	200	200	200	200	200	200
13	200	200	200	200	200	200	200	200	200	208	268	320	385	418	451	473	507	566	501	421
14	258	322	386	439	503	361	242	200	200	200	200	200	200	200	200	200	200	200	200	200
15	426	449	518	375	295	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
16	437	463	504	544	572	640	692	724	621	568	441	302	200	200	200	200	200	200	200	200
17	498	567	633	658	707	729	783	816	745	654	554	467	335	246	200	200	200	200	200	200
18	200	200	200	200	200	200	233	274	318	381	445	470	520	544	601	666	536	471	361	294
19	644	666	705	743	799	826	883	766	656	589	536	440	390	259	203	200	200	200	200	200
20	489	393	244	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
21	529	568	588	615	636	671	557	423	281	200	200	200	200	200	200	200	200	200	200	200

22	576	602	643	683	560	449	390	262	200	200	200	200	200	200	200	200	200	200	200	200
23	200	200	200	207	268	327	373	402	468	515	570	590	637	659	715	779	808	864	896	839
24	495	559	623	647	695	717	771	804	751	695	562	512	451	400	298	226	200	200	200	200
25	342	363	430	296	233	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
26	200	200	200	200	200	200	200	200	200	200	250	277	299	365	417	479	340	258	200	200
27	200	200	201	232	284	308	363	426	454	508	567	589	637	660	716	780	810	866	899	835
28	235	285	340	388	421	463	500	523	556	614	675	727	763	808	848	762	652	525	397	295
29	357	378	446	501	567	599	630	650	682	710	584	448	321	242	200	200	200	200	200	200
30	380	402	470	332	261	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
31	739	784	725	578	490	346	225	200	200	200	200	200	200	200	200	200	200	200	200	200
32	200	200	200	200	237	265	323	270	200	200	200	200	200	200	200	200	200	200	200	200
33	739	772	818	860	807	730	638	546	485	412	348	230	200	200	200	200	200	200	200	200
34	240	262	301	368	412	461	502	527	562	620	681	704	636	571	441	316	230	200	200	200
35	650	694	641	504	435	328	278	200	200	200	200	200	200	200	200	200	200	200	200	200
36	537	577	598	626	647	682	563	419	357	283	216	200	200	200	200	200	200	200	200	200
37	200	200	200	200	200	200	241	306	364	407	430	460	484	551	486	387	251	200	200	200
38	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	236	268	326	359	297
39	298	318	385	255	201	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
40	200	240	268	329	398	432	464	513	533	583	639	688	723	768	807	833	869	734	590	459

- the numbers with shadows are schedules, in the optimal solution, of Berth 1 while those with borders are of Berth 2

"Exploring Sources of Productivity Gains and Their Financial Implications: a Comparison of Aggregate and Disaggregate Approaches"

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I. INTRODUCTION

This paper explores links between productivity gains and financial performance. At the outset, the link might seem simple: productivity lowers unit costs of production therefore would be expected to improve financial performance. But it is not so simple. Productivity compares *quantities* of output compared to *quantities* of inputs, whereas financial performance measures compare *revenues* from output to *expenditures* on inputs. These are not identical measures. It is possible to establish a link between aggregate total factor productivity (TFP) and aggregate financial performance (total revenues compared to total costs) by incorporating input and output price changes (see Appendix and references cited below). But these 'bottom line' performance measures do not reveal much about the sources or components of the productivity and/or financial improvement. To do this requires disaggregation of these bottom line performance measures. This is the focus of this paper: to explore ways of identifying underlying components of increased performance both in productivity and financial measures, and whether or not links can be established between them.

The paper is in three parts. Part II contrasts aggregate or "bottom line" measures of productivity and financial performance, i.e., TFP and overall profitability. Management also desire information about the sources of profits and loss. This requires disaggregation of the production process and this is outlined in part III of the paper. Transportation (or any multiproduct enterprise) typically involves complex interactions among intermediate activities to produce the various final products or services. Costing systems are developed to enable revenue/cost comparisons to be made for specific components of the company's business, i.e., profit (or loss) contributions can be identified for categories of output. However, unlike the financial side, no systematic links have been developed between portions of total operations and overall productivity (TFP). Rather, an extraordinary variety of ad hoc partial productivity measures or performance ratios exist for monitoring performance of specific operations, but rarely has there been

any attempt to link these partial measures in some systematic way to overall TFP. This is not easy to do, and may be impossible because of how TFP is calculated. Given this situation, what disaggregation can be done with TFP measures and data to provide some insight into the components of TFP growth, and can these also be linked with changes in overall financial performance? This is addressed in part IV of the paper. The conclusion is that disaggregating TFP into its components can only give hints about sources of productivity growth and their financial implications. There is no substitute for detailed cost and profitability analysis if we are to understand specific changes in productivity and financial performance for specific commodities or services (e.g., regulated grain movements).

II. CONCEPTS OF PRODUCTIVITY AND FINANCIAL PERFORMANCE MEASUREMENT

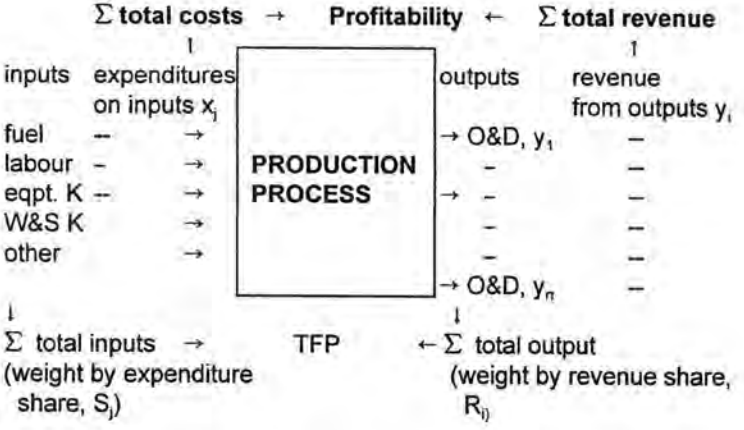
The most basic notion of productivity refers to output/input comparisons, hence productivity growth implies increases in output relative to inputs. For a multiproduct multi-input enterprises, typical of all transportation companies, there are a large number of potential partial productivity measures which compare any one or collection of outputs with any one or collection of inputs. Such "productivity ratios" or "performance indicators" are very popular for monitoring routine operating performance, e.g., cars switched per switch-engine hour, train-miles per litre of fuel, etc. But there is a well-known danger with any partial productivity measure: it excludes the influence of changes in other inputs or outputs. For example, the popular measure of labour productivity (total output divided by person hours or number of employees) has a recognized bias in that it overlooks changes in capital. In fact, most gains in labour productivity come about because of substitution of capital for labour.

Because partial productivity measures can be misleading about overall productivity results, economists advocate more comprehensive measures of productivity, such as total factor productivity (TFP). The idea is to compare *total* output with *total* inputs (factors of production). Because outputs and inputs are measured in different units, it is customary to express these as output and or input quantity indices. More specifically, productivity is a performance comparison so it compares the growth of outputs relative to the growth of inputs. That is, TFP growth provides a comprehensive or 'bottom line' productivity measure.

The measure of TFP is not constructed using any intermediate or partial productivity measures, it directly compares total inputs with total outputs, essentially treating the actual production process as a 'black box,'

as illustrated in Figure 1.[1] The overall productivity measure TFP is indicated in the bottom of Figure 1. Note that there is (typically substantial) aggregation of input and output categories in constructing the respective input and output indices. The degree and type of aggregation can affect the numerical calculation of productivity growth, but this issue is set aside for this discussion.

Figure 1
"Black Box" Model of Inputs, Outputs and Performance



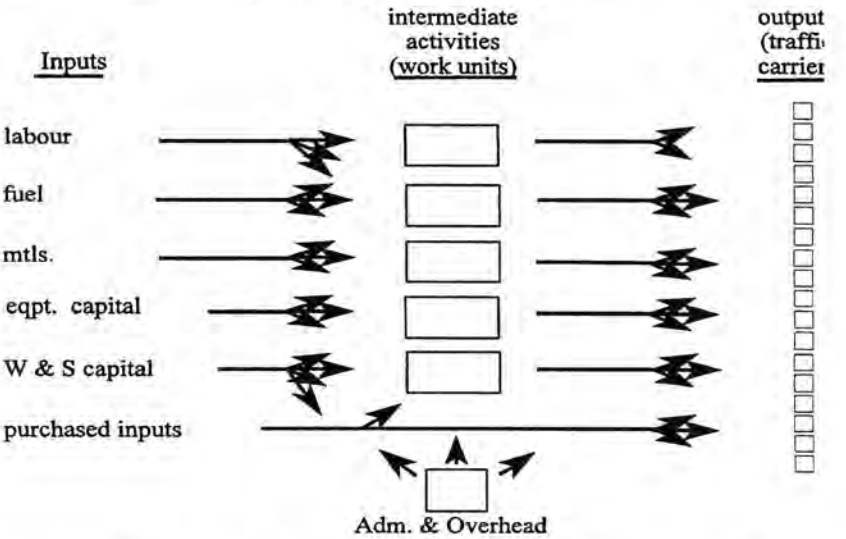
Turning to financial performance, the standard 'bottom line' financial performance measure is overall profitability, defined as the excess of revenues over costs. Of course there are many complications such as treatment of capital inputs and choice of specific financial ratios to examine, but we abstract from these for the moment. If we simply use the ratio of total revenues to total costs as the overall measure of profitability, there is an exact link between changes in TFP and changes in aggregate profitability (see Appendix). The 'bottom line' measure of financial performance, i.e., the overall comparison of total revenues with total costs, is shown in the upper portion of Figure 1.

---

[1] TFP can be expressed as the weighted sum of "partial factor productivities (PFP)," which consist of the growth of total output relative to the growth of each input category. But this is not a disaggregation of the production process, it simply separates the input categories which are in the TFP calculation.

Figure 2
Simplified Schematic of Rail Production

Inputs (factors of production) produce intermediate activities (train-miles, car-miles, maintenance) which are combined to supply specific services (freight traffic carriied]



In the 'black box' model in Figure 1, there is no mechanism to identify specific input quantities with specific outputs, therefore we cannot link components of productivity gains with components of changed financial performance. The bottom line measures are limited to what this label implies. However, managers (and policy makers) want to know more about profitability than whether it is positive or negative, they want to know how financial returns differ for different outputs. This requires opening the 'black box' and identifying portions of total operations, input use and expenditures associated with specific output categories. Costing systems are developed for this purpose. To understand disaggregate cost and profitability analysis in relation to input use, we explore the production process in more detail for a multiproduct transportation firm; I use railways as the illustration but a similar procedure could be followed for any other multiproduct enterprise.

III. SCHEMATIC ILLUSTRATION OF RAIL PRODUCTION, COST AND PRODUCTIVITY MEASUREMENT[2]

Figures 2 and 3 are schematic illustrations of the rail production process. They illustrate the link between basic factors of production (labour, fuel, capital) and supplying final demands (specific movements from origin to destination) via various intermediate production activities (train operations). Figure 2 is a simple initial illustration and Figure 3 elaborates to show the links between productivity and cost measurement.

Figure 2 illustrates a basic model of the rail production process. It is best thought of as a two-stage production process: basic inputs (factors of production) are used to produce train operations, yard operations, maintenance, and other intermediate activities, and these in turn are used to supply final demand, i.e., movements of particular commodities from particular origins to particular destinations at a particular time.

Because of the variety of inputs and activities, and the immense number of outputs, it is often difficult and may be impossible to precisely link specific input consumption with specific services provided. This is the cost allocation problem which has plagued transportation companies and regulators for at least the past century. Elaborate costing systems are developed to link expenditures on inputs with production activities, which in turn are linked to specific outputs. Invariably there is some imprecision and hence debate over the accuracy, but it is the best that can be done.

Figure 3 presents a schematic of rail production and cost relationships in more detail. The input quantities on the left hand side, used to produce the intermediate activities, have prices hence expenditures on them. These expenditures can be summed over all operations to produce total costs (shown on the upper left of Figure 4) to be compared with total revenues (indicated on the upper right of Figure 3) to measure overall profits. The costs of input requirements needed for various intermediate activities are used to establish the costs of the intermediate activities. That is, the costing system develops cost coefficients for these "work units." These are used to estimate costs of specific traffic movements. The need for commodity-specific cost/revenue comparisons is a main rationale for developing a costing system. Because different commodities moving

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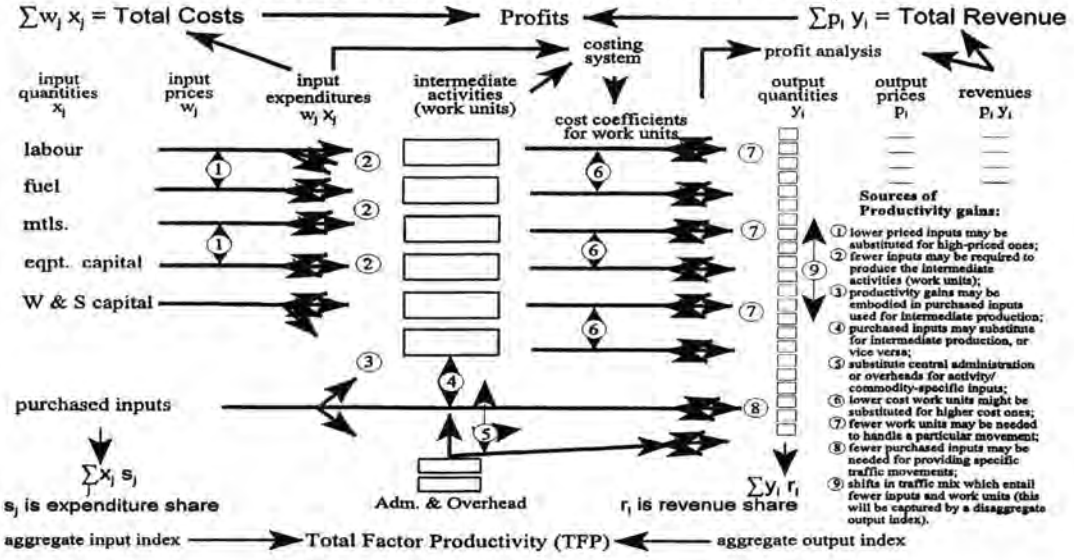
[2] This section draws heavily from Waters and Tretheway, 1997a..

different distances between different origins and destinations entail different activity and input use, the costs differ and it is important to know this to assess the contribution individual traffic makes to overall profitability. Rail costing systems concentrate on estimating the costs of intermediate activities rather than try to estimate the costs of handling specific traffic directly. The latter are estimated indirectly by describing them in terms of intermediate activities ("work units") required and their respective costs.

The disaggregate cost and profit analyses provide insight into components of overall profitability, and by examining changes in the costs of specific activities and outputs, along with changes in prices received, this provides management with an understanding of the changes taking place on both the cost and revenue side. (It might seem obvious, but note that both costs and revenues must be examined to understand the changing financial condition of an enterprise; cost analysis by itself is insufficient). This disaggregate analysis of performance is different from "bottom line" or comprehensive performance measures which gloss over the great variety of specific activities and outputs which make different profit contributions and/or impact productivity (output/input) relationships.

A costing system is developed for a base year, reflecting the cost and operating conditions of that year and the pattern and volume of commodity movements. Because it is costly to develop and refine a costing system, it is updated infrequently. In between major updates of the costing system, costs are indexed up for inflation using appropriate input price indices. This projection of total costs will be an accurate prediction of cost increases providing there are no changes in production processes, i.e., no productivity gains. If there are productivity gains, then actual costs rise by less than the rise in input prices because fewer quantities of inputs (or intermediate activities produced by those inputs) are used. Periodically, the costing system must be reexamined and redeveloped to be accurate once again. There is a complication if prices are regulated. If the regulatory goal is to limit rate increases to the increase in actual costs, this gives rise to the argument for a productivity adjustment to the input price index. That is, adjusting input price index increases by productivity gains will equal the increase in actual costs. However, this is true only on average (in the aggregate), the mix of inputs and/or specific productivity gains will differ across activities and final demands served. Average productivity advances might or might not be applicable to specific traffic.

Figure 3
Schematic of Rail Production and Cost Components



In practice, regulators may make use of the aggregate change in productivity (TFP growth) and apply it as an adjustment to specific commodity rates (e.g., grade). As noted, this may or may not be valid, but to do better requires at least some examination of the specific changes taking place in producing the specific regulated transportation services. Also recognize that rail (and other transport modes) involve shared inputs in the production process, i.e., input/cost interdependency among services provided; in these circumstances changes in the demand side can alter the optimal markups that are employed in calculating optimal prices.

IV. DISAGGREGATION OF COMPONENTS OF PRODUCTIVITY INCREASES

It could be desirable to know more about specific sources of productivity gains, both for managers and policy makers. For managers, identifying sources of productivity gains from particular inputs or activities might be the stimulus for similar innovations in other operations. Regulators would be interested in commodity-specific productivity gains to enable more efficient and precise rate regulation such as for grain rates in Canada. However, the feasibility of identifying commodity-specific productivity gains appears questionable. There are numerous ways in which productivity gains can come about, and sometimes a reduction in using one input is partly offset by increases in another.

Actual productivity gains can arise in any of the components of the rail production process. These are illustrated (and numbered) in Figure 3: (1) lower priced inputs may be substituted for high-priced ones; (2) fewer inputs may be required to produce the intermediate activities or work units; (3) there may be productivity gains embodied in purchased inputs used for intermediate production; (4) purchased inputs may substitute for intermediate production, or vice versa; (5) it may be possible to substitute central administration or overheads for activity/commodity-specific inputs (e.g., central computers and information management substitute for inputs formerly directly identifiable with particular activities or commodity movements; (6) lower cost work units might be substituted for higher cost ones; (7) fewer work units may be needed to handle a particular movement; (8) fewer purchased inputs may be needed for providing specific traffic movements; (9) there may be shifts in traffic carried which entail fewer inputs and work units (although this commodity shift is not usually regarded as a real productivity gain but may be counted as such if the output index does not distinguish among output mixes).

The total factor productivity approach abstracts from the myriad of sources of productivity gains and only looks at the total. This is valid short cut to measuring overall productivity performance. Problems of input substitution whereby reductions in one input are partly offset by expansion of others is subsumed in calculating TFP. But as noted, aggregate productivity measures may be above or below the productivity experience of particular commodities or production activities.

An accurate commodity-specific approach to productivity measurement must try to identify the specific sources of productivity gains to determine the net effect on the total input and activity requirements, and hence cost, of handling the specific commodity. The effort to do this is essentially same, perhaps even harder, than carrying out a comprehensive cost review, i.e., re-developing the costing system. In brief, commodity-specific productivity measurement requires the same effort at input measurement, including debating and allocating shared inputs among different outputs and intermediate activities, as required for a disaggregate cost analysis.

Although the overall or 'bottom line' productivity measure, TFP, may not be a guide to productivity gains associated with specific traffic (although it is so "on average"), nonetheless, it may still be desirable to explore possible decomposition of TFP to shed some light on the sources of aggregate productivity growth. There are two approaches here. Economists focus on decomposition of TFP estimates relative to properties of an aggregate cost function. A second and less sophisticated approach is simply to examine changes taking place in the main components of the input and output quantity indices which go into the TFP calculation.

Looking at the economists' approach to decomposition of TFP results, recognize that the index number approach to measuring productivity is a "gross" measure, it does not distinguish between real advances in technical knowledge (or 'true' productivity gains) from efficiency improvements which are inherent in existing technology. The easiest example is returns to scale. If a firm/industry experiences increasing returns to scale, then apparent productivity will increase as the scale of operations increase, but such productivity gains do not represent 'new knowledge' but simply advantageous exploitation of existing technology. But most empirical evidence is that there are constant returns to scale in transportation (e.g., see the review by Oum and Waters, 1996). However, what is important in transportation are economies of density. By carrying more

traffic over a given network, input requirements increase less than proportionately with increases in output. Inputs related to network size (e.g.,. miles of track, number of yards) are constant and only some inputs increase with traffic volume. Economies of density typically are an important underlying explanation of productivity improvements. For example, Tretheway, Waters and Fok (1997) show that about half of the increase in TFP for CN and CP Railways can be explained as economies of density. This is estimated by regressing TFP measures on output levels and route miles; a significant coefficient for output holding route miles constant indicates that observed productivity increases are partly explained by higher output per mile of route in recent years (further discussion in *Ibid.*).

Decomposing TFP gains this way does alert the analyst that achieving higher density operations is a source of efficiency gains, although little can be said beyond this generalization. This is a source of productivity gains accumulated over the large number of specific rail activities and services provided.

The other approach to identifying sources or components of overall productivity increases is to disaggregate the components of the TFP calculation. Partial factor productivities (PFPs) do this by calculating the output index growth relative to the growth of each input category. This reveals which input categories are increasing slower (or declining faster) overall, but this could differ among traffic types or regions served by a company. Similarly, the output index can be divided into output categories. The output index is the growth of each commodity category weighted by its revenue share. Figure 4 plots the revenue shares for CN for 1982-1995 (from Waters, 1997, which contains CPR figures as well). Ceteris paribus, increasing traffic in relatively important traffic categories has a greater overall effect on output growth hence TFP growth. Note however, TFP depends on output growth relative to input growth. If high growth of an output were accompaned by comparable increases in inputs, then the net effect on overall productivity would be minimal. As noted earlier, TFP calculations do not directly distinguish input use by output category, so we are unable to examine this important issue using aggregate TFP data. With this caveat, one can examine the contribution of different output categories to the overall output index. Figure 5 combines the weights from figure 4 with the year to year growth rates for the different commodities. The individual blocks of the bar graphs in Figure 5 indicate the relative contribution of various output categories to total output growth for that year, and the height of the bar indicates the overall change in productivity from one year to the next. Because output growth (and, to a lesser extent, revenue

shares) can vary over time, the influence of different outputs on overall output and productivity growth will fluctuate over time. This can be seen in Figure 5.

Because aggregate TFP indices do not reveal the effects on specific output markets of the overall productivity changes taking place, the reliability of using aggregate TFP for productivity adjustments for regulated freight rate increases is problematic. Aggregate TFP growth is an appropriate measure *on average*, but its accuracy for any specific commodity category is uncertain. Ultimately there is no substitute for a detailed analysis of the production/cost relationships for particular commodities, and the changes which are taking place.

4.0 CONCLUSION

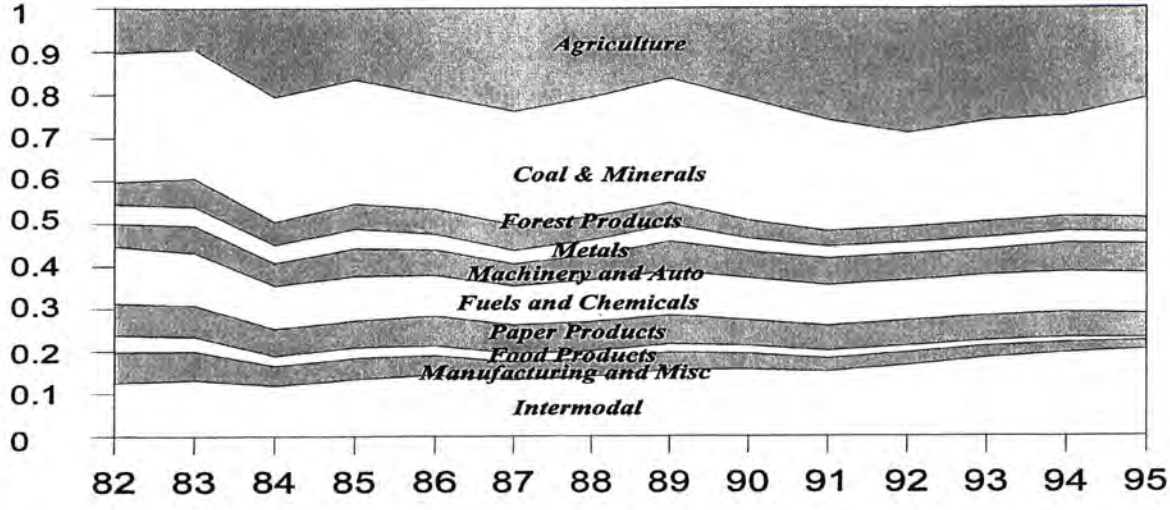
This paper is exploratory in nature, exploring any link between aggregate total factor productivity (TFP) growth and its implications for financial performance for specific commodity groups. A link between TFP and overall financial performance can be established. Combining TFP with tracking input and output price indices will reveal the net change in overall financial condition, including the sharing of productivity gains on average. But TFP is based only on overall or aggregate quantities of inputs and outputs. Actual productivity gains can come about in various ways for different commodities. To really assess the financial status of specific commodities or groups, it is necessary to investigate the intricacies of the production process and link specific input consumption with specific outputs, along with the prices paid for inputs and prices received for outputs. That is, a disaggregate cost analysis is necessary to compare with revenues for analysis of profitability.

Disaggregation of aggregate TFP reveals the relative size of input or output categories which go into the calculation, but there is no link between input and output categories.

For future research, since the link between aggregate productivity and changes in financial performance can be examined overall by comparing quantity and price movements, it may be possible to find some hints about disaggregate financial performance by tracking individual quantity and price indices for outputs and inputs, respectively, but "respectively" is an important qualifier. The nature of the data for TFP studies limit any disaggregate analysis to inputs and outputs separately, not combined. But the latter is what is necessary to shed light on the implications of productivity changes for financial performance in specific markets.

Figure 4

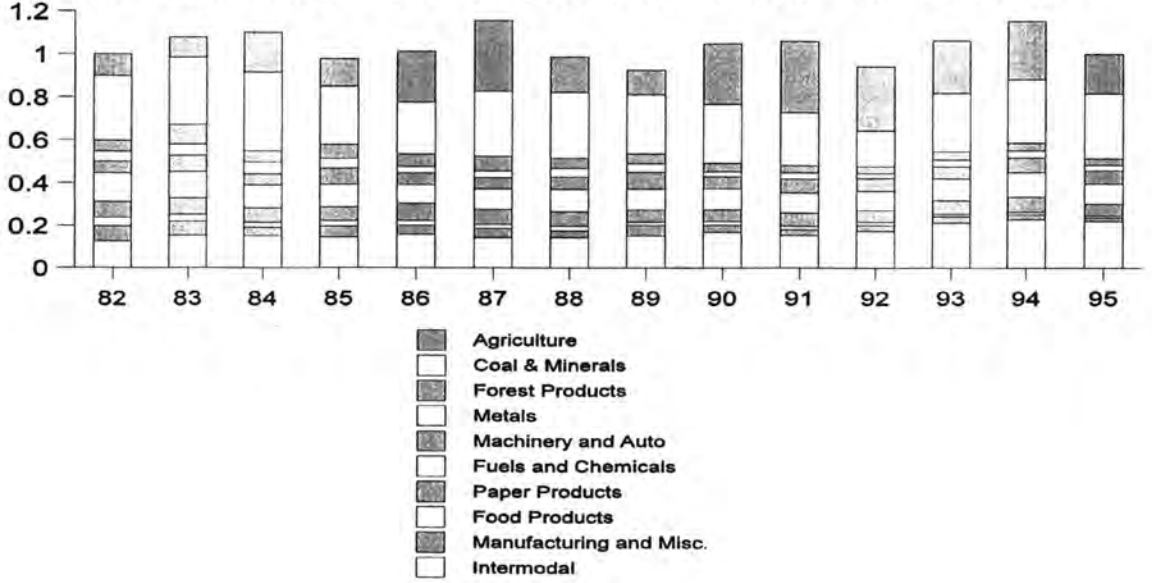
CTA 11 Commodities Revenue Share for CP Rail



209

Figure 5

CTA Commodity Share Weighted by Growth Rate for CP Rail



APPENDIX
THE LINK BETWEEN TOTAL FACTOR PRODUCTIVITY AND FINANCIAL PERFORMANCE

As noted in the introduction, productivity and financial performance do not necessarily move together. However, they are linked by examining changes in prices received for outputs and prices paid for inputs along with the productivity changes. To illustrate the links, use some simple algebra for two time periods, 0 and 1. One can think of a single product firm employing only one input, or index numbers to represent multiple output and input prices and quantities. Note that for index numbers, the respective price and quantity indices must be dual to one another so that there is computational consistency.[3]

P_0 and P_1 are output prices (indexes);

Y_0 and Y_1 are output quantities (indexes);

W_0 and W_1 are input price indexes;

X_0 and X_1 are input quantity indexes;

hence

R revenue = P x Y

C costs = W x X

Costs include capital costs, i.e., these are total economic costs.

π_0 and π_1 are measure of economic profit; for analytical convenience defined as the ratio of revenues to costs rather than the difference.

$$\pi_0 = R_0 / C_0$$

Note that there is no requirement that economic profits be zero.

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[3] The price and quantity indices must satisfy the "product test," i.e., the ratio of price indices over two periods times the ratio of quantity indices should equal the ratio of corresponding expenditure indices.

Total factor productivity (TFP) is measured by the growth of output relative to the growth in inputs:[4]

$$TFP = \frac{Y_1/Y_0}{X_1/X_0} \text{ or } \frac{Y_1/X_1}{Y_0/X_0} \quad (1)$$

(The second expression is the ratio of a TFP index for each period).

Any change in profitability between the periods is indicated by the change in revenue/cost ratios:

$$\pi_1/\pi_0 = \frac{R_1/C_1}{R_0/C_0} \text{ or } \frac{P_1Y_1 / W_1X_1}{P_0Y_0 / W_0X_0} \quad (2)$$

which is rewritten:

$$\pi_1/\pi_0 = \underbrace{\frac{Y_1}{Y_0} \times \frac{1}{X_1/X_0}}_{TFP} \times \underbrace{\frac{P_1}{P_0} \times \frac{1}{W_1/W_0}}_{1/TPP} \quad (3)$$

Any change in the financial condition of the firm/industry (economic profit) reflects the change in productivity and any change in relative prices of inputs and outputs. The first half of the right hand side of (3) is TFP. The second half is the growth in output prices relative to the growth in input prices. More in keeping with the economics literature on productivity, the right half of expression (3) is the reciprocal of what we label "total price productivity" or "total price performance" (TPP), the ratio of input prices to

[4] For simplicity, the index is written is simple ratio form. For calculations we use the Tornqvist or translog form of an index number, which would take the natural log of these expressions rather than leave them in arithmetic form.

output prices.[5] By tracking TPP along with TFP, one can directly monitor any change in the firm's financial status along with its productivity changes.

If competitive conditions prevail, the firm is a price taker for both outputs and inputs and economic profits are zero hence R/C = 1 and TFP = TPP, i.e., all productivity gains (Y/X) are passed on in the form of lower prices for outputs relative to prices paid for inputs. One need not assume perfectly competitive conditions; the same relationship holds if there is no change in the market power position of the firm. If competitive conditions change, equation (3) is all the more interesting and useful because we can monitor changes from the initial market power position. For example, suppose a firm is gaining increased market power. It will not pass all productivity gains on to customers, and this will be shown by tracking TFP relative to TPP. If TFP is greater than TPP, the firm has retained part of the productivity gains as increased revenues rather than pass the full productivity gains through to its customers. *In particular, the ratio of TPP to TFP indicates the extent to which productivity gains are shared with customers.*

REFERENCES

Jorgenson, D.W. and Z.Griliches (1967) "The Explanation of Productivity Change," *Review of Econ. Studies*, 34, 249-83.

Landel, Robert D. (1983) "Linking Productivity and Financial Performance," business case UVM-0M-436 from the Colgate Darden Graduate School of Business Administration, University of Virginia.

Miller, David M. (1984) "Profitability = Productivity + Price Recovery," *Harvard Bus. Review* 62:3, May/June, 145-53.

Oum, T. H., M.W. Tretheway and W.G. Waters (1992), "Concepts, Methods, and Purposes of Productivity Measurement in Transportation," *Transportation Research A*, Vol.26A, No. 6, 493-505

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[5] The change in input prices relative to output prices which we label TPP has been recognized for some time in the productivity literature (but not known by this name). The ratio of an input price index to an output price index is dual to the ratio of an output quantity index to an input quantity index (noted by Jorgenson and Griliches, 1967 citing earlier papers by Siegel, 1952 and 1961), but it is rarely calculated or examined (but see Tretheway, Waters and Fok, 1994; Waters and Tretheway, 1997; Waters and Street, 1997; and Waters, Oum and Yu, 1997). The reciprocal of TPP (i.e., output price index over an input price index) can be thought of as a "terms of trade" concept for a firm and is known as "price-cost recovery" or "price performance" in the management literature on productivity and profitability (e.g. Miller, 1984; Landel, 1983; Sink, Tuttle & DeVries, 1984).

Oum, T.H. and W.G.Waters II (1996) "A Survey of Recent Developments in Transportation Cost Function Research," *Logistics and Trans. Review* (December) pp. 423-463.

Siegel, I.H. (1952) "Concepts and Measurement of Production and Productivity," U.S. Bureau of Labor Statistics, March.

Siegel, I.H. (1961) "On the Design of Consistent Output and Input Indexes for Productivity Measurement," in *Conference on Research in Income and Wealth, Output, Input and Productivity Measurement, Studies in Income and Wealth*, Vol. 25 (Princeton: Princeton Univ. Press), 23-41.

Sink, D. Scott, Thomas C. Tuttle and Sandra J. DeVries (1984) "Productivity Measurement and Evaluation: What is Available?" *National Productivity Review* (Summer) 265-287.

Tretheway, M.W., W.G.Waters II and A.K.Fok (1994) "Measuring Productivity Performance and Financial Returns for Canadian National Railways and CP Rail - 1956-1991" monograph, Centre for Transportation Studies, University of British Columbia.

Tretheway, M.W., W.G. Waters, and A. K. Fok (1997), "The Total Factor Productivity of the Canadian Railways, 1956-1991", *Journal of Transport Economics and Policy*, vol. 31, No. 1, January, 93-113

Waters, W.G., II (1997) "The Total Factor Productivity of the Canadian National and CP Rail: an Update and Extension of the UBC Rail Productivity Study," Report for the Canadian Transportation Agency by the Centre for Transportation Studies, the University of British Columbia, Vancouver, (March 16).

Waters, W.G.II, Tae Oum and Chunyan Yu (1997) "Productivity and Price Trends in the World's Major Airlines, 1986-1995" paper presented to the international conference of the Air Transport Research Group (ATRG), Vancouver, June 25.

Waters, W.G.II and John Street (1997) "Why Total Factor Productivity is an Incomplete Measure of Performance for Government Enterprises," *Proceedings of the Australasian Transport Research Forum*, Vol. 21, Part 2, 533-550.

Waters, W.G.II and M.W.Tretheway (1997a) "The Feasibility of Grain-Specific Productivity Measurement for Regulating Railway Grain Rates in Canada," Report for the Canadian Transportation Agency, 15 March, 1997.

Waters, W.G.II and M.W.Tretheway (1997b) "Measuring Total Factor Productivity and Price Performance -- Concept and Application to Canadian Railways," Faculty of Commerce and Business Administration. The University of British Columbia, revised working paper, (December, 1997).

Estimating the Derived Demand for Transport: A Gravity Model Approach

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Introduction

Transportation policy changes are inducing capacity expansion in pork production in Western Canada. The end of freight subsidies under the Western Grain Transportation Act (WGTA) encourages prairie farmers to sell their grain domestically rather than incur the higher shipping costs for export sales. Hog producers across Western Canada are building large hog barns that take advantage of sophisticated mechanical feeding systems and computerized controls. Notwithstanding low prices in 1997/98, optimism prevails that the hog industry could easily double in size within a decade. This creates a critical need to develop new international markets for Canadian pork industry. In spite of the potential for capacity expansion in pork production, increased pork trade will not take place, if the cost and efforts of movement are too great.

During 1992-1996, Canadian pork exports to the United States increased 43%, from $361 million in 1992 to $515 million in 1996. Meanwhile, Canadian exports to the world grew 58%, from $566 million to $893 million. Among the major exporting provinces, exports from Alberta increased 82%, followed by 77% for Manitoba, 58% for Ontario, 48% for Saskatchewan, and only 19% for Quebec. As the result, Western provinces' share in Canadian pork exports to the United States increased from 44% in 1992 to 49%, while that for Central provinces declined from 56% to 51%.

The impact of transportation costs can be observed in the pattern of Canadian pork exports to the United States. Alberta's largest pork markets are California, Oregon and Washington. Saskatchewan's dominant destinations are California and North Dakota. The nearby markets of Wisconsin and Minnesota are the

major markets for Manitoba. The major markets for Ontario are New York, Virginia, Massachusetts, Illinois, Florida, Wisconsin, and Ohio. Quebec's exports mainly go to New York, Florida, Pennsylvania, Massachusetts, New Hampshire, New Jersey, and Georgia. As the origin of pork supply shifts from west to east, market penetration in the United States moves in parallel. Clearly, transportation costs play an important role in determining the volume and direction of trade flows.

The objective of this study is to quantify the demand for refrigerated truck transportation of pork exports from Alberta, Saskatchewan, Manitoba, Ontario, and Quebec to the United States. The specific objectives are to (1) empirically estimate the effects of transport costs on the opportunities for marketing pork from major export provinces to the United States and (2) identify potential markets in the United States where exports from Canada could be increased. The demand for transport is estimated using a gravity model. The estimate method is SAS/STAT/REG.

Following this introduction, a theoretical model is presented that shows how the gravity model is the same as the derived demand for transport. The empirical gravity model is constructed using Canadian pork exports to the United States to estimate the derived demand for transport. The model is employed to identify the potential markets for the five major export provinces.

Theoretical Consideration

The one commodity, two region trade model can be represented mathematically as follows:

$Qx = Qx(Px, Sx)$	(excess supply)	(1)
$Q_I = Q_I(P_I, S_I)$	(excess demand)	(2)
$F = P_I - Px$	(Spatial equilibrium condition)	(3)
$Qx = Q_I$	(market clearing condition)	(4)

where Qx is the quantity of excess supply;
Q_I is the quantity of excess demand;
Px is commodity price in the export region;
P_I is commodity price in the import region;

S_X is the vector of exogenous supply and demand shifters in export region;
S_I is the vector of exogenous supply and demand shifters in import region;
F is transportation costs to move the commodity from the exporting region to the importing region.

From equations (1) and (2), the following inverse functions with respect to P_X and P_I could be obtained:

$$P_X = P_X (Q_X, S_X) \quad (5)$$
$$P_I = P_I (Q_I, S_I) \quad (6)$$

Substitute equations (5) and (6) into equation (3),

$$F = P_I - P_X = P_I (Q_I, S_I) - P_X (Q_X, S_X), \text{ or,}$$
$$F = F (Q_I, Q_X, S_I, S_X) \quad (7)$$

When market clearing condition is satisfied,

$$Q_X = Q_I = Q_E \quad (8)$$

Substitute Q_X and Q_I with Q_E in equation (7),

$$F = F (Q_E, S_I, S_X) \quad (9)$$

In its reverse form, equation (9) become,

$$Q_E = Q_E (F, S_I, S_X) \quad (10)$$

Equation (10) says that, in equilibrium, trade volume between the exporting and importing regions is determined by transportation costs, supply and demand shifters in both importing and exporting regions. This is exactly a gravity model in terms of explicitly relating trade flows to factors rather than price

difference. The gravity model is derived from interregional trade model and it is a reduced form of the interregional model.

Empirical Model

In the case of pork exports from Canada to the United States, for the period of 1992-1996, equation (10) could be rewritten as:

$$Q_{ijt} = Q(F_{ijt}, S_{it}, S_{jt}) \qquad (11)$$

where

$i = 1,2,3,4,5$;
$j = 1,2,3, \ldots 50$;
$t = 1992, 1993, 1994, 1995, 1996$;
Q_{ijt} is defined as the quantity of pork exports, in terms of truckloads, from province i to state j in year t;
F_{ijt} is the truck freight rate of transporting pork from province i to state j in year t.
S_{it} and S_{jt} are the vector of supply and demand shifters in exporting region i and importing region j, respectively, at time t.

There is no evidence to justify differentiated specifications for S_{it} and S_{jt}. Two variables are specified for both of them. The first variable is the total disposable income (Y) in the importing and exporting regions. The second variable is called a production specialization index, (INX) which is calculated as the ratio of hog inventory to human population in importing and exporting regions. For an importing region, import quantity is expected to increase as income goes up or specialization index declines. For an exporting region, export quantity is supposed to decrease as income rises or specialization index decreases.

As mentioned above, the major objective of this study is to identify potential U.S. markets for Canadian provinces, rather than search for promising supply sources for certain U.S. states or find out the most economic transport path of pork transportation between Canada and the United States. In other words, the issue is to determine the prospective destinations of pork exports from fixed

originators. It is believed that the variables in the importing states are much more substantial in this case. Therefore, the vector of shifters in the exporting provinces are excluded from the econometric model to emphasize more important factors. As the result, equation (11) is reduced to:

$$Qijt = Q\ (Fijt,\ Sjt) \qquad (12)$$

substitute Yjt and INXjt for Sjt,

$$Qijt = Q\ (Fijt,\ Yjt,\ INXjt) \qquad (13)$$

In its multiplicative form,

$$Q_{ijt} = \alpha_0 F_{ijt}^{\beta 1} Y_{jt}^{\beta 2} INX_{jt}^{\beta 3} U_{ijt} \qquad (14)$$

Take natural logarithm,

$$LnQ_{ijt} = \beta_0 + \beta_1 LnY_{jt} + \beta_3 LnINX_{jt} + e_{jt} \qquad (15)$$

where

$\beta_0, \beta_1, \beta_2, \beta_3$ are coefficients to be estimated, and

$\beta_0 = \mathrm{Ln}\,\alpha_0$,

$e_{ijt} = LnU_{ijt}$

Based on the econometric model of equation (15), a modified version with a dummy variable is specified to distinguish high volume, relational trade linkages from low volume, spot market trade flows. Discussions with Canadian pork exporters revealed that they enjoyed long term relations with some import markets, such as California, Minnesota and Wisconsin. These states are consistent importers and have disproportionally large volumes. The "spot market" states have relatively small volumes and do not import every year. As a result, the gravity model without the dummy variable produces coefficient estimates that are specificationally incorrect and the intercept term represents

neither type of market. Typically, the overall effects of other exogenous variables are overestimated and/or the intercept is inflated. To eliminate this specification error, a dummy variable is set to unity when a state's annual pork imports from a province are consistent and significant and, zero otherwise.

The pooled cross-section time series technique, as described by Kmenta (1986), is used to estimate the derived transport demand equation. According to Koo and Karemera (1991), a pooling technique is especially needed for agricultural commodities because weather conditions make annual trade flows highly volatile in importing and/or exporting countries[1]. A particular year may not provide accurate information to evaluate trade-flows of a commodity with cross-section data only. Therefore, a pooling technique that combines the cross-section and time series data was considered appropriate to estimate the parameters for each province.

Estimate Results and Discussion of the Gravity Model

The estimation results obtained with the gravity model of the derived demand for transportation are presented in Table 1. Inferences are made regarding the effects of transport costs on Canadian pork exports to the United States. Finally, the estimated model is used to examine the penetration of Canadian pork exports from each province to U. S. markets.

Income Effect The income coefficients represent the percentage change in quantity of pork exported by a province in response to a one percent change in importing states' income, other factors held constant. The small elasticity estimates for the four provinces except Alberta, from 0.25 for Quebec to 0.49 for Saskatchewan, indicate that changes in Canadian pork exports to the U. S. are not very sensitive to changes in U. S. personal income. However, the income elasticities are significant at 5 percent level for all the provinces except Quebec.

The inelastic import demand is expected because pork is a basic product and Canadian imports compete with local and domestic supplies. The dispersion of income effects across provinces, especially the much higher elasticity for

Alberta, might be attributed to different characteristics of the major markets for each province.

Specialization Index The elasticity of U. S. pork imports from Canada to production in the United States (as represented by the specialization index) is not significant at 5 percent level, suggesting that Canadian pork may not be a perfect substitute for U. S. pork. Any affect that might exist is minor. All elasticity estimates either fall into a narrow range, from -0.17 for Manitoba to -0.03 for Quebec.

Table 1. Estimate Results of the Gravity Model for Canadian Pork Exports to the United States, 1992-1996

	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Intercept	14.65 (5.85)**	9.41 (2.40)	8.48 (3.21)**	1.66 (0.68)	5.30 (2.57)**
Transport Costs Elasticity	-3.26 (-7.81)**	-1.79 (-2.68)**	-1.53 (-0.57)**	-0.67 (-2.57)*	-0.91 (-3.95)**
Income Elasticity	1.02 (6.43)**	0.49 (2.71)**	0.31 (1.92)**	0.41 (2.46)*	0.25 (1.64)
Specialization Index Elasticity	-0.11 (-1.72)	0.10 (1.03)	-0.17 (-1.87)	0.08 (1.23)	-0.03 (-0.45)
Dummy Variable	2.54 (11.22)**	4.61 (16.28)**	2.35 (8.49)**	2.64 (8.47)**	3.05 (11.51)**
Adjusted R Square	0.80	0.84	0.63	0.67	0.68
F value	91.76	67.66	36.13	51.97	70.07

Note: ** and * indicates the coefficient estimate is significant at 1% and 5% level, respectively.

A decline in pork production in a state decreases its specialization index, but the increase in demand for pork directly exported from a Canadian province might be slight. There are three reasons for this. First, a specific province is only one of the many import sources for a certain state. Sources might also include other states within the U. S., other Canadian provinces, and Mexico. Second, the United States is a significant pork exporter to overseas markets. A moderate decline in U. S. production might only cause fluctuations in its exports, rather than an immediate increase in imports.
Third, Canadian provinces, especially the central provinces, depend heavily on interregional trade within Canada. Although the United States is the biggest pork export market for Canada, large quantities are shipped inter-provincially. For instance, Honey (1998) estimates that the quantity of pork traded between Manitoba and the rest of Canada is greater than that traded between Manitoba and the United States. It is possible that when a production decline occurs in the United States, more Western Canadian pork is transferred to the U. S. via the Central provinces.

The interstate and interprovincial pork trade and overseas pork exports from North America are beyond the scope of this study, because mainly of insufficient data.

Transportation Costs The transportation costs used in the estimate are truckload freight rates between major cities involved in Canadian-U. S. pork trade[2]. The dispersion of transport costs depends on differences in the level and structure of freight demand in each province and the opportunities for loaded backhauls from the United States to Canada.

The elasticity estimates for the freight variable, which is of major importance here, are significant for all the five major exporting provinces. The significance level is 1 percent for Alberta, Saskatchewan, Manitoba and Quebec, and 5 percent for Ontario, indicating that transportation costs have significant impact on Canadian pork exports to the United States across all provinces.

Changes in transportation costs have a decreasing impact on pork exports from west to east across Canada. Transportation cost elasticity is estimated to be highly elastic for the Western Canadian provinces and inelastic for the Central provinces: -3.26 for Alberta, -1.79 for Saskatchewan, -1.53 for Manitoba,-0.67 for Ontario and -0.91 for Quebec. Specifically, a one percent decrease in transport costs could cause Alberta pork exports increase of 3.26%, on average, while in Ontario, a similar change would cause a 0.67% increase in the quantity of pork exported. With the recent expansion in hog and pork production capacity across Western provinces, transportation costs are more likely to be a problem for Western provinces than for Central provinces. Transportation will play a critical role for the further expansion of production capacity in Western Canada.

The difference in export elasticity to transportation costs could also due to efficiency gaps in hog and pork industries across provinces. With the same freight rate level and structure, the more efficient the hog production and processing industries are, the less elastic is the export volume to freight rate changes. A major concern in the Canadian pork processing industry is the rapid increase in live hog exports to the United States. Rice (1998) notes that 3.18 million market hogs and feeder pigs were exported to the U.S. in 1997. The live trade represents 15% of total pigs born in Canada.

Considering the minimal level of aggregation and the lower ratio of freight costs to pork price, the freight rate elasticities estimated in this study are believed to be plausible, although they are higher compared with the coefficient estimates reported in the literature (Geraci, 1984). This could be explained by their unique character. First, most of these other studies use distance as a proxy for transport costs, which may result in a serious underestimate of the sensitivity of trade flows to transport costs. Second, estimates obtained from time series analysis are viewed as a short-term response, while cross sectional estimates are assumed to approximate long-run response. Finally, most of the published transport demand elasticity demand elasticities refer to ocean borne trade because most global trade is transported by water. Water transport is much cheaper than other modes of transport so the demand elasticities could be lower.

These elasticities refer to truck movement of agricultural products between Canada and the United States. The rates are higher, the distances are shorter, and service is a much more important component of carrier choice.

Market Penetration Analysis

The gravity model relates pork export volume to income, production in the importing region and the cost of moving supplies from origin to destination. One use of this model is to explore the issue of market penetration. The model is employed to produce the expected volumes of exports from each province to each state. These expected volumes were then compared with actual shipments. Those states that consistently import less than expected from a province may be identified as the province's potential targets for export market development.

While any state that is importing less than expected has potential for expansion, those states importing frequently with regular quantities are the most promising markets. Markets with wild year-to-year variation have potential, especially those that have imported large quantities. The most marginal markets are states that only imported once during the study period. The market potential identified for each province is presented in Table 2 in terms of truckload volumes for 1996.

Table 2. Market Penetration Opportunities for Canadian Pork Exports to the United States in 1996, Truckloads

	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Colorado	46	25	19		
Connecticut				37	5
Florida	9		5		
Georgia				24	34
Illinois		8			47
Kansas			20		

Kentucky				**44**	
Massachusetts			**22**		
Maine					**7**
Michigan	**6**			**95**	
Minnesota		**5**	**19**	**33**	
Mississippi					**15**
North Carolina	**6**		**24**		
New Jersey			**27**		**25**
Ohio				**32**	
Pennsylvania				**47**	
Rhode Island			**8**		
Texas	**55**	**14**	**25**	**13**	**27**
Washington		**13**			
Wisconsin	**9**				**18**
Total	**131**	**65**	**169**	**325**	**178**

The gravity model results suggest that Alberta should direct most of its promotional efforts to increase pork sales in Texas and Colorado, with Florida, Michigan, Wisconsin and North Carolina as secondary targets. Saskatchewan should also focus on Colorado and Texas, but include Washington ahead of Illinois and Minnesota. The Manitoba hog industry has good opportunities for expansion in Texas, Colorado, Kansas, Minnesota, Massachusetts, New Jersey and North Carolina, with Rhode Island and Florida as secondary targets. The potential markets for Ontario are Michigan, Minnesota, Ohio, Pennsylvania,

Kentucky, Connecticut, Georgia and Texas. The best expansion opportunities for Quebec are in Illinois, Georgia, Texas and New Jersey, with Wisconsin, Mississippi, Connecticut and Maine as secondary targets.

Overall, Ontario would appear to have the best opportunities for exporting pork, given its location and freight rates to potential import markets. Its potential to export is almost double its closest rival. The reality, of course, is that Ontario imports pork from other provinces so its true export potential is less than estimated here. From a national perspective, all efforts should be focussed on developing pork exports to Texas. This may be a woefully under served market. It is interesting that two of the largest pork import dependent states, California and Florida, may be very well served. Exporters would appear to have exploited most of the opportunities for cheap backhaul freight rates that were identified by Prentice et al (1992).

Concluding Comments

Gravity models have a long history in modelling trade flows, but lack a strong economic foundation. This study demonstrates that the gravity model can be reconciled with existing economic theory within the framework of international trade. Essentially the gravity model represents the derived demand for transportation. This finding could make it possible to examine interregional trade in a new light and provide an important test of the validity of traditional commodity price-based interregional trade models. In addition, gravity models may be a useful tool for directing export market development efforts. The gravity model identifies promising markets for Canadian pork exporters to target their efforts.

The estimation results of the gravity model demonstrate the influenced of transportation costs on the volume of pork exports from Canada to the United States. The higher export elasticities of transportation costs for the Western provinces imply that reductions in transport costs could have a high payoff for a rapidly growing pork sector of Western Canada. It is inferred based on the transport cost elasticities that strong price competition exists in the US importing markets. Alternatively, the opening of new lower-cost processing facilities, e.g. Maple Leaf at Brandon, could have a significant impact. The

gravity model could be used to estimate the impact of lower pork prices on exports. Theoretically, the impact of a change in pork prices could be measured as the equivalent change in the truckload freight rate, assuming that greater demand has minimal impact on freight rates.

Further efforts should be made to (1) identify other variables affecting trade flows in commodity specific gravity models; (2) incorporate swine exports from Canada to the United States into pork trade modelling; (3) use SAS/STAT/SYSLIN, SAS/STAT/ SURE and other advanced procedures to partially capture the effects of interstate and interprovincial trade flows on Canadian exports; and (4) test for significance difference between the provincial coefficients.

References

Geraci, Vincent J. et al. Bilateral Trade Flows and Transport Costs, Review of Economics and Statistics, Vol. 60: 67-74.

Koo, W. W. et al. Determinants of World Wheat Trade Flow and Policy Analysis. Canadian Journal of Agricultural Economics, Vol. 39, No.3: 439-445.

Honey, Janet. Manitoba Department of Agriculture, personal interview.

Prentice, Barry E., et al. Demand for Refrigerated Truck Transport: A gravity Model Analysis of Western Canadian Pork Exports to the United States. University of Manitoba Transport Institute. March, 1996.

Prentice, Barry E., et al. Transport-related Opportunities and Barriers to Diversification of Value-added Agricultural Exports from Western Canada. Research Bulletin No. 12, University of Manitoba Transport Institute. 1992.

Rice, Martin. Pork Outlook Perspectives. Paper presented at *GrainWorld 98*, Winnipeg, Manitoba, March 1-3, 1998.

Endnotes

1. Rice (1998) describes the North American hog market as the world's "Shock absorber" for changes in supply and demand. "No other region has so few safeguard mechanisms and barriers to protect against major changes in feed availability or demand shifts ..."

2. Truckload freight rates for refrigerated pork products were supplied courtesy of Atomic Transportation System Inc.

Locating A Meat Processing Plant in the Prairies

Mark Gannon, Laura Morrison, Les Stelmach

Abstract

In the autumn of 1997, Maple Leaf Foods made the decision to locate their new high capacity hog processing plant in Brandon, Manitoba. Edmonton, Alberta was another city in the running for the plant, and it has been suspected that Edmonton was passed over on account of negative labour relations. In reality, this decision was likely based on a combination of several factors considered together. We were curious about what those factors might have been and how Edmonton and Brandon would have measured up. We decided to investigate this from a multi-criteria decision-making perspective, and modeled the problem using the Analytical Hierarchy Process and the software program Expert Choice.

Background & Problem

On November 17 of last year, the workers at the Maple Leaf pork-processing plant in Edmonton, Alberta walked off the job, joining their coworkers in Burlington, Ontario and North Battleford, Saskatchewan. The workers were members of the United Food & Commercial Workers (UFCW) union and had been without a contract since December 15, 1996 (Sheremata 1997).

Shortly thereafter, in December of 1997, Maple Leaf Foods closed the Edmonton plant for good. This was a surprise to the union; even though Michael McCain, president of Maple Leaf Foods, had informed the workers that if a strike were to happen he would close the plant, the union believed it a bluff. This was not entirely without reason; previous owners of the Edmonton plant, such as Peter Pocklington and Burns Foods Ltd., had used the same bargaining tactics in the past (Sheremata 1998).

More importantly (and to the dismay of many Edmontonians) it was announced within days of the closure that the site for a new high capacity Maple Leaf Foods plant would be in Brandon, Manitoba. It had previously been thought that the $75 million plant would be built in Edmonton, replacing the timeworn existing plant.

It was this decision of Maple Leaf Foods to locate in Brandon that sparked our interest in this project. The question that we wanted to answer was this: Why did Maple Leaf Foods prefer the Brandon location to Edmonton for their new facility? Was the decision solely based on labour relations? Were politics, perhaps, behind the choice? We thought that it would be interesting to determine if Brandon was, in fact, the optimal location for a hog processing plant in the Canadian prairies.

Because companies in the process of choosing where to locate a facility of this variety likely base their decisions on many different factors, the analysis of the decision lends itself to evaluation using multi-criteria decision-making techniques.

It would have been optimal to interview someone of authority from Maple Leaf Foods to research our problem, but we were unable to successfully contact the company. Despite this setback, we decided to evaluate the company's choice of Brandon from our own perspective. We defined eight criteria from which to investigate the location decision: proximity to markets, proximity to supply, proximity to competitors, cost of land, environmental and nuisance laws, strength of unions, availability of labour, and business and tax incentives.

In order to evaluate this multi-criteria decision-making problem, the best method seemed to be the Analytic Hierarchy Process (AHP). To implement this analysis, we employed a AHP software package, Expert

Choice, distributed by Expert Choice Inc. The AHP formulation enabled us to compare each candidate location to each other across all decision criteria one at a time; this simplification of the process is valuable as we suspect that it is beyond the cognitive capabilities of human beings to accurately compare seven alternatives over eight criteria simultaneously.

Method

To structure a decision-making problem into the analytical hierarchy process there are two important elements that must be defined. At the top of the hierarchy is the *goal*. For our project, the goal is our objective: determining the best location for a hog processing plant in one of the three prairie provinces. The second level of the hierarchy is made up of *factors*, which are the criteria on which the *alternatives*, the third level of the hierarchy, are evaluated. The alternatives in our problem are the seven candidate locations for a hog processing plant, and the factors that we have identified to assess them by are:

- Proximity to Markets
- Proximity to Supply
- Proximity to Competitors
- Cost of Land
- Strength of Unions
- Availability of Labour
- Environmental & Nuisance Laws
- Business & Tax Incentives

We chose these particular factors based on our own perception of what a company such as Maple Leaf would look at when selecting a location for a new facility, and thus part of our problem was to discover how relevant these criteria in fact are to the decision.

To make this judgement, we relied on personal knowledge, information reported by the media, and communication with specialists at Alberta Agriculture.

As our project progressed, we came to realize that a couple of our criteria were not relevant to our problem from the level that we were examining it at. Shortly after beginning this project, we realized that municipal zoning was more important to the question of where to build a hog processing plant in a particular city than to the question of in what city to locate the

plant. We also have realized that proximity to rail lines is a similar type of issue. As the major Canadian rail companies serve each of our candidate locations, the related location problem is where to locate in a particular city. Additionally, the majority of Canadian pork is shipped to market by refrigerated truck, so having a rail loading dock on site is not a location-related prerequisite.

To rank each of our candidate locations within the AHP framework, subject to our decision criteria, we used both quantitative and qualitative information and methods.

Proximity to Demand

The proximity of a prospective meat-processing plant to its demand points (markets) is an important factor to consider when deciding where to locate the facility. This criterion relates to a firm's cost of distribution directly. By minimizing the distance between the facility and the demand points, the length of time needed to transport from the facility to the demand point is also minimized. The predominant method of transporting pork across the prairies is by truck, and the less time that it takes to make a delivery, the smaller is the expenditure on wages of the driver (if the drivers are employees of the company). Shorter distribution distances translate into less expenditure on fuel and vehicle maintenance, and also would extend the useful life of the vehicles.

To obtain a quantitative estimate of the distribution costs for each of our candidate locations, we solved a variation of the 1-median problem. This formulation was appropriate as it computes the approximate distribution costs resulting from locating at one point and traveling to all the other (demand) points. To calculate the costs, the travel distance is weighted by the amount of demand at each demand point.

The final results of our analysis of demand revealed that North Battleford, Saskatchewan had the lowest cost of distribution out of all of the towns that we solved the 1-median problem for, and interestingly, Maple Leaf Food has a hog processing plant in North Battleford. For our seven candidate locations, the results are shown below:

Rank	Location	Distribution Cost
1.	Saskatoon	1,804,193,382.26
2.	Calgary	1,835,057,918.41
3.	Red Deer	1,873,257,708.53
4.	Edmonton	1,887,735,550.41
5.	Regina	1,959,129,967.54
6.	Brandon	2,503,883,470.73
7.	Winnipeg	2,919,667,513.52

Proximity to Supply

Though it may not seem so, the proximity of a hog processing plant to its source of supply, the hogs, is an important consideration in deciding where to establish a processing facility. This arises for two reasons.

Firstly, it is characteristic in this industry for the individual producers (farmers) to pay for the transportation of their hogs to the processing plant. Thus, the farther the hogs must be shipped, the greater is the cost to the producer. Secondly, It is typical for hogs to weigh less after being transported to the processing plants than they did before the onset of the journey. Because transportation is stressful to the animals, some weight loss occurs. Since hogs are priced based on their weight at the time of arrival at the processing plants, producers generally try to minimize the amount of profit they lose to shrinkage.

Based on the combined effect of both of the issues outlined above, one of our contacts at Alberta Agriculture advised us that the maximum length of time that producers generally prefer to have their hogs in transport for is about four hours. This equals 320 kilometers if travel is at eighty kilometers per hour.

We decided to evaluate this criterion by developing a covering model. This formulation enabled us to estimate the percentage of total hogs that could be covered within a four-hour radius from each of the candidate locations. We converted the four-hour standard to several kilometre-

based radii, representing different travel velocities. A radius of 320 km, translating to an approximate trip of four hours at eighty kilometres per hour on the highway, was judged to be the most reasonable scenario, and thus we used the corresponding coverage percentages for our Expert Choice model. The results of this analysis were as follows:

Rank	Location	Percentage of Total Hogs Covered
1.	Winnipeg	39.4%
2.	Red Deer	29.3%
3.	Brandon	27.9%
4.	Calgary	26.3%
5.	Edmonton	22.0%
6.	Saskatoon	11.5%
7.	Regina	6.5%

Proximity to Competitors

There are currently ten hog processing plants in Alberta, Saskatchewan, and Manitoba. This competitive landscape will change geographically when the current Maple Leaf facility in Winnipeg is decommissioned and the Manitoba operations are transferred to the new high capacity plant in Brandon.

The way that we chose to evaluate this criterion is by cost of distribution. A new plant would have an advantage over nearby competitors if it is able to distribute the product to the market at a smaller expense than competitors. This saving could be re-invested into the operation or once again passed on to the consumers through lower product pricing.

We hypothesized that if one of our prospective facility locations had a lower total distribution expense than its nearest competitor, it would have a competitive advantage. Our analysis is summarized in the table below:

Rank	Candidate Location	Savings Over Competitor
1.	Calgary	38,199,790
2.	Brandon	33,065,523
3.	Red Deer	0
4.	Saskatoon	0
5.	Edmonton	- 14,477,842
6.	Regina	- 46,815,440
7.	Winnipeg	- 382,718,519

Cost of Land

To evaluate this criterion within the AHP framework, we researched the average cost per acre of for serviced industrial land, for each of our candidate locations. We made the assumption that a new hog processing plant would be located on heavy industrial land for the following reasons. First, zoning regulations are very strict in most cities and would not permit a facility of this nature to be located near residential areas. Second, it is in the best interest of the plant to locate near a major traffic artery in the city to reduce transport costs. Third, there are only a few areas in each city where large tractor-trailers shipping live hogs would be permitted to travel. Heavy industrial areas are the areas that would be fully accessible.

The results of our analysis revealed that there is a substantial amount of variance amongst each of the prospective locations. Each city's average per acre land cost values used in our decision are shown below (Alberta Economic Development 1997):

Rank	Location	Heavy Industrial Land Cost (per acre)
1	Red Deer	$ 40,000
2	Regina	$ 62,500
3	Saskatoon	$ 65,000
4	Edmonton	$ 65,000
5	Brandon	$ 75,000
6	Winnipeg	$ 88,750
7	Calgary	$ 158,300

Note: Values for Regina and Brandon were estimated using the available data.

We realize that a decision-maker cannot rely too heavily on these values. Municipalities are likely to offer attractive concessions to large meat processing companies to attract their business. These concessions could greatly reduce land costs in each city and would vary amongst each city. For these reasons, the real estate values must be taken with a grain of salt. However, at very least, we do believe that these costs do accurately reflect the ranking of each city with respect to the general range of land prices.

Strength of Unions

The strength of the local union is an important consideration when building a hog processing facility. To state it simply, it is the willingness of the union to strike that is a deterrent to investing in a particular area.

The union governing the employees of meat processing plants like those of Maple Leaf, the United Food and Commercial Workers (UFCW), is a national union. Thus, in theory, no single local should be stronger than another local in another city. We were advised that the Edmonton Maple Leaf plant's history of poor management-union relations was an exception rather than the norm. It is felt that the tension between plant management and the UCFW was due more to the history of the plant, and as such it is not evidence of a stronger union in Alberta.

As data on the labour relations for each of our candidate cities was not available, we evaluated this criterion as a provincial measure. We used statistics from Alberta Economic Development on the average number of

disputes per ten thousand person-days worked, as an indicator of union power. These measures are shown:

Province	Number of Disputes
Alberta	0.95
Saskatchewan	11.83
Manitoba	1.92

Availability of Labour

When deciding where to locate a hog processing facility, companies likely seek the assurance that the chosen location has an available labour force to provide the facility with workers to operate it. Typically, hog processing facilities require two different types of employees. The majority of employees working at these facilities are manual labourers. The standard industry wage for these workers is about eight dollars per hour. In addition, hog processing facilities also require a number of trained meat cutters. Most of these trained employees have finished a five-month or longer technical school program to obtain a meat-cutting certificate.

We evaluated this criterion by ranking our candidate locations by their unemployment rates, believing this to be the best representation of the availability of unskilled workers. Next, we increased or decreased the ranking of the cities to incorporate the availability of skilled workers by considering whether there was a trade school offering a meat-cutting program in close proximity, and whether there might already exist a surplus of trained meat cutters.

For our seven candidate locations, the results of our labour availability analysis are shown below:

Rank	City
1	Edmonton
2	Calgary
3	Red Deer
4	Regina
5	Saskatoon
6	Brandon
7	Winnipeg

Environmental and Nuisance Laws

We thought that we must not overlook the importance of environmental and nuisance laws when deciding where to locate a hog processing facility. Despite the fact that hog processing plants make an enormous contribution to a municipality's economy, these facilities are viewed as a nuisance in many communities. Meat processing plants are often thought to contribute to air pollution and an increase in heavy truck traffic, emit noxious odours, and exceed city noise regulations.

Assigning an objective value to our candidate locations using this criterion would require the ability to forecast future environmental and nuisance problems in each city. While we assume that there is equal probability the occurrence of public protest in each of candidate locations, we cannot judge the magnitude or frequency of such problems due to their unpredictable element. For this reason we have not found a logical means to differentiate between our candidate cities within the AHP framework in a reasonable way, and thus have assigned each alternative the same weight to reflect their equal potential.

Business & Tax Incentives

The business & tax incentives that municipal governments offer companies in order to encourage them to locate their operations within civic boundaries are another factor that may be an important consideration when deciding upon where to establish a pork-processing facility. There may be some evidence to support this. For example, the decision of Maple Leaf to build in Brandon may have been heavily influenced by the fact that the province of Manitoba offered the company a $8.5 million

incentive package. This package included manpower training as well as free road and other infrastructure improvements.

While we feel that while business and tax incentives are important criteria, they are very difficult to evaluate. Because of this difficulty and the fact that provinces and municipalities offer incentives to companies on a case-by-case basis, we decided to rate all alternatives equally in Expert Choice. By doing this, we actually remove any effect this criteria may have on the decision; however, if information became available, the effect on the decision could be easily seen by revising the ratings of our alternatives.

Results

The quantitative data that we collected to rank each of our location alternatives enabled us to use Expert Choice's assessment by data function to determine scores for each of our seven cities under each of the eight criteria. This method of evaluation seemed to be more suited to our data than the typical preference-based pairwise assessment as we found it difficult to say precisely how much more we prefer one location to another based on numbers. By entering our actual data into the program and then letting Expert Choice perform the pairwise comparisons, the need for us to determine a reasonably accurate scale for degree of preference was eliminated, and inconsistencies in judgement were avoided.

We assigned weights to our criteria based on our discussions with Alberta Agriculture and our own thoughts on the agri-food industry. We recognize that the assignment of weights imposes a large degree of subjectivity onto the analysis

After entering the data into Expert Choice and evaluating all candidate locations, the following final results were obtained (in order of most-preferred site to least-preferred site):

Location	Score	Location	Score
1. Red Deer	0.166	5. Winnipeg	0.143
2. Edmonton	0.163	6. Saskatoon	0.121
3. Calgary	0.154	7. Regina	0.110
4. Brandon	0.144		

Some candidate sites fared quite well in some areas, while they may have done quite poorly in others. For example Brandon (& Winnipeg) are superior in terms of supply, but both were inferior in terms of demand and union strength.

The Saskatchewan locations performed the best under the proximity to demand criterion. Because this province is centrally located in terms of the market that we defined, we could have anticipated the strong results for Regina and Saskatoon. The apparent heavy rate of unionization in Saskatchewan appears to be what hampered these two cities the most in the final analysis.

Red Deer received the highest score in the AHP analysis out of all our candidate locations, and the other Alberta locations; Edmonton and Calgary followed in rank. Red Deer scored quite high for the proximity to demand, proximity to supply, and cost of land criteria. Though Edmonton received the top score for availability of labour, Red Deer's performance on the other criteria compensated enough to produce a marginally higher final score.

Once we obtained these final scores, we were able to examine how Edmonton and Brandon compared directly with each other through a sensitivity analysis. To define our sensitivity triangle, we grouped our eight criteria into three categories based on characteristics. We grouped the proximity characteristics together under Market Factors, as they deal with supply, demand, and competition. We grouped labour availability and union strength together into Human Resources. Lastly, we grouped business incentives, environment, and cost of land together under Location Factors. The weights of each individual criterion were aggregated into a group weighting.

By varying the weights of these three "super-criteria", we were able to able to define the sensitivity triangle shown below. In a graphical representation it shows the range of weights under which one candidate site is preferred over the other.



The result of this analysis is that Edmonton is preferred to Brandon for sets of weights that are heavily focussed on the Human Resources and Location super-criteria. Brandon is preferred only when approximately eighty percent of the total weight is on the Market criteria.

Conclusion

Our perception of the location decision does not explain why Maple Leaf Foods selected Brandon over Edmonton as the site of their new hog processing super-plant. Our analysis suggests that the optimal location for a processing plant in the prairies would be in Red Deer, Alberta. The city of Edmonton was ranked second. This end result suggests to us that the decision-makers at Maple Leaf had a different perception of the relevant importance of the criteria, or perhaps they used a completely different set of factors in judging the suitability of particular locations.

References

Alberta. Alberta Economic Development. Facts on Alberta. Alberta: Alberta Economic Development.

Golden, B.L., Wasil, E.A, and P.T. Parker (Eds.). The Analytic Hierarchy Process. Heidelburg: Springer-Verlag Berlin, 1989.

Sheremata, Davis. "A Pig-Ugly Labour Dispute." Alberta Report 25 August 1997: 15-16.

Statistics Canada. 1996 Census of Agriculture.

The Canadian Press. "Lethbridge Hog Plant Gets Gov't Go-Ahead." Internet Publication: http://

www.southam.com/edmontonjournal/news/alberta/111397ab10.html 13 November 1997

Thomas, Don, & Johnsrude, Larry. "Strikers Feel Betrayed as Maple Leaf Decides to Build New Plant in Brandon." Internet Publication: http: //www.southam.com/edmontonjournal/news/alberta/111397ab10.html 3 December 1997.

Ziegler, Rod. "City Pushes Gainers Site As Alternative To Lethbridge." The Edmonton Journal 24 March 1998, E1.

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All authors contributed equally to this project.

VALUE OF GOODS TRANSPORTED BY TRUCK IN ONTARIO

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Introduction

In the past, transportation planners have not fully developed planning tools specifically to assess the intercity movement of goods. However a wide range of data has been collected and associated analytical tools developed to address priority setting and infrastructure demands of the auto and transit modes. Realizing this deficiency, the Ministry of Transportation of Ontario (MTO) completed a survey of commercial vehicles and created a truck model to address this problem.

There are many benefits derived from creating a truck model based on origin-destination survey data. This paper discusses the model development process and presents a broad selection of the results.

Truck Model

The 1995 Commercial Vehicle Survey (CVS) involved interviews of 32,000 truck drivers collected at 68 roadside locations capturing inter-city characteristics on the vehicle, driver, carrier, commodity and detailed trip information. This wealth of data has warranted the development of a truck model. The models greatest benefit is the ability to read survey point data from the 68 survey locations and generate a province wide simulation for the 5,000 highway links. The inherent graphical strengths and computing power are ideal in presenting layers of geographical based data not otherwise available from a flat database file.

Most planning reports state that commercial vehicle data sources are limited. The primary complaint is that origin and destination (O/D) data

* The views expressed are those of the author and not necessarily those of the ministry

is rarely available or that when it exists its statistical reliability and compatibility with other sources are in question. A freight model provides a platform upon which to maximize the available data, linking relational data sources e.g. routing, travel distance and value of commodities. The O/D data collected provides statistically accurate measurements of international and inter-provincial border crossings, regional and inter-city trucking activities.

In the data expansion stages it is also imperative to eliminate survey bias associated with double counting at each survey location. This methodology is documented in the paper titled "An Experience in Modelling Commercial Vehicle Surveys". The transportation model developed using EMME/2 software became an integral component into the data expansion process. Within the EMME/2 environment, modelling of transportation systems takes place using a highway network and O/D data. The O/D trips from the matrix are assigned to highway links, optimizing the route choice based on a set of predefined parameters. Unlike most modelling exercises taking upwards of three months, this model was operational in only three days. This was accomplished by using simple digitized link files previous used for display purposes for the provincial traffic count data. The inventory of count data for the entire highway system was then installed into the model, adding information on: design, link classification codes and auto volumes.

In an effort to maximize the utility of the CVS data in the model and permit future data linkages, considerable effort was undertaken to expand the survey data to represent the truck population. The first goal of the expansion process was to be able to replicate the daily truck volumes at each survey site within the model. Once this was achieved, additional goals were set. Given the importance of trade to the Ontario economy and resulting trucking activity, matching flows through border crossings became the next benchmark for success. This was also achieved.

Within the model, the value of each kilogram of commodlity can be associated to each truckload with freight. This data was calculated from Statistics Canada and US Commodity Flow data and expressed as a value per kilogram. Thus, the model becomes an economic analysis tool capable of generating transportation costs and economic relationships at the corridor and link levels.

The model is also a useful tool to measure any deficiencies in the simulation at the detailed highway link level. This was completed by adding as a background layer the annual average daily traffic (AADT) truck volumes and measuring the differences. In these tests I identified deficiencies in simulating local short distance travel. However, this was not a surprise given that the survey was designed to capture inter-city movements. This test did provide a measure of the significance of these trips and may aid in planning the proposed 1999 CVS.

Generally, most truck surveys are limited by, sample size, duration of surveying, geographical density of data collection and site selection. These limitations were addressed and subsequently overcome, to the extent possible, early in the planning stages.

In most modelling applications, exhaustive and detailed calibration is required in order to resemble the survey flows. Rarely is there significant confidence that the exact routing is matched in the model. There are two requirements for matching actual survey flows. First, the person making the trip must accurately describe the route and the surveyor, transcribe these details. Second, there must exist a method to represent these legs in the model. In most modelling exercises Select-Link analysis would be conducted to achieve this result.

This model reached the required high level of simulation early in the calibration process without a lengthy process. To some degree, the statistically valid survey sampling methodology played a role. Only limited calibration was required to compensate for the loss of cross border activity. This adjustment was anticipated in that the majority of the surveys were conducted at Ontario's Truck Inspection Stations (TIS) which are generally located between urban nodes not directly at the customs staging areas. As a result, trip interactions between United States centres and Canadian border cities are not captured. The Windsor and Sarnia TIS's are typical sites where both are located to the east of the cities. Thus, any trip activity or mode change conducted between the border and the TIS is not captured. As a result, Canada Customs and bridge authority counts were used to re-calibrate the lost trips.

Another technique to accurately simulate long distance travel to/from external points was applied to both the network and trip matrix. This

involves identifying the border crossing rather than the external zone. This method is very effective in accurately reflecting the actual trip route rather than simply allowing the model to determine the optimal but perhaps wrong route choice and border crossing.

In the future, the model will be expanded to include the travel demand and value of goods for the rail, pipeline, marine, air and auto modes. Thus, this may become a true multi-modal model revealing volumes and level of service deficiencies for all modal links for today and future years.

Value of Commodities

For planning purposes, the importance of value of goods data can not be overstated, specifically for capital planning and maintenance priority setting. Many travel characteristics are directly correlated to the value of the commodity in transport. Strong parallels exist between: value, trip distance, level of utilization, commodity and origin-destination pairs.

Generally, all survey records in the CVS were associated with a commodity for loaded trucks and empty trucks. To achieve this for empty trucks, additional steps were necessary since the commodity was not know. This was completed using available database information for loaded trucks. Commodity frequency distribution tables were produced based on carrier name, vehicle configuration and body style. These simular attribute were associated to empty trucks and a commodity sector association was achieved.

Commodities in the CVS were initially coded to the Harmonized System Commodity Codes (99 codes) but for forecasting reduced to the nine industrial output sectors.

In the 1995 survey, the value of the commodity on-board was not captured at the time of survey. In previous surveys, the waybills were photocopied and the information processed at a latter date but not imputed for the entire database. This process was not followed for a number of reasons: electricity and photocopiers were not available at all sites; attempts were made to limit the inconvenience to the drivers and improve the safety to the surveyors while reducing their level of fatigue. However, in order to gain this desirable information, an alternative approach was

necessary.

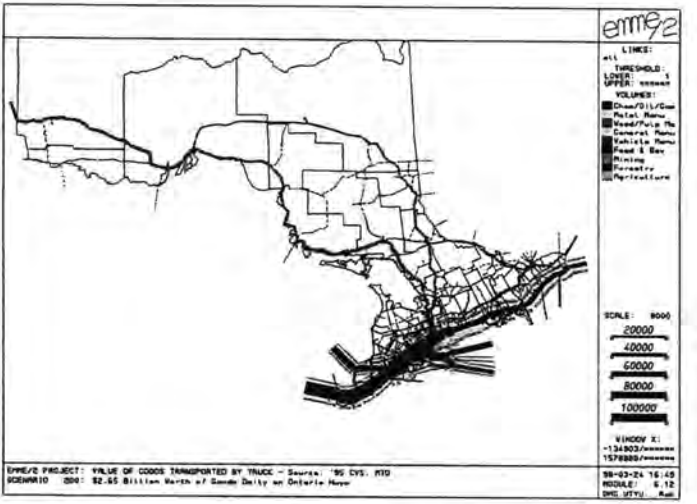
Unfortunately, few sources exist with broad trip data on intra-provincial flows. Those that exists includes the Transport Canada TOD survey, it contains trip origin-destination data on trips greater than 25 kilometres and limited to for-hire carriers with excess of $1.0 million in revenues. An alterative source is the Canada Customs data, containing significant data on commodities flowing across the international borders. This data is published by Statistics Canada in the report "Export Merchandise Trade". Published import data was not as beneficial for my purposes since it contained only the value for specific commodities and no units of measurement to derive the value per kilogram.

Goods involved in export are generally of higher value than average domestic goods; thus, some degree of caution must be exercised in using Import/Export data. Checking this assumption, a comparison of the values expressed in the US Domestic Commodity Flow Survey (CFS) was completed. Differences in the two sources were identified (aside from and US $ and metric conversion) and a blending of the two was applied to the CVS. In general, the CFS values were greater than those published by Statistics Canada. As can be expected, this trend was also observed with the Statistics Canada Import/Export data. These differences were primarily attributed to customs clearance factors. Perhaps in some cases the values are escalated to reflect insured value for goods not subject to duty, while lower values may be declared to lessen duty fees.

Travel demand in Ontario is not purely a function of internal production and consumption, external traffic contributes to infrastructure expansion and maintenance needs. With the model, O/D assigned to the highway network identifies the travel demand between cities. The combined impact of all O/D pairs identifies corridor demand and global route choice. From the model, the economic importance of corridors can be measured by: movements, specific commodities, values of commodity, commodity weights and trade composition., or truck utilization levels, we start to derive economic measures. Taking this to the next step, adding the per kilogram commodity value of goods per truck load, we are able to identify the actual value of goods travelling in specific corridors. This may assist in determining the importance of corridors in support of the Provincial economy. Leaping even further, we can calculate and display

cost ratio related to all travel on a link by link basis and identify costs associated with congestion or time lost due to accidents.

The following plot display the results of linking the value for each kilogram of commodity to the O/D data within the model:

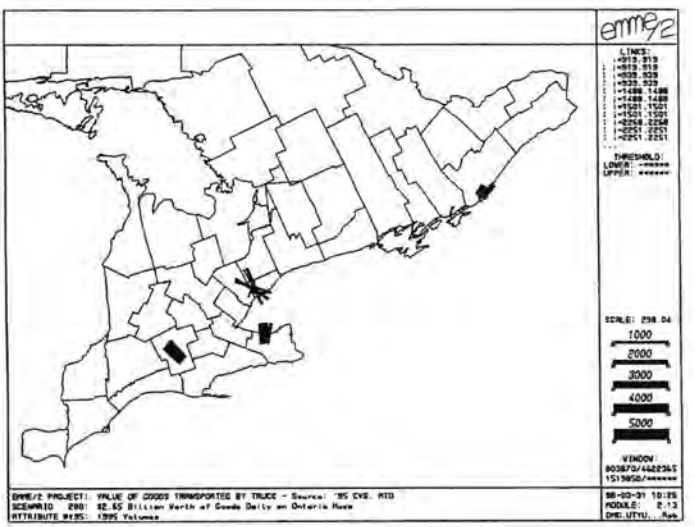


Although difficult to identify at this scale, the commodity values, a reflection of trips associated with each commodity, are displayed with band width signifying the magnitude of the volume. The values are attached to each of the 5000 directional highway links forming the provincial network. This graphical display illustrates the complexities of load logistics as shown by any uneven directional flows. Trips involved in vehicle manufacturing have mirror image reverse directional flows, indicating their ease in findings back hauls and reinforcing the trade relationships with the USA. As shown here, a picture is worth a thousand words. The amount of information displayed could not possibly be presented in a meaningful table format.

The simulation of trip data, commodity weight or a combination of many variables can be installed into the model and presented in simular form. Trip data indicates that the majority of travel takes place in the southern

Ontario, in this area, trade with the USA is constricted to ten border crossings all of which are toll bridges or tunnels accessed from three highways, (Highways, 401, QEW, 402).

This information not only defines the primary corridors but also provides detailed insight into the corridor functions as it relates to industrial commodity usage. The link with the highest value of all commodities is located on Highway 401 on the west side of Toronto, between Pearson International Airport and Highway 427. Realizing that the model network consists of only 49 zones in Ontario and does not contain municipal roads, this must be considered an approximate location. The value of commodities carried on this link is $560 million per day. General manufacturing goods represent 46% of the total value with $238 million per day, vehicle manufacturing $142 million, metal manufacturing $78 million and food manufacturing $40 million. The remaining five sectors represent $62 million or 11% .

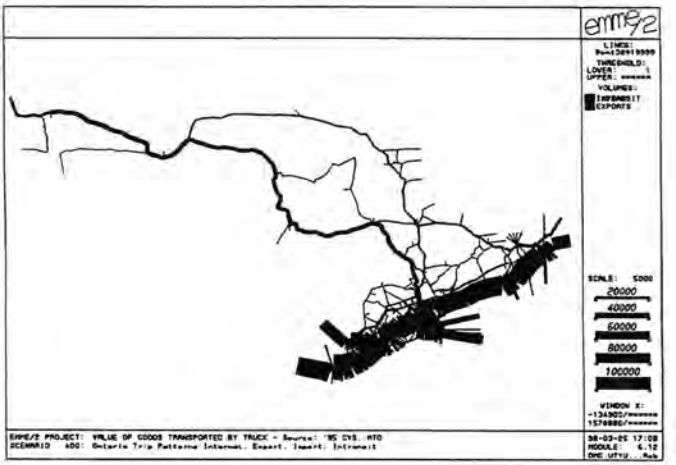


Examining the highest value on a link by sector, it is interesting to note that this same link holds the highest value reported, for six of the nine sectors including: agriculture, food, general manufacturing, wood, metal and chemical. The highest value of forestry goods is reported on Highway 401 at Gananoque worth $1 million per day, vehicle manufacturing goods on Highway 401 at Ingersoll worth $96 million and mining goods on the QEW at Grimsby worth $.9 million.

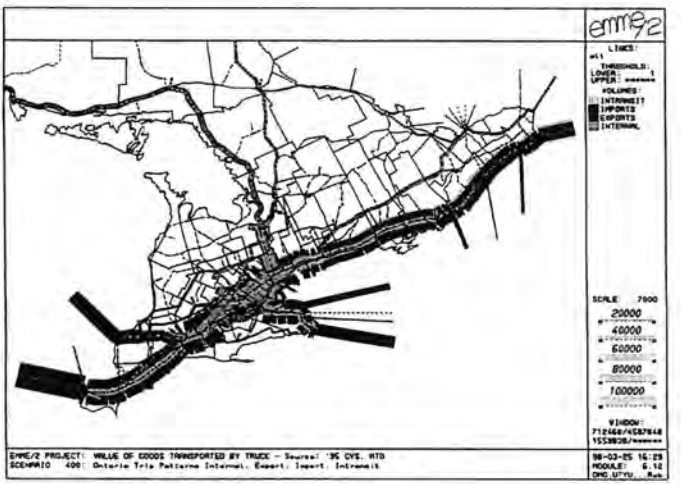
The border crossings are also included, shown as long links protruding from the provincial boundary. The significance of each crossing is clearly obvious and the goods involved in the trade are also included. The benefit of the model becomes even more apparent when we stop to consider what information would be missing if the model was not used. Picture this plot with information for only the 68 survey locations displayed. All the information between stations would be absent and one could only estimate how the composition of the flow would change from link to link.

Since Statistics Canada Import\Export trade data is not published with O/D data, the impact of this trade on Ontario's highways is not easily identified. With this valuable data source by itself we do not have clear understanding of the inter-city trade relationships and activity except for at the border itself. Alternatively, linking this data to the CVS and model we are able to strengthen gaps in the CVS. In addition, we are then able to identify how this vast amount of trade is distributed throughout the province. This work was carried out linking the Import/Export data to impute the value of goods and calibrated to the bridge crossing count data. Considerable confidence in both the trip pattern, values and the volume of trade were achieved. We are able to not only address highway infrastructure demands but also address nodal economic development patterns. By adding a forecasting module, future demand becomes a known variable and we are able to plan for the increased growth.

Specific border movements or trade relationships can also be modelled, as shown in the example below. Here, only exports and import movements are shown. The highway 401 corridor obviously the backbone serving carriers engaged in trade.



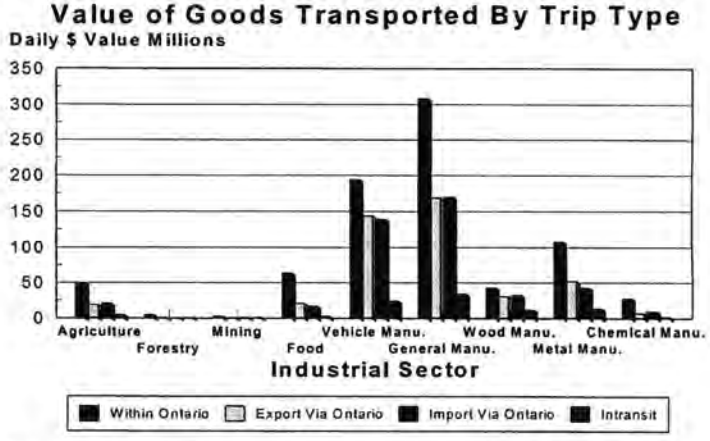
Examining the composition of trips engaged in intransit, imports, exports and internal activities, the function of certain highways become unmistakable, as shown in the plot below:



Here, we see that the GTA is the hub of internal movements and that the majority of freight travel takes place in the Highway 401 and QEW corridors but there is still a widespread use of other highways. The dispersion of internal traffic flows fairly evenly from the GTA in all four directions. This travel differs from imports and exports where we see very high usage of only the Highway 401 and QEW corridors in and east-west and southern directional flow. It appears that Highway 400 carries predominately internal traffic.

The modelling environment is very flexible, in that any database variable can be added. For example, a third dimension could be added to the plot above, relating trip type and commodity sector. By graphically displaying layers of relational information, relationships develop that may otherwise go unnoticed if we only had a survey database to rely on.

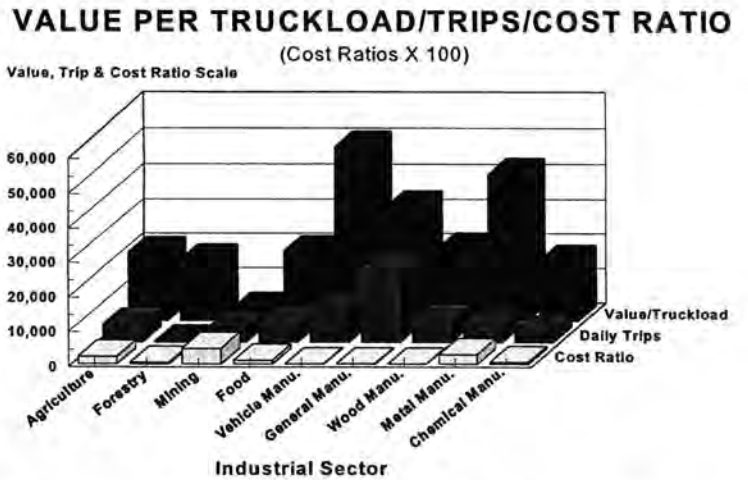
By trip type, commodity values of internal trips within Ontario represent 45% of the value of all movements using Ontario highways and 62% of the trips, on average worth $22,017 per truckload. In contrast, intransit trips represent 6% of value and 3% of trips at $50,640 per truckload.



Values of imports and exports are fairly balanced with 24% and 25% respectively. However, in terms of trips, imports represent a greater share of the total with 18% and exports 17%. This trend is supported by the fact that the export truckload value is $45,515 and imports at $40,588.

Transportation Costs A Measurement of Truck Trip Activity

The average value of goods per truckload travelling on Ontario's highway system is $30,599. By commodity sector this varies widely between $3,779 for mining to a high of $53,067 for vehicle manufacturing goods. Trip activity is greatest in the manufacturing goods sectors, with general manufacturing and vehicle manufacturing representing 50% of all trip activity and averaging $39,502 per truckload.



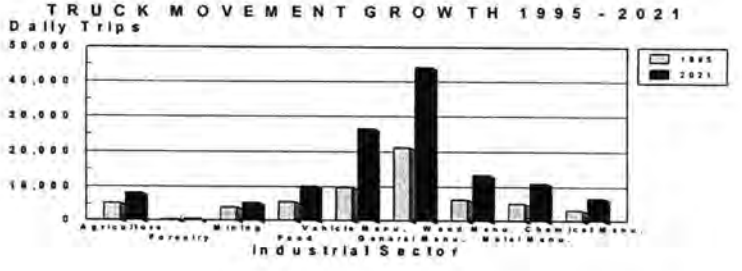
The relative difference between the market value of goods and the transportation costs, is the cost ratio. The information related to cost ratios was obtained from the document titled "Transportation - Economic Linkages in Ontario", prepared by Econometric Research Limited in 1997. The transportation costs associated with vehicle manufacturing goods is a low 2.1% of producers price. While, the cost of transportation for mining goods is high representing 45.5% of the producers price. The most significant effect on cost ratio is the value of the goods transported. However, to a lesser degree, the added cost of purchasing specialized equipment to transport the goods also plays a role. Thus, truck body style also becomes a good indicator of the highway travel demand and trip pattern. This is confirmed by the fact that the majority of long distance travel takes place by five axle van style truck configurations.

Cost ratios are very important in planning as this is a good measure of the sensitivity to mode choice and travel characteristics. Products with higher cost ratios travel shorter distances by truck and rarely cross provincial and international boundaries. If these goods do travel long distances, as in the case of produce, the mode choice has more to do with the delicate nature of the product or logistics and these costs are passed on to the consumer.

One might question why low cost construction goods are transported by truck since half their cost is associated with transportation costs. To answer this we might step back in time to review modal shifts. In the railway age the railroads provided the first access and promoted development while roads served a local function. Today the roles have changed. Roads provide the first access to new urbanization and if required, rail spur lines may be added later. The goods related to construction must be transported to the site by truck regardless of the cost. If we examine the hierarchy of travel, ultimately all goods transported by marine, rail and air at some point in the manufacturing cycle will depend on the trucking mode. For some goods, from start to finished product, the truck mode dominates, for others the truck mode provides only the final local transportation needs, but almost all will rely on trucking at some

Forecasting Capability

Forecasting capabilities to the year 2021 were added to the model, using industrial sector output projections based on The Conference Board of Canada projections and measures of elasticity. These forecasts were developed by Hickling Lewis Brod Inc. and are published in the report "Economic and Highway Transportation Scenario Outlook Model for the Province of Ontario: Methodology, Scenarios, and Planning Tool".



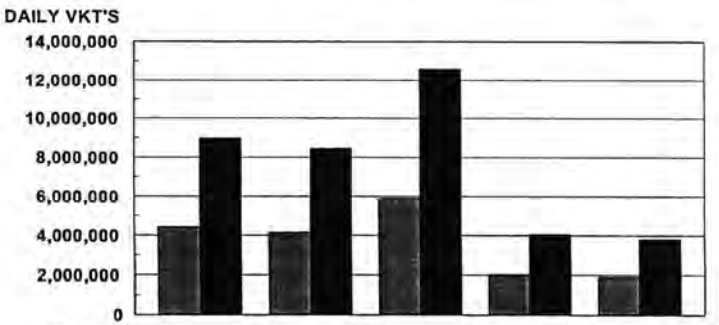
Economic Importance of the Trucking Industry

Examining the economic importance of the trucking industry in Ontario, $2.65 billion worth of goods move daily travelling 18.4 million vehicle kilometres (vkt) on provincial highways. By the year 2021, daily truck vkt's are projected to increase by 106% to 37.9 million.

The greatest travel occurs in Southwestern region, the area bounded by Windsor/Sarnia extending east to the Greater Toronto Area (GTA) and north to Georgian Bay. This area will also experience the greatest growth by year 2021 at 113%. The highways in this corridor connect the GTA with gateways to the USA at Sarnia and Windsor. The lowest present travel activity occurs in Northwestern region and is also expected to grow at the slowest rate at 99%. This is the largest geographical area of Ontario but also the least developed.

Travel growth for the year 2021 by region ranges between 99% and 113%, it is clear that minute shifts in regional growth are taking place over this time period. This in itself is a measure of the unique commodity sector travel characteristics that exist within each region.

ONTARIO DAILY COMMERCIAL VKT GROWTH 1995 - 2021

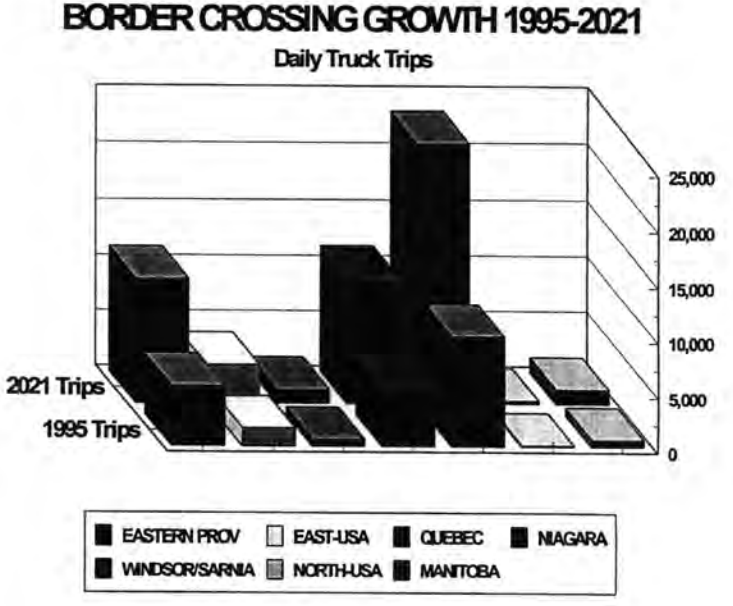


GROWTH	EASTERN	CENTRAL	SOUTHWESTERN	NORTHERN	NORTHWESTERN
1995	4,412,225	4,140,025	5,907,650	2,029,035	1,911,113
2021	8,965,641	8,445,651	12,583,295	4,058,070	3,803,115

Border Crossing Travel

Ontario is situated in the middle of Canada, annually representing $216 billion of Canada's $551 billion GDP (1986 $) for a Ontario share of 39%. Model results indicate trade carried by truck equals $390 billion per year with exports representing 50.5% or worth $197 billion and imports 49.5% or $193 billion.

Based on the model forecasts for year 2021, the export share will increase at a higher rate than imports, representing a 52% share of the total. The total value increases to $843 billion, a 116% increase. Exports are worth $439 billion (1998 $'s) and imports worth $403. The average truckload value for exports increases from $46,560 to $48,632. While the average truckload value for imports decreases from $42,048 to $41,278. The trip distribution varies by border crossing as does the growth by border crossing between 1995 and 2026, as indicated below.



Conclusions

The model has become an invaluable tool in meeting our planning needs and is assisting us to streamline future survey needs. Many benefits have been derived in ways not originally envisioned, with new applications in development.

In our goal to provide better transportation systems for today and in the future this information may help us address the user requirements and be more responsive to their needs.

Understanding the composition of traffic on specific highway sections has contributed to the introduction of several safety initiatives and has already resulted in modifications to vehicle monitoring programs. The trade composition may also assist us in negotiating weights and dimensions agreements between other provinces and the United States

The methodology applied to derive the value of goods to each kilogram of commodity in transport has been a success. The results generated at the highway and corridor levels have brought a new meaning to the term added value. This unit of measurement has gained some interest and turned a few heads, thus achieving the desired effect.

References

Tardif, R.J. 1997. "An Experience in Modelling Commercial Vehicle Surveys"

Econometric Research Limited, 1997. "Transportation - Economic Linkages In Ontario"

Hickling Lewis Brod Inc. 1997. "Economic and Highway Transportation Scenario Outlook model for the province of Ontario: Methodology, Scenarios, and Planning Tool"

Statistics Canada, Exports & Import Merchandise Trade 1995, Catalogue no. 65-202-XPB and 65-203-XPB

United States Department of Transportation, Commodity Flow Survey Program

Technical Change in Capital and Energy Conservation in the Canadian Trucking Industry : An Empirical Analysis of an Experiment

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École nationale d'administration publique, Université du Québec

1. Introduction

Freight transportation firms must become more and more efficient as rates are presently determined, for a given service quality level, in a competitive regime by the least costly producer, whatever be the mode. For instance, if trucking firms do not follow the strategy adopted by the lowest marginal cost producer in their respective market segment, not only they will slowly drive themselves out of their industry, but the latter will also shrink relatively to the other components of the freight transportation substitutes such as railways and water transportation. Various ways exist to improve economic performance in trucking firms as in every industry. Among the most important actions taken, firms can change or enhance their production function and diversify their portfolio of clients. Our own interest in the following empirical study is to focus on two particular elements of the production function which are important in increasing the overall efficiency of any trucking firm, the capital good (tractor) and the fuel consumed by each unit.

The starting point of the research is a data bank coming from a control experiment that took place in Manitoba from 1988 to 1995. Data were obtained from this technical contest, known as the **Pro-Trucker Challenge**, for the last six years, namely 1990 to 1995. Data collected from the participants over the period are generally similar so that very few discrepancies were detected when editing files.

This paper outlines, first of all, the actual empirical results obtained by various researchers when explaining the performance and the growth of the trucking industry over the last twenty-five years and then presents some preliminary results coming from the estimation of an incomplete production function. It is organized as follows : In section 2, a brief review of empirical research on the growth of technical progress and of multifactor productivity in the trucking industry is described. Section 3 discusses the results that come from estimations of an incomplete production function for 1990-1995. The first step consists of estimating an aggregate model that considers the technical progress and reduction in fuel consumption as a whole in the trucking industry. Then the data set is subdivided into three categories to take

account of the different ways trucking firms served their customers. The combination of time-series and cross-section components gives estimates on the cumulative effect of technical change over the period because new vintage tractors are regularly added and because energy efficiency is improving as time goes on. Concluding remarks are in section 4.

2. A Review of the Economic Literature

There are two fundamental approaches of total factor productivity measurement in the academic literature[1] : the index number approach and the measurement of technical change by estimating a production or a cost function. The first is a *nonparametric* measure since it is directly constructed from data, generally at the firm level, and the second approach is referred to as a *parametric* measure because a shift parameter has to be included in functional form chosen. Two types of instrument are currently used, a time trend or time dummy variables representing state of technology and a firm dummy or firm-specific time trend variables.

The index number measures of productivity are based on the construction of price and quantity indices for each of the inputs and also for the output. The end result of the index number approaches is considered as a « gross » measure of productivity since it does not distinguish among various sources of productivity growth. Observed gains in productivity are contained in the growth of the index that translates the total factor productivity occurring in the industry over time.

The second approach consists of estimation of a specific functional relationship from the data set. If a production function is selected, productivity is defined as a *shift* upward of the function form over time whereas for a cost function, the observed *shift* must be downward over time. Empirical studies attempt to isolate productivity gains which reflect the advance in technical abilities from productivity gains due to exploiting existing knowledge. In other words, the statistical technique estimates the contribution of technical change by including a time trend or a time dummy variables that measure the shift, namely the change in the industry's efficiency over time. This particular source of productivity growth is naturally one of the various elements that are included in the multifactor productivity index of the first approach.

We conclude these preliminary remarks by discussing causes of productivity change that are specific to the trucking industry[2]. First of all, trucking shares with railways and water transportation the fact that output, defined as tonne-kilometre, is almost entirely an intermediate good, and so changes in its quality do not directly affect aggregate output and productivity. For instance, as more and more trucking firms are constrained by just-in-time schedules, cost-savings on inventories are enjoyed by forward producers as users of that

specific capital good. They therefore take credit from changes in the quality of output that increases their own total factor productivity. On the inputs side, total factor productivity comes from improvements in truck performance and durability, in cost-saving innovations in energy efficiency, in maintenance costs of equipments and in labour productivity. Except the contribution of the labour force, the sources of productivity growth are achieved outside by the manufacturing firms that produce transportation equipment. They have to be credited for them. In other words, the attributes of a truck such as the horsepower, the physical dimensions, the transmission drive and the number of gears have to be considered when analysing the performance of the trucking industry, but the increase in productivity has to be imputed to their producers and not to their direct owners. Finally, an intensive use of owner-operators by trucking firms that causes a shift in output relative to employment and that is interpreted as an increase in productivity is spurious.

Index Number Approach

The first empirical study on the measurement of the total factor productivity in the trucking industry is done by Gordon for the National Bureau of Economic Research. His assessment of the performance is from 1948 to 1987. The level of analysis is not at the firm level, but at a higher level of aggregation, the industry. He uses Törnqvist price and quantity indices for inputs and output and he divises his analysis in four distinct periods. He concludes that the growth of multifactor productivity in the American industry slows down from a rate of 2.06 % per year for 1967-1978 to an annual rate of 0.82 % for the last period, 1978-1988.

Transport Canada[3] has recently produced a unpublished similar research with the index number approach for 1981-1996. Most of the data are derived at the level of individual firm from two Statistics Canada's surveys, For-Hire Trucking Commodity Origin-Destination (TOD) and Motor Carrier Freight (MCF). Törnqvist quantity and price indices are used as well for inputs as for output and the base year is 1986 = 100. Their conclusion is a annual rate of growth of 2.01 % for the overall period, although it is increasing during the last two years. As a matter of fact, the computed rate of growth is 2.87 % in 1995 and 5.03 % in 1996.

The Statistical Approach

Only nine studies are found in our review of the empirical research done in the trucking industry that concentrates on the measurement of technical change and total factor productivity over the last twenty-five years. All authors reviewed use a translog cost function, a variety of the so-called flexible functional forms introduced in the early 1970s. Nobody uses a production function. The translog function is very popular because it is easier to estimate and interpret as it is a quadratic function with all the arguments in natural logarithms.

Friedlaender and Wang Chiang[4] are the first to measure the growth of technological change and total factor productivity in the trucking industry. Their paper is important because it is the starting point and that subsequent works are built on it. The general cost function is expressed as C = f (y,w,t,T) where C represents costs, w a vector of input prices, y a vector of output, t a vector of operating characteristics and T represents time. A sample of interregional motor carriers of general commodities for the period 1965-1973 is utilised. The shift in the cost function is caused by the action of four following effects : a factor price effect (w), a characteristic effect (t), an output effect (y) and a residual productivity measured by a time effect (T). Their conclusions are not robust because the estimated coefficients are not statistically different from zero. However, they observe reduction in labour and fuel costs when firms hire owner-operators. Moreover, it is clear that operating characteristics have a direct impact upon costs and a direct impact upon productivity growth. In a nutshell, econometric evidence suggests relatively modest productivity growth, but not on firm ground.

A second work by Friedlaender and Bruce[5] shares the same philosophy. The sample is composed of eighty-five regulated common carriers of general commodities for the years 1974 to 1979. To overcome the difficulties faced by the previous authors, they introduce some changes : a different translog function (a third-order approximation instead of a second-order approximation) is specified and technological variables are also modified to take account of the network of each firm. Their principal finding is that technical change appears to occur primarily through operating characteristics, namely the network, rather than through inputs or output. As the change in the specification of the translog, namely the augmentation effects, does not contribute at all from a statistical point of view, no other writer will use it.

Keeler[6] suggests in a paper that analyses the effects of the imposition of a nationwide 55 mile per hour speed limit the following conclusions : the time trend indicates that the productivity, unexplained by other variables in the translog function, did rise, but the coefficient is not statistically significant. As the 55mph speed limit has a negative and significant impact on costs, the measure can be counterproductive. Faster speeds mean better utilisation rates of the trucks and drivers, but they also imply higher fuel consumption. If the trucks are not engineered to operate at high speed, they lead to higher operating costs as well. In other words, there is a tradeoff between higher speed that increases fuel consumption and its opportunity cost, an increase in factors productivity. A third comment is that the American deregulation could costs to rise if shippers would prefer to take some of the benefits in the form of improved service.

Some years later, two teams of researchers conclude for different samples of carriers and periods that the production structure found in a regulated regime is different from that found in a competitive environment. This finding is

consistent with the hypothesis that certain technologies in the trucking industry have resulted solely from the operating rights restrictions under regulation. With deregulation, firms have adjusted their technologies in both input choice (substitution of owner-operators for their own equipment and labour) and technical attibutes (their levels of average length of haul and the average shipment size). In other words, these authors suggest that regulation affected the degree of substitution possibilities for firms. As this conclusion does not immediately follow from the cost function estimations, inferences about the effect of regulation have to be drawn from simulations. To obtain additional insight into the productiviy growth, McMullen and Stanley[7] and Daughety and Nelson[8] compare the costs that firms experienced under the regulatory regime with those that they would have experienced if they had utilised the technology of a competitive environment with the factor prices and operating characteristics induced by regulation. The comparison reveals that the hypothetical average cost curve would be lower than the average cost curve observed under regulation [9]. McMullen and Stanley get a sample of « other specialised carriers », a group of predominantly truckload carriers, for two precise years, 1977 and 1983, whereas Daughety and Nelson use a sample of common carriers of general commodities for four epochs, 1953-1958, 1968, 1978 and 1982.

We complete the review by analysing the most recent studies of which the results are relevant from a statistical point of view. However, it is worthwhile to point out that data available are completely different from those used by previous transportation analysts. More and more variables are aggregates, in fact averages, extracted from the overall performance of each trucking firm rather than variables coming from individual observations as before. With the deregulation, the quantity and the quality of data on trucking firms have considerably diminished. For instance, the level of output has to be measured by revenue tonne-kilometre, because more disaggregate data from shipments are no longer available. The same procedure has also to be used for many independant variables such as all the operating characteristics that are included in the cost function.

Ying[10] introduces in the translog cost function a dummy variable which takes account of the 1980 deregulation and a time trend variable which serves to control for dynamic effects on the cost function, and typically for unmeasured factors such as technological progress. The data set consists of Class I and II common carriers specialised in relatively small less-than-truckload (LTL) shipments. The sample period is from 1975 to 1984. An examination of the translog estimation results suggests that deregulation has a positive effect on costs in the trucking industry. His simulations indicate that the savings in costs are 22.84 % for the 1980-1984 period. This conclusion holds because an hypothesis test has shown that as a group, all the relevant independant variables are statistically significant, although individually they are not. The cumulative effect of annual reduction in costs induced by deregulation on

productivity increases to 16.5 % in 1984. However, we do believe that his estimated parameters allow a calculation of the marginal effect of deregulation on trucking productivity. It is only an estimate on efficiency gains caused by deregulation, and not an estimate on the level or rate of change of actual productivity.

Ying and Keeler[11] try to surmount some problems faced by Ying in the previous study by improving the relationship linking technological variables and those dummy variables representing respectively the deregulation effect and the productivity effect. The data set used by Ying is extended to include 1985 and two periods are considered, 1975-1983 and 1975-1985. As all previous studies mentioned, statistical tests, in fact F-tests, indicate that all variables are significant at a level better than 0.05, although many of them, taken individually, are not at all statistically significant. As expected, the deregulation effect is decreasing over time as it is shown by the 1975-1985 estimation results. Simulations of the direct effect of deregulation on rates indicate that the size of these rates reductions grows in the 15-20 % range in 1983 and in the 25-35 % range by 1985. Once again, these sizable productivity gains are not all related to actual productivity growth per se, but to the overall flexibility allowed by competitive market forces.

Dionne and Gagné[12] attempt to replicate the measurement of technical change and productivity growth developed in the 80s for the American industry to the Canadian context. They use an incomplete panel data of 358 observations on general freight carriers operating in Québec from 1981 to 1988. Data at the level of individual firm come from two surveys conducted by Statistics Canada, For-Hire Trucking Commodity Origin-Destination (TOD)and Motor Carrier Freight (MCF). As econometric evidence is not robust, we only mention that their annual values of technical change and total factor productivity growth, computed from the estimated coefficients of their three specifications, are unpredictable and very unstable. On the other hand, they conclude that adjusted technical change and adjusted total factor productivity growth decline sharply during the period 1981-1988. For instance, the decline of adjusted technical change is 4.2 % in 1988 and that of adjusted total factor productivity to 4.6 %. Their rationale is that these two percentages are « similar to the aggregate measure of productivity growth for the U.S. trucking industry during the same period » by Gordon !

The last study reviewed is an article published in 1995 by Allen and Liu[13] that indirectely considers technical progress and total factor productivity. Their initial objective is to evaluate the inclusion of a service quality variable into a translog cost function. They also add a time trend variable to capture carriers' technical efficiency. A sample of less-than-truckload carriers is picked up from Motor Carrier Annual Reports for 1985 to 1989. Selected firms are then matched with the annual Distribution surveys for the same period. The time trend is negative and statistically significant for each variant

of their two service quality indices. Although this result is only a by-product in the research, it clearly indicates that the carriers' operating efficiency has improved overtime. It is a pure technological progress effect since deregulation, carriers have continously improved their input utilisation.

General Comments

Table 1 reports the principal conclusions about of technological change and total factor productivity which appeared in the literature over the last 15 years. It can be deduced from reviewing many studies that the index number approach generates results that gets an internal coherence. However, as the nonparametric measure as such is a « gross » measurement of all possible influences, endogenous (for instance, economies of scale) as well as exogenous (for instance, pollution and noise created by carriers) to the industry, it does not matter what the sources of productivity gains are. Concerning the findings obtained by estimating cost flexible functions, it must be pointed out that their conclusions and simulations drawn from estimated parameters are generally based on shaky ground. As a matter of fact, writers are unable to obtain estimated coefficients representing the interactions of the four effects (factor price, characteristics, output and time trend) that cause the cost function to shift downward over time. Their best finding is always that relevant variables are statistically significant as a group, but not individually. When decomposing observed cost changes as Dionne and Gagné did, their computed total factor productivity (TFP) index is generally dubious.

Although some researchers pretend that efficiency gains coming from deregulation are real technical changes and pure productivity growth, it must be plainly stated that they only compute the marginal effect of deregulation on trucking productivity and not the level or rate of change of actual productivity. Only Allen and Liu get estimated parameters which are really linked to technical change. The inclusion of service quality in cost estimation reveals that large carriers have large advantages over small carriers. Therefore, large LTL motor carriers are in a position to enjoy, by adjusting their network to their demand, economies of network size and traffic density[14] and reduce the full price of transportation. This explains the large number of less-than-truckload bankruptcies since deregulation and the increasing domination by a few and high quality carriers. It leaves small regional LTL carriers to serve mostly linear markets and supplement national carriers.

3. Preliminary Results on Technical Change

The data set contains 756 observations on a six year period and the type of body is classified in three categories : single vans, multiple vans such as double vans, rocky mountain doubles and triple vans and the third, others, includes flatbed, specialty and supervisors. For each year, information on drivers, on tractor-trailer units, and performance is available. The incomplete production function used is logarithmic and the dependant variable is the

gross weight in kilograms and independant variables consist of fuel consumption, the elapsed time or the average speed and various combinations of dummy variables taking account of the technological characteristics of the tractor-trailer units. The shift variable is measured by two types of dummy variable, a time trend defined as T = 1 = 1990 ; ... T = 6= 1995 and a year variable defined as t = 0 = 1990 and t =1 = 1991 and... t = 1 = 1995. The time-series is thus composed of a pool of cross-sectionnal data from six years.

The empirical analysis is performed in two steps. In the first, estimates are presented for the overall sample, whatever be the categories. Some estimated coefficients describe how necessary inputs are mixed by carriers to move shipments. Technical progress variables as defined reveal how efficient they become over time to do more with less resources. In the second step, the sample is broken down into three categories of body. The idea of subsets is to observe if technical change is uniformly introduced among categories or if it is more specific to some particular configurations. Disaggregated models, by focusing on more homogeneous observations, can reveal a better understanding of the inderlying forces inducing trucking firms to become more efficient in their input utilisation.

Table 1
Recent Computations and Estimates of Technological Progress and Total Factor Productivity

Authors (date)	Period	Technological Progress %	Total Factor Productivity %
Index Number Approach			
Gordon (1991)	1978-1988	no measure	0.82
Transport Canada (1996)	1981-1996	no measure	2.01
Estimation of a Cost Function			
Friedlaender and Wang Chiang (1983)	1964-1973	Weak	weak
Friedlaender and Bruce (1985)	1974-1979	Positive	no measure
Keeler (1986)	1966-1983	no measure	weak
McMullen and Stanley (1988)	1977-1983	Possible	no measure
Daughety and Nelson (1988)	1953-1958,1968 1978,1982	Possible	no measure
Ying (1990)	1980-1984	High	high
Ying and Keeler (1991)	1975-1983, 1975-1985	Positive Positive	high high
Dionne and Gagné (1992)	1981-1988	Negative	negative
Allen and Liu (1995)	1986-1989	Positive	no measure

Note : no measure means that no measure is calculated.

Findings from the Aggregate Model

Ordinary least squares coefficient estimators of the incomplete production function for all observations are presented in Table 2 for two specifications. All coefficients are generally of the expected signs, though some of them are not statistically significant at the five-percent confidence level as indicated by t-statistics in parentheses near the parameters. Also included are standard measures of goodness of fit. Model 2 is exclusively included to indicate that technological progress, as defined by a time trend, is not statistically significant. Model 1 is considered superior from a statistical point of view. Moreover, it reveals that some technical change occurred in 1994, the year effect being significant. So the interpretation given to this specific model is the following. Only 1994 carriers whose type of body is multiple vans and whose tractors have a Detroit engine equipped with at least 400 h.p. are more efficient than 1990 carriers using single vans whose tractors are fitted with other engine makers (International, Mack, Ford Mercedes, Volvo) having less than 350 h.p.

Table 2
Coefficients of the Aggregate Model

Variables/ models	Model 1		Model 2	
Constant	-0.402	(1.90)*	-0.441	(2.05)
Fuel consumption	0.826	(42.32)	0.825	(41.05)
Time in minutes	0.165	(1.76)*	0.173	(1.82)*
400 h.p. Detroit Engine	0.015	(2.59)	0.015	(2.54)
Multiple Vans	0.022	(3.99)	0.021	(3.96)
Year 1994	0.075	(2.71)	---	---
Time trend	---	---	0.010	(1.80)*
* not significant	R^2_a= 0.717, F =384.2		R^2_a= 0.714, F = 381.1	
	ρ = 0.799, D.W.= 2.35		ρ =0.799, D.W.= 2.35	

Disaggregate Models

The results of each disaggregate model are presented in the following table. As expected, each model reveals that technical characteristics needed to carry goods strongly differ and the disaggregation process is worthwhile.

Let consider the first category, carriers whose tractor-trailer unit is composed of a single van. We begin by two general comments. It must be mentioned that Keeler has written that running a tractor-trailer unit at faster speeds can increase factor productivity if the truck engine allows it. Indeed, time-savings become valuable because the same unit can move more shipments over a given period. The fact that the elapsed time variable and its opposite, speed, are not statistically significant implies that trucking firms have accepted the tradeoff. There are signs, in model 3, that trucking firms become more

efficient by producing more services with either the same amount of resources or less, but it is not statistically perceptible. This is our explication of the fact that the time trend variable, though effectively significant, is not perceived per se as evidence of technical change : the marginal cost of its inclusion is greater than the marginal benefit created by its presence in the equation, as computed by an F-test.

So, model 4 permits to infer that all firms carrying shipments with a tridem or a quad axle trailer and whose tractor is equipped with either at least a 350 h.p. Detroit engine or at least a 400 h.p. Detroit engine are more efficient than the typical 1990 carrier who drives a given tractor with a tandem axle trailer whose engine has less than 350 h.p., made by a given group of makers, and whose standard transmission has such attributes as a direct drive and less than ten gears. However, among carriers who get all those characteristics, those whose transmission is Fuller made with an over drive and 13 gears achieve an inferior level of performance because the variable is negative.

In the multiple van category, it is easy to infer that there is no detectable technical progress for 1990-1995 since econometric evidence from models 5 and 6 is clear about it. Only carriers who own 1993 vintage trucks tend to be more efficient than 1990 carriers who have a given number of attributes, being the pivot of the equation. For the overall period, trucking firms whose tractors have a Fuller transmission with an over drive and less than 10 gears are short of the efficiency level attained in 1990. Moreover, carriers who bought 1995 vintage trucks obtain an inferior performance relative to that enjoyed by 1990 vintage truck buyers. Finally, all carriers who were operating in 1991 saw their performance decrease relative to those in business in 1990. In this case, it could be a « recession effect » because the demand for products delivered by multiple vans would have fallen more than those moved by single vans. Finally, the estimated parameters of both fuel and time variables seem to indicate that there exists no additional gain by carriers to drive faster.

Finally, the estimated coefficient of the time trend in the model 8 of the last category, other bodies, lets clearly see the presence of technological change, being statistically different from zero. This shift upward of the production function allows actual carriers to outperform the base year carriers, ceteris paribus. Results from model 8 give the following interpration. Carriers who own either a tridem or a quad axle trailer or a unit with more than five axles and whose overall units (tractor-trailers) also use 24 inch Bridegstone steering and drive tires have a strong tendency to be more efficient than those getting the basic attributes of pivot carriers in 1990, such as 22 inch steering and drive tires produced by other tire makers.

Table 3
Coefficients of Disaggregate Models

Categories Variables	SingleVans		MultipleVans		Other Bodies	
	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	0.091 (1.40)*	0.142 (2.38)	-1.171 (2.04)	-1.130 (1.96)	-2.059 (3.41)	-2.259 (3.79)
Fuel	0.725 (22.40)	0.722 (22.30)	0.824 (16.0)	0.820 (15.77)	0.826 (12.46)	0.838 (12.91)
Time	---- ---	--- ---	0.549 (2.17)	0.545 (2.16)	0.936 (3.47)	0.976 (3.70)
350 h.p.Detroit Engine	0.022 (2.40)	0.023 (2.15)	--- ---	--- ---	--- ---	--- ---
400 h.p.Cat Engine	0.015 (1.92)*	0.015 (1.91)*	--- ---	--- ---	--- ---	--- ---
400 h.p.Detroit Engine	0.016 (1.95)	0.016 (1.97)	--- ---	--- ---	--- ---	--- ---
3-4 axle trailer	0.021 (2.40)	0.021 (2.44)	--- ---	--- ---	0.036 (2.18)	0.032 (2.19)
5+ axle unit	--- ---	--- ---	--- ---	--- ---	0.087 (4.43)	0.077 (3.94)
Fuller Trany od 13gears	-0.016 (2.51)	-0.015 (2.43)	-0.027 (2.25)	-0.026 (2.17)	--- ---	--- ---
24 inch Bridgestone	--- ---	--- ---	--- ---	--- ---	0.039 (1.88)*	0.034 (1.67)*
Truck 93	--- ---	--- ---	0.036 (1.87)*	0.036 (1.87)*	--- ---	--- ---
Truck 95	--- ---	--- ---	-0.015 (3,73)	-0.141 (3.29)	--- ---	--- ---
Year 1991	--- ---	--- ---	-0.046 (1.87)*	-0.059 (1.84)*	--- ---	--- ---
Time trend	0.013 (2.04)	--- ---	--- ---	-0.006 (0.63)*	--- ---	0.030 (2.52)
R^2_a	0.603	0.601	0.620	0.620	0.570	0.586
F	91.22	104.0	48.19	41.72	44.37	40.30
ρ	0.744	0.749	0.561	0.571	0.701	0.718
D.W.	2.38	2.39	2.16	2.17	2.04	2.04

4. Concluding Remarks

The empirical study shows for the period that the aggregate production function, though incomplete, has shifted upward. However, the statistical significance of the estimated coefficient is not at the five-percent level, the usual standard. When dividing the sample into three categories, there is evidence that shifts occurred in two out of three production fonctions, implying that trucking firms produce more with less resources. Once again, estimated parameters are not statistically significant, except for the residual category, other bodies. It has to be noted that Transport Canada study on total factor productivity, a gross measure, reveals an increase of 1.52 % per year for the same period.

On the other hand, the subdivision of the data bank really indicates that carriers outperform, in general, carriers from the base year 1990 when they buy recent vintage tractors and trailers of which productivity has to be credited to their manufacturers. On the energy conservation side, our results are only preliminary and suggestive because of the dilemma when taking account of speed and fuel consumption increase and increase in operating costs, for a steady state level of technology. To give a good answer, marginal benefits received by trucking firms by allowing their units to speed up to obtain additional revenues by carrying additional shipments must be known, what it is not the case. Only marginal costs of faster speeds are presently known. However, it is possible to argue that trucking firms using single vans have may be tried it because the link between fuel consumption and speed is broken for them. That issue, plus the questions of the underlying causes of the changes observed here, must be left to future research.

Notes and References

*This paper is a by-product of a more extensive research funded by Transport Canada. It reflects the views of the author and not necessarily those of Transport Canada.

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[1] Oum, T. H., M.W. Tretheway and W.G.Waters II (1992), « Concepts, methods and purposes of productivity measurement in transportation » *Transportation Research*, vol. 26A, no. 6 November, p. 494.

[2] Gordon, R .J. (1991*), « Productivity in the Transportation Sector » Working paper no. 3815 and Appendix*, National Bureau of Economic Research, Cambridge, Massachusetts, pp. 1-60 and others.

[3] Transport Canada (1996), « Concepts and Methodology. The economic and financial performance of transport industries » *Working paper*, Economic Research, May, pp. 1-22 and tables.

[4] Friedlaender, A.F. and S.J.Wang Chiang (1983), « Productivity Growth in the Regulated Trucking Industry » in T.E. Keeler editor, *Research in Transportation Economics*, vol. 1, JAI Press, Greenwich, Connecticut, pp. 149-184.

[5] Friedlaender, A.F. and S.C.Bruce (1985), « Augmentation effects and technical change in the regulated trucking industry, 1974-1979 » in A.F. Daughety editor, *Analytical Studies in Transport Economics*, Cambridge University Press, Cambridge, pp. 29-64.

[6] Keeler, T.E. (1986), « Public Policy and Productivity in the Trucking Industry : Some Evidence on the Effects of Highway Investments, Deregulation, and the 55 MPH Speed Limit » *American Economic Review*, vol. 76, no. 2 May, pp. 153-158. On the other hand, Gordon suggests that the weak productivity of the trucking industry since 1978 could be imputed to the 55 mph speed limit, if the technology does allow it.

[7] McMullen, B.S. and L.R.Stanley (1998), « The Impact of Deregulation on the Production Structure of the Motor Carrier Industry » *Economic Enquiry*, vol. 26, no. 2 April, pp. 299-316.

[8] Doughety, A.F. and F.D. Nelson (1998), « An Econometric Analysis of Changes in the Cost and the Production Trucking Industry, 1953-1982 » *Review of Economics and Statistics*, vol. 70, February, pp. 67-75.

[9] It must be noted that Friedlaender et Wang Chiang (1983) have previously done this simulation. They have obtained the same result. However, their conclusion was solely suggestive because their econometric evidence was not statistically significant.

[10] Ying, J.S. (1990), « The Inefficiency of Regulating a Competitive Industry : Productivity Gains in Trucking Following Reform » *Review of Statistics and Economics*, vol. 72, no. 2 May, pp. 191-201.

[11] Ying, J.S. and T.E. Keeler (1991), « Pricing in a Deregulated Environment : The Motor Carrier Experience » *Rand Journal of Economics*, vol. 22, no. 2 Summer, pp. 264-273.

[12] Dionne, G. et R. Gagné (1992), « Measuring Technical Change and Productivity Growth with Varying Output Qualities and Incomplete Panel Data » *Working Paper*, Centre de recherche sur les transports, Université de Montréal, January, pp. 1-28.

[13] Allen, W.B. et D. Liu (1995), « Service Quality and Motor Carrier Costs : An Empirical Analysis » *Review of Economics and Statistics*, vol. 75, no. 3 August, pp. 499-510.

[14] Wang Chiang, S.J. and A.F. Friedlaender (1984), « Output Aggregation, Network Effects and the Measurement of Trucking Technology » *Review of Economics and Statistics*, vol. 66, May, pp. 267-276.

KEY INDICATORS AND BEST PRACTICES IN THE NORTH AMERICAN TRUCKING INDUSTRY

by

Jan Bowland
&
Don McKnight

KPMG

This paper summarizes the results of our 1997 KPMG survey of selected North American trucking companies considered to have best practices in the industry. It is the second KPMG survey of trucking industry best practices and updates the results of the initial survey carried out in 1995.[1]

Our overall objective was to assess important trends in the North American trucking industry over the 1994 to 1996 time period. We examined the following trends and practices in the truckload (TL) and less-than-truckload (LTL) sectors in Canada and the U.S.

- Trends in financial performance using key financial ratios.
- Trends in major expense items incurred by trucking companies.
- Use of technology-based information systems (e.g., satellite tracking, EDI).
- Operating and financial policies regarding fleet management and driver compensation.
- Safety and driver training issues.
- Areas of opportunity to decrease costs.
- Impact of future market trends on the trucking industry.

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[1] Bowland, Jan and McKnight, Don, **Best Practices in the North American Trucking Industry,** CTRF 1996 Proceedings.

A. Approach and methodology

Thirty carriers with best practices or those considered leaders in certain aspects of their operations participated in this survey. Our sample included representatives from the TL and LTL sectors in the United States and Canada. Although, the results are not statistically representative of the TL and LTL sectors in Canada and the United States, they are considered to be good indicators of the performance, practices and views of the North American trucking industry.

We collected information using a detailed questionnaire sent to senior representatives of the selected companies. Follow-up discussions were held to clarify or augment the information provided.

It is generally difficult to collect accurate and consistent information in the trucking industry, particularly in Canada. Many companies are privately held, financial statements are closely guarded and there is no uniform methodology for certain accounting practices. Financial information was easier to collect for U.S. carriers due to the information available from the American Trucking Association (ATA) for Class I and Class II motor carriers. During the interviews with carriers, we confirmed the ATA data and explored some areas of expense information in greater detail. In Canada, the motor carriers prepared the necessary data.

The following exhibit presents the average profile for those carriers who participated in the survey.

	Canadian TL	U.S. TL	Canadian LTL	U.S. LTL
Operating revenues ($000's)	80,641	686,526[1]	55,256	1,195,025[1]
% TL[2]	63.3	100.0	26.4	28.0
% LTL	36.7	0.0	73.6	72.0
Fleet size:[3]				
Number of tractors	434	4,065	231	4,521
Number of trailers	1,084	10,041	661	14,181
Number of employees	510	5,430	653	10,235
% unionized	26.8	0.0	34.4	21.3
Number of owner-operators	195	369	70	155
Number of terminals	11	25	14	148

[1] *Converted to Canadian currency using an average 1996 exchange rate of $U.S=$1.36 Cdn.*

[2] *Includes bulk and flat bed transport.*

[3] *Includes owned, leased and owner-operator equipment.*

B. Financial performance

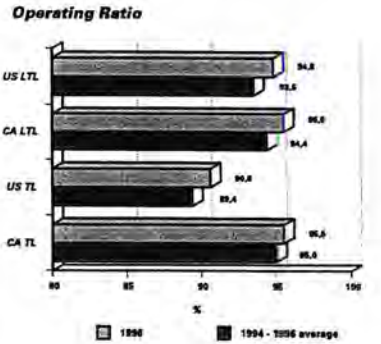
The financial performance of the U.S. TL and LTL carriers surveyed was superior to the performance of the Canadian TL and LTL carriers over the 1994 to 1996 time period. This was a change from the previous survey which demonstrated in terms of operating ratio and return on equity that the Canadian carriers surveyed had outperformed their U.S. counterparts during the 1991 to 1993 time period. This change may partially be explained by some change in the sample of individual carriers who participated in the initial survey versus this second survey.

Most carriers experienced a deterioration in financial performance in 1996. However, all indications are that 1997 will see a significant improvement in financial performance on both sides of the border. This trend is expected to continue in 1998.

The results for key financial ratios for the year 1996 as compared to the average over the 1994 to 1996 time period were as follows.

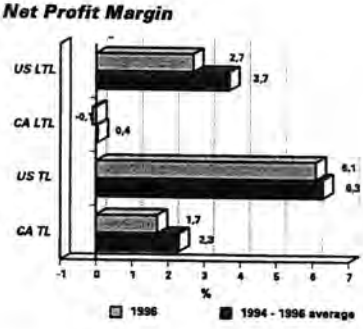
1. Operating ratio

In terms of operating ratio (i.e., expenses excluding interest and taxes divided by gross operating revenues), the U.S. TL and LTL carriers outperformed their respective Canadian counterparts. The overall results for 1996 deteriorated versus the 1994 to 1996 average.



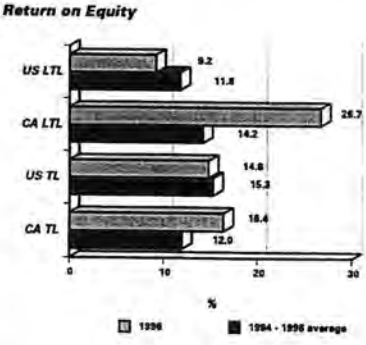
2. Net profit margin

The net profit margin determinations (i.e., net income divided by gross operating revenues) produced similar results. U.S. carriers again outperformed their Canadian counterparts. TL carriers outperformed LTL carriers in both countries. Again performance in 1996 was less than the 3-year average.



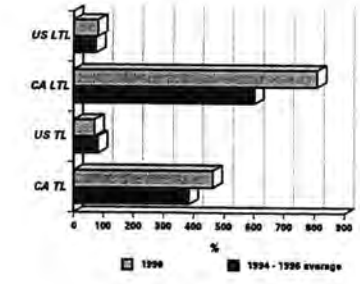
3. Return on equity

When return on equity (i.e., income divided by equity) was measured, U.S. TL carriers outperformed their Canadian counterparts. However, the situation was revised for LTL carriers. The Canadian carriers are highly leveraged which caused return on equity to be very sensitive to net income results.

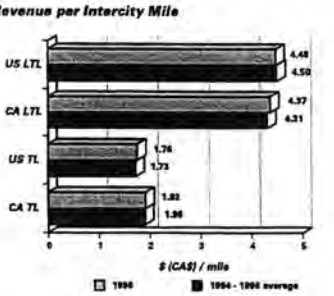


4. Total liabilities to equity

Canadian carriers and in particular Canadian LTL carriers are much more highly leveraged than U.S. carriers. This was also the case in the previous survey.



5. Total revenue per intercity mile

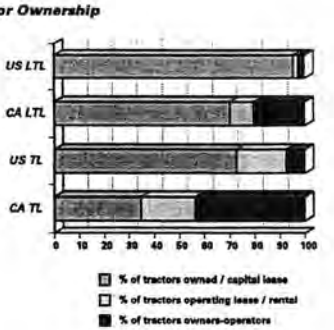


Total company revenue per mile results (all are expressed in Canadian currency) are similar between Canadian and U.S. carriers. LTL carriers generate significantly more revenue per operating mile than do TL carriers on both sides of the border. This is due to the higher rates charged by LTL carriers for the transport of smaller shipments. The similarities between the 1996 and the three-year average results, suggest that rate levels were stagnate over this time period.

C. Operating and financial policies

Some highlights with respect to operating and financial policies employed by the TL and LTL trucking sectors on both the U.S. and Canada are as follows.

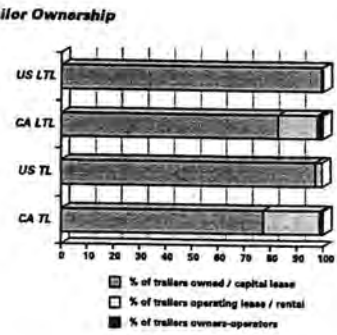
1. Tractor ownership



Canadian carriers and in particular Canadian TL carriers, make much greater use of owner-operators to provide their power needs. Carriers in both countries lease (i.e., operating lease) or rent a greater percentage of their equipment than LTL carriers. TL carriers who generally turn over their tractors faster, make greater use of leases to finance their tractor acquisitions.

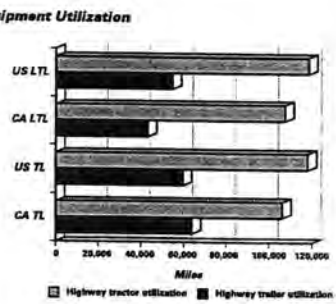
2. Trailer ownership

A much higher percentage of trailers (versus tractors) are owned by carriers on both sides of the border. Canadian carriers make greater use of operating leases and rentals to finance their trailer acquisitions than do their U.S. counterparts. The use of owner-operated trailers is very limited in Canada and practically non-existent in the United States.



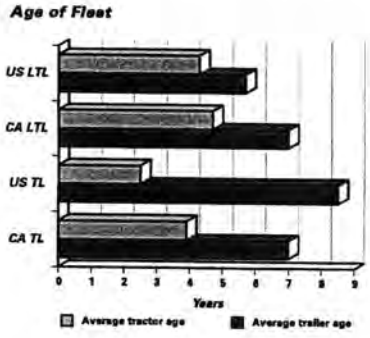
3. Equipment utilization

Equipment utilization is the key measure employed by carriers to measure operating performance. The U.S. TL and LTL carriers surveyed had a higher 1996 utilization rate for their tractors.



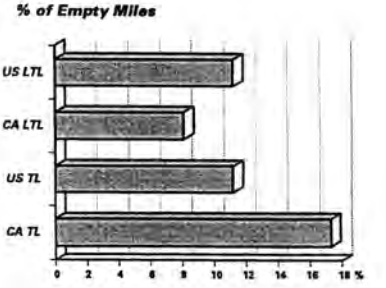
4. Age of fleet

The U.S. carriers surveyed had younger tractor fleets than their respective TL and LTL Canadian carriers. However, in regard to trailer fleets, the situation is reversed comparing Canadian and U.S. TL carriers. TL carriers on both sides of the border have younger tractor fleets than their LTL counterparts.



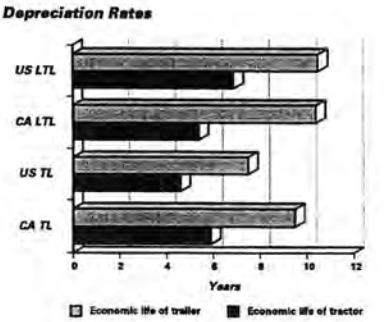
5. % of Empty miles

Canadian TL carriers experienced a significantly higher percentage of empty miles (17.3%) than Canadian LTL carriers and U.S. carriers in 1996. Excluding the results of Canadian bulk carriers who participated in the survey, the percentage for Canadian TL carriers reduces to 9.0%. U.S. TL and LTL carriers had similar empty mile utilization rates of 11.2% in 1996.



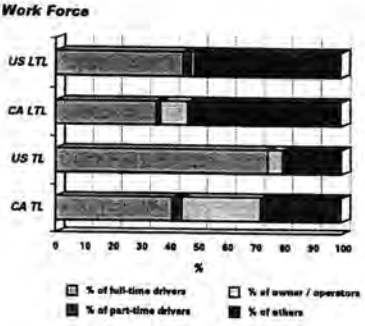
6. Depreciation rates

TL carriers estimate shorter economic lives than do LTL carriers for both tractors and trailers. LTL carriers tend to place older line-haul equipment into local services to extend the useful life of the equipment. U.S. TL carriers estimate a shorter economic life for their tractors and trailers than do Canadian TL carriers. Canadian LTL carriers on the other hand estimate shorter economic lives for tractors and similar economic lives for trailers versus their U.S. counterparts.



7. Work Force

U.S. carriers and in particular U.S. TL carriers, have a greater proportion of full-time drivers than their respective Canadian counterparts. Canadian carriers and in particular Canadian TL carriers, make much greater use of owner-operators. Owner-operators make up 28% of the workforce of the Canadian TL carriers and 10% of the workforce of Canadian LTL carriers. In contrast, the number is 5% for U.S. TL carriers and only 1% for U.S. LTL carriers. LTL carriers as expected have a higher percentage of "others" (e.g., maintenance, terminal and administrative staff).



D. Information systems and technology

All U.S. carriers and a high percentage of the Canadian carriers interviewed use computerized management information systems to manage their operations. The measurement of profitability is a key application of these information systems.

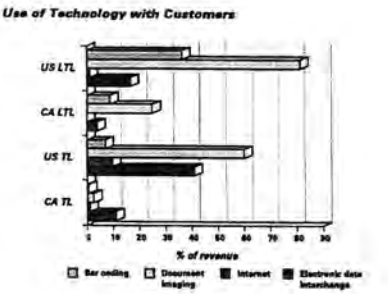
LTL carriers on both sides of the border monitor profitability by a variety of measures. All of the U.S. LTL carriers interviewed measured profitability by customer and 75% of the U.S. carriers measured profitability by traffic lane. Profitability by weight break and by terminal was measured by 50% of the U.S. carriers. The Canadian LTL carriers placed greater emphasis on terminal profitability—all carriers used this measure. Over 70% of the Canadian carriers measured profitability by customer and by weight break. Profitability by traffic lane was monitored by just under 60% of the Canadian carriers.

TL carriers which provide door-to-door services on a truckload basis have less need to measure profitability by weight break and by terminal. All the U.S. TL carriers interviewed measured profitability by traffic lane and by customer. The vast majority of Canadian TL carriers also used these two

measures. Some of the Canadian TL carriers transporting LTL shipments, also measured profitability by terminal and by weight break.

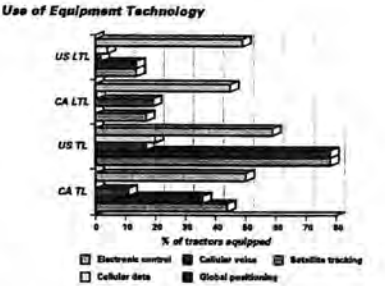
1. Use of technology with customers

Carriers were asked what portion of their customers (as a % of revenue) were interacting with them using electronic commerce. In general, U.S. carriers make greater use of electronic commerce in communication with customers than their Canadian counterparts. U.S. TL carriers make the greatest use of EDI in dealings with customers. Document imaging is used extensively by U.S. carriers, particularly U.S. LTL carriers.



2. Use of equipment technology

Carriers were also asked what portion of their tractor fleet was equipped with various enabling technologies. U.S. TL carriers in general have a greater percentage of their tractors equipped with electronic tracking and communications equipment. TL carriers on both sides of the border have a greater percentage of their tractors equipped with satellite tracking or global positioning systems. LTL carriers which operate line haul operations on fixed schedules between terminals have less need for equipping tractors with tracking technologies.



E. Major expense items

The survey examined the importance of major expense items as a per cent of total operating revenues over the 1994 to 1996 time period for the TL and LTL sectors in both Canada and the United States.

In order to examine the relative importance of major expense items of motor carriers on a comparable basis, a number of factors must be considered—the most important being the extent to which motor carriers employ owner-operators (other factors include the use of operating leases to acquire equipment and the use of purchased transportation services).

For the purposes of comparing major expenses, we decided to remove owner-operator expenses and revenues from the financial results to study the impact on expense ratios. The results are provided below for Canadian carriers which use a much higher proportion of owner-operators than their U.S. counterparts.

Expense ratios of Canadian carriers—1996

	TL		LTL	
	with O/O's	**without O/O's**	**with O/O's**	**without O/O's**
Revenue	100.0	100.0	100.0	100.0
Salaries & benefits	28.3	48.5	46.9	54.5
Owner-operators	29.5	—	10.5	—
Fuel & oil	8.9	14.9	7.8	9.1
Other material & supplies	5.5	9.9	6.4	7.1
Equipment depreciation	5.1	8.2	5.7	6.6
Purchased transportation	7.0	12.6	1.6	1.9
MIS operations	0.6	1.1	1.7	2.0
Total	84.9	95.2	80.6	81.2

Revenues generated by owner-operators were assumed to be 133% of owner-operator expenses for this purpose based on previous work carried out by KPMG.

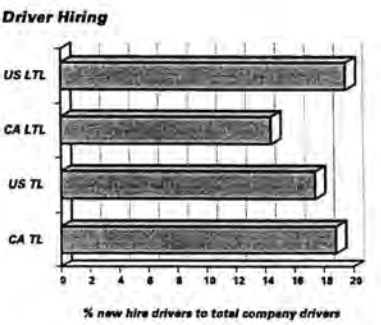
F. Safety and training

This survey examined existing safety practices and driver training in light of increasing public awareness of transportation safety. A very high percentage of drivers are performing pre-trip or post-trip inspections of their equipment. Carriers are also training drivers in areas such as dangerous goods and customer service.

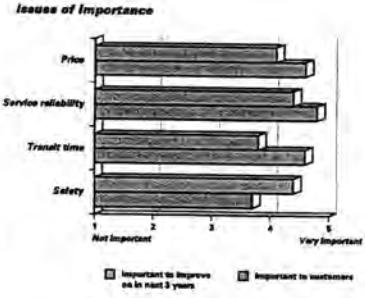
A higher percentage of Canadian carriers receive safety audits from government officials and shipper groups than do their U.S. counterparts. Regarding mandatory facility audits, carriers felt that cost, carrier rating harmonization, audit frequency and the experience of auditors were all important factors to be considered when governments perform facility audits.

1. Driver hiring

Carriers were asked how many new drivers they hire in a year. As a percentage of total company drivers, U.S. LTL and Canadian TL trucking companies had the highest percentages. Although not a direct measure of driver turnover (we did not ask for the number of drivers which left), the percentage of drivers hired could be a relative indicator of driver turnover among the four trucking categories. However, KPMG's experience with driver turnover in the trucking industry is that a much higher percentage (i.e., in the 50% to 100% range) is the norm.



2. Issues of importance



Carriers were asked two separate questions on the issues of safety, transit time, service reliability and price regarding:

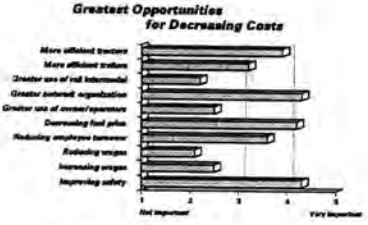
- the importance of these issues to their customers; and
- the need for improvement of these issues in the next three years.

Service reliability was ranked the most important to customers closely followed by transit time and price. With respect to improvements, safety and service reliability were considered the most important.

G. Future outlook

We asked carriers for their opinions on areas providing the greatest opportunities to reduce costs and the market trends which will have the greatest impact on their financial results in the future.

1. Greatest opportunities for decreasing costs



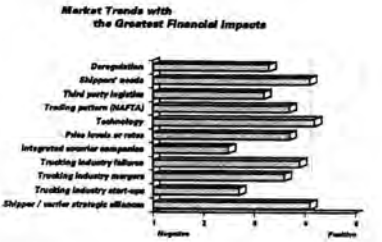
The most important areas which carriers felt would bring the greatest opportunities for reducing costs were the following.

- Improving safety
- Greater network optimization
- Decreasing fuel prices
- More efficient tractors.

It is interesting to note that increasing got a higher score than reducing wages. Carriers want to attract and retain good drivers.

2. Market trends with the greatest financial impacts

Carriers were asked which market trends will have the greatest impact on their future financial results.



The market trends which will have the greatest positive impact are:

- Technology developments.
- Shipper/carrier strategic alliances.
- Shipper needs.

The market trends which had the least positive (i.e., more negative) impact were: integrated courier companies and trucking industry start-ups.

CONFERENCE LEGISLATION - EMERGING DEVELOPMENTS, TRENDS AND A FEW MAJOR ISSUES*

Joseph Monteiro: Competition Bureau, Industry Canada.
Gerald Robertson: Coordination & Management Services, Industry Canada.

I. Introduction

Conference legislation provides an exemption for certain ocean liner shipping practices from the provisions of the *Competition Act*. This exemption is a privilege which most industries in the economy do not enjoy. With deregulation being introduced in most of the regulated sectors, the rationale and the need for continued exemption is being increasingly challenged.

As a result, dissatisfaction with the state of conference legislation is being expressed by a number of agencies. In Canada, the National Transportation Act Review Commission expressed opposition to the intent of the *Shipping Conference Exemption Act* as it runs counter to the general policy of encouraging competition. In addition, the Canadian Shippers' Council is opposed to the philosophy of continuing the exemption. Similarly, in Europe and Japan, Shippers' Councils are strenuously advocating an end to open antitrust exemption enjoyed by liner conferences. Pressures for change are also mounting in the US, as evidenced in numerous attempts for some form of reform through various Bills. The competition agencies too, in Canada, the EU and the US have left little doubt that they prefer that the liner shipping industry, like any other industry, should be subject to competition and not be protected by an outdated and antiquated system of shipping laws.

Everyone seems to agree that some change is necessary. The question is what and how much? In addition, fundamental changes in technology are occurring which are rendering these laws inappropriate, as the circumstances which first gave rise to them are no longer prevalent. The need for change is further accentuated by new forms of organization, new business arrangements and demand for new services.

Facilitating and encouraging the role of market forces by eliminating the exemption could lead to greater competition among ocean liner carriers and ultimately to increased efficiency, lower prices, improved services and perhaps

* The views expressed are those of the authors and are not necessarily those of the Competition Bureau. The authors thank Margaret Sanderson, Jim Innes, Lilla Csorgo and Judith Carrigan for helpful comments or information.

greater international trade.

In this paper, the emerging developments and trends in liner shipping and some of the major issues will be briefly examined. Section 2 briefly reviews the background to conference legislation in Canada, EEC and USA. This is followed by an examination of the two basic rationales for exempting ocean liner shipping from competition laws: the economic (i.e., the need to provide stability of rates and services) and the political (i.e., considerations of international comity) in section 3. Its purpose is to shed some light on why conference legislation developed and what were the justifications used to retain the exemption of conferences from the competition laws.

Section 4 examines the recent developments such as technological change (i.e., containerization, new mega-sized carriers, etc.), new forms of organizations (i.e., superconferences, consortia, etc.), new forms of agreements (i.e., capacity, space chartering, etc.), and new forms of service (i.e., global service, etc.) that have led to some of the emerging legislative developments. Thereafter some of the ensuing issues from this debate such as intermodal rates, service contracts, independent action, tariff filing and antitrust immunity are briefly reviewed. The implications of the above developments for competition policy in the liner trade are briefly examined in the conclusion.

II. Background to Conference Legislation in Canada, EEC and the USA

A. Canada. Canada did not have any specific legislation governing shipping conferences until 1971. After World War I, the Canadian approach to conferences was dominated by the shipping policies in Great Britain. In the early 1920s, three separate inquiries in their reports were strongly critical of shipping conferences. After the 1920's no formal inquiries were made into shipping conferences or ocean freight rates till 1959, nor did the government attempt to legislate the regulation of rates.[1]

In February 1959, the Industrial and Trade Bureau of Greater Québec invited the Helga-Dan, a ship specially fitted for winter navigation, to sail to and from the port of Québec. As the Helga-Dan belonged to a shipping line not a member of the shipping conference it was necessary for the shipper to obtain a release from their exclusive patronage contract with the Eastern Canada-United Kingdom Shipping Conference. The Conference refused to release the shipper despite the fact that it did not provide winter service. This resulted in a complaint being filed with the Director of Investigation and Research and led to an inquiry under the *Combines Investigation Act*. The investigation subsequently resulted in charges by the Director and hearings before the Restrictive Trade Practices Commission (i.e., R.T.P.C.). In 1965, the R.T.P.C. issued its report.

Though the R.T.P.C. determined that the Conference did hinder competition and take advantage of shippers, its main criticism was against exclusive patronage contracts. However, it declined to apply the *Combines Investigation Act* to shipping conferences. It maintained that "Although the member lines lessened competition within the meaning of the Combines Investigation Act, the public interest would not be served by excessive rate competition and instability in the liner trades." The R.T.P.C. also declined to regulate shipping conferences indicating that "governmental regulation of rates in ocean transport would not be feasible or conducive to the welfare of the Canadian public." Based on the rationale and recommendations of the R.T.P.C., the *Shipping Conferences Exemption Act* (i.e. *Act*) was passed in 1970.

Despite the R.T.P.C.'s strong criticism against patronage contracts, the *Act* continued to allow it. Further, the *Act* did not give any regulatory role to the Canadian Transport Commission. Its sole responsibility was to ensure that agreements were properly filed with it. Furthermore, there were no specific provisions designating responsibility for the enforcement of the *Act*. The main penalty for prohibited practices of shipping conferences was that agreements lost their exemption from the *Combines Investigation Act*. Other than the exemptions provided in the *Act*, shipping conferences continued to be subject to the *Combines Investigation Act*. This led to the *Shipping Conferences Exemption Act, 1979*. However, it did not introduce any effective procompetitive measures. The provision to strengthen the position of the shippers through a shipper group, designated to represent shipper interest, was not very effective due to the vagueness of the provision on the meaning of 'information sufficient for the satisfactory conduct of the meeting'. The *1979 Act* further increased the power of the conferences by extending the scope of the exemption between one or more conferences and between conference and non-conference carriers. This led to the *Shipping Conferences Exemption Act, 1987*.

B. EEC. In the early 1900s, Western Europe adopted the United Kingdom's "laissez-faire" approach to conferences. Since then, conferences have had a peaceful existence in Western Europe. In general, conferences were excluded de facto or de jure from the application of competition laws as the European governments tolerated and even favoured them. When European shipowners wanted their governments to protect them from the antitrust laws of the U.S., those governments wanted to know what would be done to protect shippers' interest. In 1963, a note of understanding was signed by the representatives of European liner conferences and shippers, which was considered the right way for taking into account shippers' interest. As a result, the Committee of European National Shipowner's Associations was formed.

Simultaneously, developing countries were largely concerned with discriminatory practices of conferences. This resulted in the adoption of the

Code of Conduct for Liner Conferences by a number of Member States even though the Economic Community was not a party to the Code because of its incompatibility with the competition provisions of the *EC Treaty*. As a compromise, the "Brussels package" was adopted in 1979 by the EC Council of Ministers. It recognized the stabilizing influence of conferences while implicitly establishing the principle of block exemption. As a result, a regulation on the application of competition rules to maritime transport was proposed. In addition, a regulation exempting liner conferences from Articles 85 and 86 of the *Treaty of Rome* was adopted and went into force on July 1, 1987.[2]

The principal regulation concerning the exemption of shipping conference agreements from the application of competition rules is Council *Regulation No. 4056/86 of 22 December 1986 laying down detailed rules for the application of Articles 85 and 86 of the Treaty of Rome* to Maritime Transport. In addition, a number of supplementary regulations on maritime transport were adopted.[3]

C. USA. Before the passage of the 1916 legislation on shipping, the United States Government brought legal suits under the *Sherman Act* against a number of international steamship combines. The House Committee on Merchant Marine and Fisheries under the chairmanship of J. W. Alexander investigated the problem of shipping combinations and published its findings in 1914. Based on these recommendations, Congress decided in 1916 that with federal regulation, the shipping industry could provide public benefits not otherwise available. It feared that, if this industry was precluded from entering into anti-competitive agreements, rate wars would erupt which would result in concentration. Such concentration would make for a more effective monopoly than existed by agreement in a less concentrated environment.

Congress, however, recognized that the conference carriers had abused their power. It believed that it could prevent this industry from abusing its monopolistic power in several ways. First, it prohibited altogether certain particularly anti-competitive or discriminatory practices. Second, it required all carriers to disclose to a federal agency, the Shipping Board, and to the public all multicarrier agreements. Finally, the carriers were required to obtain the agency's approval prior to implementing their agreements. Unapproved agreements were declared unlawful.

The US *Shipping Act, 1916*[4] was largely based on the recommendations of the Alexander report. It recognized certain benefits and shortcomings of the conference system and therefore provided for limited acceptance of the conference system with active government supervision. In 1960, two congressional committees investigated the industry and its regulations and noted the dissatisfaction with the operation of the system.

Congress, however, remained persuaded that the conference system was necessary to avoid rate wars and monopoly. Consequently, the *Shipping Act, 1916* was amended. A number of developments led to the *US Shipping Act of 1984*: dissatisfaction with the regulatory process, uncertainties about the outcome of regulatory decisions, the container revolution and development of intermodal services; and, general dissatisfaction with the existing legislation.

III. Rationale for Exempting Ocean Liner Shipping from Competition

Over the history of conferences, two basic rationales - the economic and the political - have been put forward to provide a justification for the exemption of ocean liner shipping from competition. The economic rationale which has been developed under various theoretical models has been increasingly questioned and its justification for continuing the exemption for ocean liner shipping from competition has been questioned. This rationale is based on the argument that conferences are needed to provide stability of rates and services in an otherwise unstable industry which works to the benefit of users as well as carriers.[5] This rationalization has been advanced under two basic models: 1) The monopoly-cartel model; and, 2) The theory of the core model.

The rationale for the monopoly-cartel theory is based on the presence of cream-skimming and fly-by-night entry by competitors. This leads to excessive entry and unrestrained competition, resulting in instability and destructive competition. This forces carriers to collude and erect barriers which prevent entry.[6] The above rationale and result has been subject to careful scrutiny and the literature generally concludes that in order for instability or destructive competition to occur the industry must exhibit, three major characteristics. One, sunk costs - i.e., costs which cannot be recouped - must represent a large portion of total costs. Two, the industry which is profitable in the short run must be vulnerable to entry of competitors even when it is inefficient from a social point of view. And three, there are extended periods of excess capacity - i.e., production at less than one's lowest cost - when demand falls.[7] In such circumstances, it is possible that firms may be forced to reduce prices to levels that are too low to cover their total costs.

Whether the above characteristics hold has been the subject of extensive discussion. In general, it is argued that liner markets do not exhibit the characteristics of markets that are subject to destructive competition. First, sunk costs do not appear to be a large proportion of total costs, as ships are mobile and firms can move their assets from one shipping route to another.[8] However, it is recognized that in some trades ships have been developed to meet special requirements of users and are therefore less readily transferable than in other routes. Further, some carriers may also have significant investment in port

facilities on particular trade routes some of which may obviously be saleable. Second, regarding inefficient entry, the danger is rather limited as firm level economies of scale on individual trade routes are not extensive. This is suggested by the number of firms with varying capacities which exist on major trades in a Federal Maritime Commission (i.e., FMC report). It indicates that concentration on major routes is typically in the low to moderate range. Third, the purported risks associated with uncertain demand can be addressed through long term contracts between carriers and shippers.[9]

In view of the above, other economic models have been used to provide an alternative justification for the destructive competition argument which has received attention recently. One such model is the "economic theory of the core", this theory implies that in certain kinds of markets, there is no sustainable competitive equilibrium.[10] It has been argued in a paper in 1989 that liner shipping may be an example of such an "empty core" industry.[11]

It has been pointed out that the theory of the empty core is also of questionable relevance as a justification for shipping conferences. The principal paper on which this view of conferences is based has been criticized on technical grounds.[12] More generally, the evidence indicates that in most trade routes, there are a large number of carriers operating at different levels of capacity. This is a condition that is unlikely to prevail if there is an empty core. The existence of the empty core is most probable if an individual firm's capacity in the industry is large relative to the total demand, and if firms are homogeneous in their cost structures. This does not appear to be the situation in the liner industry.

It may also be noted that conferences have not, in practice, provided stability of rates and services. Indeed, in recent times, conference rates have tended to be volatile.[13] In 1990, conference rates were affected by significant increases in surcharges as well as base rates. Evidence of instability of services was provided in a number of submissions to the Industry Advisory Group Relating to the Review of the *Shipping Conferences Exemption Act, 1987* (*SCEA*), which drew attention to the recent withdrawals of conference services from the Atlantic ports despite *SCEA*.

The political rationale is based on the argument that conferences are required by considerations of international comity.[14] Conferences operate on all of Canada's major trading routes with Europe, the United Kingdom, Japan, South-East Asia and South America. Their role has been sanctioned by specific legislation in many jurisdictions. In this context, a desire to ensure compatibility of Canadian maritime policy with our major trading partners appears to have been a consideration in adopting the present exemption for conferences from competition law under *SCEA*.

The argument that conferences should be accepted by Canada for reasons of international comity, while still important to consider, also seems less compelling than in the past. In 1991, the U.S. Assistant Attorney for Antitrust, James F. Rill, has categorically rejected the view that acceptance of conferences is required by the traditional concept of comity in international law. In his remarks before the U.S. Advisory Commission on Conferences, Mr. Rill stated "It takes a broad stretch of ingenuity to transform the comity doctrine to a justification for an outmoded and wasteful regulatory regime."[15] Mr. Rill's viewpoint is supported by U.S. jurisprudence indicating that the comity doctrine does not require nations to maintain policies which are fundamentally prejudicial to their national interests.[16]

IV. Emerging Developments and Trends, and a Few Major Ensuing Issues

A. Emerging Developments and Trends *a. Recent Developments and Trends - Technological changes, new forms of organizations, new forms of agreements, and new forms of services*: Even as the rationale for exemption is being challenged, fundamental changes are occurring in liner shipping. The most significant of these changes is technological change. This together with developments such as new forms of organizations, new forms of agreements, and new forms of services are having a dramatic impact on liner shipping. These developments have become so noticeable that some authors refer to them as 'the new paradigm'. Though less important when viewed individually, these developments are quite significant when considered jointly, since they can be considered as enhancing the power of conferences. Some of the emerging developments and trends will be examined.

Technological changes - containerization, multimodal transportation and new mega-sized carriers: Though containers were introduced into the

Table 1-Container Cargo Loaded /Unloaded in International Shipping 1981-95

Year	Loaded ('000 t)	%	Unloaded ('000 t)	%	Handled ('000 t)	%
1981	4,344	3.0	3,232	4.7	7,576	3.5
1985	4,546	3.2	4,547	7.6	9,093	4.5
1990	7,063	4.4	5,194	7.1	12,257	5.3
1995	9,242	5.2	6,354	7.6	15,596	6.0

Source: Shipping in Canada, Statistics Canada, Catalogue 54-205 Annual.

shipping industry several decades ago, containerized cargo continues to grow and represent an increasing share of international cargoes handled at ports. For example, in Canada this is indicated in the table 1 which shows that containerized cargo has nearly doubled over the period 1981-95. Though the total percent of containerized cargo (i.e., 6.0%) may not appear very large, in terms of value it is much more significant (i.e., 25% of the total value) than

appears on the surface. The change in containerized cargo can also be seen in the growth of TEUs (twenty-foot equivalent units) at a few ports shown in table 2.

Table 2 - TEUs at a Few Selected Ports 1970-1997 ('000)

Ports	1970	1974	1978	1982	1986	1990	1994	1997	% Δ
NY	930	1,700	1,800	1,900	2,300	1,900	2,000	2,518	171
Seattle	20	430	640	800	850	1,200	1,400	1,480	705
Long Beach		400	560	720	1,400	1,600	2,600	3,400	75
Hamburg	78	310	600	890	1,200	2,000	2,700	NA	3,361
Rotterdam	300	1,100	1,600	2,200	2,900	3,700	4,500	NA	1,400
Felixtowe	150	220	300	630	900	1,400	1,700	NA	1,033
Montreal	72	100	190	320	530	570	730	900	115
Halifax	30	170	190	170	270	450	310	450	1,400
GLOBAL	6.3m	16m	28m	43m	61m	86m	125m	NA	1884

Figures for 1997 are Estimates. Where figures are not available, the % change refers to 1970-1994.
Source: Containerisation International Yearbook data and Journal of Commerce/Piers and ports.

This growth in containerization has had a tremendous impact on the entire shipping industry. It has led to developments such as new multimodal networks, new technologies in port infrastructure, sophisticated logistical network systems, and new vessel configurations. This has not only led to dramatic operating efficiencies but has also led to an unprecedented improvement in services throughout the world.

The above noted developments have now also attracted greater attention. This can be seen in the increase in multimodal traffic which has been particularly pronounced in the US. This is shown in the figures on trailer/container loadings in the following table. As one source noted "To say

Table 3 - Annual Trailer/Container Loadings 1982-1994

Year	Trailers	Containers	Total
1982			3,396,973
1985			4,590,952
1989	3,496,262	2,491,093	5,987,355
1990	3,451,953	2,754,829	6,206,782
1991	3,209,239	3,034,208	6,243,447
1992	3,350,506	3,359,926	6,709,732
1993	3,458,406	3,692,051	7,150.457
1994	3,763,799	4,280,589	8,044,388*

Source: Association of American Railroads. * 51 Weeks.

that 1994 was really a good year for intermodal would be understating its growth. Bordering on the incredible would be a fairer description."[17] Perhaps what is noteworthy is that the growth in containers in the foregoing figures is more dramatic and relevant to liner shipping as containers are used basically in international and offshore trade.

The increase in intermodal traffic has also spread to Canada, as noted by the National Transportation Agency of Canada "Intermodal traffic increased more than any other major traffic segment in 1994." In terms of magnitude, in 1992, intermodal rail traffic (i.e., containers and trailers-on-flat-cars) totaled 13 million tonnes or 7 percent of total freight of Class I carriers (in terms of value this intermodal traffic is significantly more important). Of this total, 4.5m. tonnes were domestic intermodal movements and 8.5m. tonnes were international (i.e., it moved intermodally either through or from Canadian ports, or to or from the U.S.). This increasing trend was noted earlier by the NTARC in its statement "The widespread implementation of an intermodal approach to the movement of domestic and export/import freight has been one of the most significant developments on the transportation scene in North America in recent years."

To accommodate the increase in intermodal traffic a number of strategic investments have also taken place. CP Rail undertook a $27.5m. investment to enlarge its Windsor-Detroit tunnel which it opened in May 1994 and CN undertook a $155m. investment in its recently completed Sarnia-Port Huron tunnel. This would enable the railways to move tri-level railcars or double-stack cars, the latter has been described as the most important innovation in multimodal transportation. CN also undertook a $17m. investment in the Halifax intermodal terminal, and has set up a network of modern hub terminals across Canada equipped with top-lifting equipment. In keeping with the latest developments elsewhere, CN offers its customers an Internet-based shipment tracking system, becoming the world's first rail carrier to provide such a service.

Even in Europe, intermodalism is beginning to take hold, though it has not kept up with the pace of developments in U.S. and Canada. In terms of volume, the EU Transport Directorate calculated that intermodal transport moved about 5.6 million TEUs in 1993 compared to the 6.4 million TEUs in 1994. This represents about 4 percent of the total European freight market. Maritime containers moving by rail to and from seaports were estimated to be about 2.5 million TEUs. The interest in intermodalism has recently been renewed with the opening of the Channel Tunnel and EEC Directives 440/91, 18/95 and 19/95.

In addition to the foregoing changes, one of the latest technological developments that has attracted attention is new vessel configurations. The size of containerships has evolved over the last two decades and has reached dimensions that have been termed 'behemoth', as the quest to achieve economies of ship size continues. This can be seen in the statistics on size of containerships of one company (i.e., Maersk) as an example:

Table 4 - Size and Speed of a Typical Maersk Containership 1968-1996

Year	Name of Vessel	TEU Capacity	Speed (knots)
1968	Weser Express	700	20.6
1969	Encounter Bay	1,500	21.5
1972	Liverpool Bay	3,000	26
1984	American New York	4,482	18
1992	CGM Normandie	4,425	24
1996	Regina Maersk	6,000	25

Source: American Shipper, March 1996, p. 40.

Other shipping companies are following in the footsteps of Maersk. For example, P & O Containers, NYK, Evergreen, OOCL, Neptune Orient Lines, Hanjin Shipping, Hyundai Merchant Marine and Cosco have ordered ships with capacities of nearly 5,000 TEUs or more. As if the new sizes were not enough, the concept of a 15,000 TEU ship was recently considered. Experts claim that further evolution in sizes may lead to ships of up to 8000 TEUs.[18] Sizes beyond that have raised doubts as to whether further economies of ship size could be achieved and whether the present day size of cranes and terminal landside facilities could cope with this increase.

New forms of organizations - superconferences, consortia and joint ventures, global carrier alliances and shippers' alliances: The first of these recent forms of organization was the emergence of superconferences. Superconferences are basically large entities formed from the amalgamation of existing smaller conferences. Their emergence in various jurisdictions was not simultaneous. In Canada they began to emerge after 1987. At times, as many as 19 smaller conferences joined to form one major conference.[19] In 1984 there were 44 conferences, ten years later the number of conferences had fallen to 25.

In the U.S., the formation of superconferences began much earlier roughly in 1984. This has been attributed to the *US Shipping Act of 1984* which moved away from a public interest standard. This provided the opportunity for the consolidation of smaller conferences into larger superconferences. For example in 1984, nine conferences operating between the U.S. East Coast and Europe combined into one eastbound and westbound conference; and on the US East coast there were 19 conference and rate agreements in the Pacific Far East trade which were replaced by one superconference and three small conferences.

While superconferences have attracted attention in Canada and USA, the development of consortia has been particularly noticeable in the EEC. Of the 57 consortia operating worldwide in 1990, 40 consortia operated in Community liner trade.[20] The Competition Directorate of the European Commission believes that consortia are the wave of the future as these arrangements are generally based on the need for technical rationalization, an increase in the

capital intensity of the shipping industry, the development of containerization, bigger ships and the need to compete.

Another organizational form that has recently come into the limelight are global alliances. A global alliance is simply another consortium or carrier agreement. The basic difference is that a traditional consortium operates in a single trade lane and a global alliance is a multiple trade lane consortium. The significance of this new form of organization is shown in the formation of five alliances as of the beginning of January 1996 and in their total market share shown in the Table 5 for the Asia/US West Coast market. Since the above data

Table 5 - Asia/US West Coast market shares 1996

Alliance	Eastbound	Westbound
APL/OOCL/MOL Nedlloyd	23%	23%
NYK/Hapag/NOL/P&O	10%	10%
Sea-Land/Maersk	16%	12%
Hanjin/DSR-Senator/Cho Yang	12%	13%
K Line/Hyundai/Yangming	19%	20%
Total of 5 alliances	80%	78%

Source: OECD. Note these global alliances are changing in 1998 due to mergers.

was published, a sixth alliance was formed between K Line and Yang Ming. These newly formed alliances deploy an armada of between 49 and 67 big boxships, each representing a shipboard capacity of between 189,000 and 230,000 TEUs. These numbers appear to be dwarfed in comparison to some of the big ships that have been ordered and are currently entering service. In the words of one observer "big is beautiful. Global alliances are another quantum leap in that direction and, ... they are here to stay."[21]

This effect is rubbing off on shippers too, as shippers are forming global alliances. In 1994, the NITL, the European Shippers' Council (consisting of seventeen Shippers' Council from various countries in Europe) and the Japan Shipper's Council formed a Tripartite Shippers' Council. Though information sharing appears to be one of their major activities, they support each other in efforts such as shipping reform legislation, international agreements on maritime, shippers' changing relationship with ocean carriers, etc. This effort at shipper solidarity 'could well translate into cooperative joint ventures in educational opportunities and coordinated activities of a host of policy issues.' The Tripartite was expected to expand its membership to shippers in Canada, Hong Kong and Korea in 1997.

New forms of agreements - discussion agreements, bridging agreements, capacity reduction agreements, interconference agreements, space chartering agreements: Besides the foregoing developments, new forms of commercial agreements have emerged. For instance in Canada, discussion

agreements, bridging agreements, space chartering agreements, etc. have evolved since *SCEA, 1987*. Table 6 shows the number and types of these new agreements. The significance of these new agreements is shown in the last row.

Table 6 - Number and Type of Agreements in Canadian Shipping 1988-97

Types of Agreements	1988	1989	1992	1997
Discussion Agreements	0	3	(6	(5
Bridging Agreements	0	1	(	(1
Capacity Reduction Agreements	0	1	1	0
Inter Conference Agreements	0	1	1	0
Space Chartering Agreements	0	0	4	2
Rate Agreements	32	30	25	23
Total Agreements	32	36	37	31
Other Agreements as a % of total	0	16.6	32.4	25.8

Sources: Annual Reviews of the National Transportation Agency of Canada. See Reviews for the years 1988, p. 71; 1989, pp. 91-92; and 1992, p. 140.

These agreements have increased from zero in 1988 to 32.4 percent in 1992 or 25.8 percent in 1997. Discussion and bridging agreements provide a forum to discuss general conditions of liner trade. Space chartering and sailing agreements are formed for the purpose of rationalizing service through vessel space, including equipment interchange and scheduling of ports. Stabilization agreements attempt to reduce the available carrying capacity on a trade route in an attempt to stabilize rates and improve profitability.

In the EEC too, a number of new commercial arrangements have also emerged some of which go beyond conference agreements. They not only include agreements between conference and non-conference carriers but also consortia agreements. For example, the most notable agreements between conference and non-conference carriers are Eurocorde I, the Trans Atlantic Agreement and the Trans Atlantic Carriers Agreement. The importance of consortia agreements has been reflected in the EC Council Decision of December 1991, and later with the passage of Regulation 870/95 which provided shipping lines antitrust immunity to form operational consortia in ocean transportation. The first four consortia to have been approved under the new regulation are the St. Lawrence Coordinated Service between North Europe and Canada, the Joint Mediterranean Canada Service, the East African Container Service between Europe and East Africa and the U.K./Poland Joint Pool Agreement.

In the United States also, new types of agreements have increased in proportion to all agreements filed. This can be seen in the statistics on agreements filed with the Federal Maritime Commission which indicates that the proportion of other types of agreements filed in 1987 has risen to 37% from 15% in 1981; and that of all new agreements, as much as, 96% are other types of agreements (See table 7).

Table 7 - Number and Type of Agreements in U. S. Shipping 1981-1987

Types of Agreements	1981		1983		1987	
	New	Mod	New	Mod	New	Mod
Rate Agreements	2	127	3	112	3	147
Joint Ser. & Con. Ag.	0	5	1	10	4	5
Pooling Agreements	0	1	0	15	0	25
Sail & Space Ch. Ag.	3	6	5	12	15	14
Coop. Work & Dis Ag.	2	3	1	3	14	28
Misc. Agreements	6	7	8	3	38	15
Total Agreements	13	149	18	155	74	234
Other Agreements as a percent of Total	**84.6**	**14.7**	**83**	**27.7**	**95.9**	**37.2**

Mod=Modifications to existing agreements.

In addition, the geographic scope of agreements have increased in several ways. Conference agreements typically now involve superconferences, whose geographic scope has been expanded. Further, a number of recent agreements also include independent carriers covering a significant share of a trade, for example the Trans Atlantic Agreement. Agreements also include intermodal rates covering other modes of transportation. These new developments have tended not only to increase the power of conferences, but also to provide more efficient and varied services.

New forms of services - multimodal service,[22] *global service*: As a consequence of the above developments and in response to demand, new forms

Table 8 - Number of Weekly Landbridge Services 1987-1994

Year	Eastern Canada to Far East		Western Canada to U.K./Cont	
	Conference	Non-Conference	Conference	Non-Conference
1987	9	3	2	
1988	10	1	2	
1989	12	3	3	
1990	14	3	3	
1991	17	6	5	
1992	23	6	4	3
1993	28	9	4	4
1994	24	13	8	3

Source: Annual Review of the National Agency of Canada 1994, p. 159.

of services are developing for frequent, reliable, rapid service at a minimum cost so as to enable exported products to be competitive with domestic production. Over the last few years (1987-1994), the growth in conference landbridge services (i.e., the overland portion of international intermodal movements) has been spectacular. This is shown in the table hereafter.

Besides the intermodal services shown above the new global alliances serving North America have established a number of services on the trades shown in the table hereafter.

Table 9 - Service Routes of the Global Alliances

Carriers	Routes
NOL-APL/MOL/Hyundai	Trans-Pacific, Asia-Europe, Transatlantic, Latin America
Sea-Land/Maersk	Trans-Pacific, Asia-Europe, Asia-U.S. East Coast, Europe-Middle East, Asia-Middle East/Mediterranean
P&O Nedlloyd/NYK/ Hapag Lloyd /OOCL/Malaysia International	Trans-Pacific, Asia-Europe
Hanjin/DSR Senator/Cho Yang/UASC	Trans-Pacific, Asia-Europe, Transatlantic, Mideast
K Line/Yang Ming	Trans-Pacific, Asia-Europe

Source: "Will mega-alliances mean mega-benefits for shippers?" Logistics Management, May 1996, pp. 65A-69A and "Twisting Alliances," American Shipper, January 1998, pp. 8-11.

b. Legislative Developments in Canada, EEC and US: In an effort to ensure that conference legislation, appropriately considers the above noted emerging developments, attempts are being made to withdraw the exemption or to amend liner legislation in the major jurisdictions throughout the world. In particular, attempts are being made to restrict the scope of the exemption for liner conferences and to bring about a convergence in liner legislation which has often created friction between various jurisdictions. The legislative changes or developments in Canada, EEC and the USA will be examined below.

Canada: In Canada, since *SCEA 1987* was enacted, three major developments on legislative proposals have occurred. First, an Industry Advisory Group conducted hearings on *SCEA, 1987*. The major issues recurring through the majority of the submissions submitted to the Group were: 1. Is there need for conference exemption from the *Competition Act*? and 2. What are the major difficulties with *SCEA*? The majority of submissions indicated that *SCEA* had little or no impact and that the potential repercussions do not provide any convincing reasons for the retention of the exemption. The discussion on the major difficulties with *SCEA* focused on: the interpretative difficulties of the *Act* pertaining to definitions, the ineffectiveness of the Canadian Shippers' Council, the dispute mechanism provision, the notice period provision and how *SCEA* should be interpreted in a changing environment? The roles and responsibilities of the National Transportation Agency and Industry Canada were also raised.

Second, in March 1993, the National Transportation Act Review Commission (i.e., NTARC) reviewed transportation legislation and released its report.[23] It made three recommendations and a few proposals on conference liners.[24] The Commission noted that the exemption runs counter to the general policy of encouraging competition. In principle, opposition was expressed regarding the intent of *SCEA* as it is clearly in conflict with the competitive thrust of the *NTA, 1987*. Due to the possible uncertainty and the need for international action the Commission recommended that "the Minister of Transport introduce legislation to repeal SCEA at such time as United States antitrust immunity for shipping conferences is withdrawn." On the issue of

multimodal rates, the Commission indicated that conferences should be allowed to negotiate with inland carriers for through freight rates. To encourage more carriers to set independent rates, the Commission recommended that "the federal Cabinet reduce to ten days the notice period for independent action by shipping conference members." The NTARC also listed a number of other proposals.[25]

Third, the Standing Committee on Transport in June 1993[26] commented on the recommendations of the Commission. The Standing Committee agreed with two of the recommendations of the NTARC: to shorten the notice period to 10 days; and to permit intermodal conference contracts for 'through freight rates for precarriage or onward land carriage'. Regarding the NTARC's recommendation to repeal *SCEA* when the US repeals its legislation, the Standing Committee recommended that "That the Minister of Transport not accept the NTARC's recommendation to automatically repeal the SCEA when the U.S. government removes anti-trust immunity of shipping conferences, but undertake a review of the legislation at that time and refer it to the Standing Committee on Transport." Since June 1993, no further major attempts at legislative reforms in conference legislation have been undertaken in Canada.

EEC: In the EEC too, regulatory reform has gradually begun to take off. This can be seen in the passage of the recent regulation on consortia and other developments regarding conference legislation. The Vice-President of the European Commission stated that "...times are changing. Criticism is mounting against the conference system and efforts towards liberalization are being pursued worldwide. How can the European Community ignore this trend?" Attempts at bringing about further regulatory reform are continuing.

On April 21, 1995, Regulation No. 870/95 pertaining to rules for consortia went into effect. The key elements of this regulation are: 1. A consortium formed from members within a conference will be exempt from EU competition laws if its market share is less than 30%. 2. A consortium of non-conference carriers can have a market share of up to 35%. 3. A consortium with a market share of between 30% or 35% and 50% must notify the European Commission and will be granted exemption if no objection is issued within six months. 4. Members of a consortium must have the right to withdraw without penalty on six months notice, after an initial period of 18 months. In the case of a highly integrated consortium, the initial period is 30 months.

The above consortium regulation does not address the issue of joint intermodal operations by alliances. Nevertheless, it is held that global shipping alliances wishing to cooperate on inland transportation or to negotiate jointly with inland transportation modes or to jointly determine intermodal rates must apply for individual exemption from the European Commission.

Besides the recently adopted consortia regulation, an advisory group has been working on establishing guidelines to determine whether certain inland cooperation practices of ocean carriers should be exempted. Simultaneously, jurisprudence is evolving on the Commission's view of intermodal pricing, as several cases involving intermodal pricing are before the European Courts.

A more serious issue has developed regarding the applicability of EEC Regulation 4056/86 granting antitrust immunity to conferences. This regulation specifies that a conference must operate under 'uniform or common rates' sometimes termed as the 'uniform rates doctrine'. Taken literally, this could imply that a carrier agreement which allows its members to deviate from the conference tariff is not a true conference and consequently loses its exemption from the competition laws.[27] Thus according to a 1995 OECD report "It is apparent that, with respect to tariff discipline, the idea of a common or uniform rate by conferences is a definition which no longer reflects the reality of ocean container shipping industry."[28]

Even as the interpretation of Regulation EEC 4056/86 is being challenged, the European Shippers' Council consisting of seventeen Shippers' Councils from various European countries are calling for a withdrawal of the block exemption for liner conferences. Other organizations are calling for a new regulation that would force shipping lines wanting to form a conference to apply for individual exemptions rather than obtaining automatic block exemption without having to notify the European Commission. Neither the EU Commissioner for Competition, Karel Van Miert nor other EU competition agencies have left any doubt they would prefer to see EEC Regulation 4056/86 disappear.[29] Unfortunately recent reports indicate that EC is unlikely to revise this Regulation in the immediate future, since it is a new law and in light of cases before the courts.

US: The developments on the legislative front in the US since 1992, can perhaps be grouped under two major headings: the report of the Presidential Advisory Commission released on April 10, 1992[30]; and bills introduced to revise or repeal the *US Shipping Act of 1984*. These developments are reviewed.

The Report of the Advisory Commission examined a number of issues in the shipping industries and in the absence of any consensus, the Report did not provide any conclusions or recommendations. On antitrust immunity to conferences, ports and terminal operators, carriers believe that conferences are a necessary part of the liner shipping industry. Supporters of conference anti-trust immunity, indicate the absence of abuses of anti-trust immunity, the increase in the level of service and lack of supra-competitive profits. Opponents point to the health of the U.S. flag fleet, the possibility of excessive service competition, new

commercial arrangements that would arise to deal with rate fluctuations, and the development of superconferences and discussion agreements which have undermined competitive forces. Regarding need for retention of antitrust immunity for ports and marine terminal operators, a number of reasons were advanced such as, absence of abuse of immunity, immunity resulting from other legislation and uncertainty due to non-uniformity.

On tariff filing and enforcement (TFE),[31] common carriage and service contracting, proponents of TFE contend that its benefits come largely from principles of access and nondiscrimination, in addition to its stabilizing influence on rates. Opponents of TFE see it, as too bureaucratic, inflexible, expensive and, most importantly, incapable of adequately protecting small shippers from unjust discrimination. The similarly situated shipper arguments are largely ineffective given the commodity specific nature of tariffs and the availability of point-to-point through rates. Further, it is pointed out that TFE permits price-signaling. Furthermore, the need to file tariffs by NVOCCs (i.e., non-vessel operating common carriers) has been questioned because it would disadvantage NVOCCs in attracting cargo of small shippers.

The *1984 Act* embodies the principles of common carriage and nondiscrimination.[32] However, the *1984 Act* does not call for blanket "non-discrimination," for example, FAK tariff, service contracts, time/volume contracts, etc. Most carriers, in their testimony before the Advisory Commission, argued for a system of common carriage as it ensures a non-discriminatory shipping industry. Intermediaries and shippers presented more divergent views than the carriers.

Service contracts (i.e., SCs) are being used in most trade lanes however, the Commission noted a number of problems relating to SCs: lack of independent action, the requirement that they must be negotiated by the conference, disclosure of essential terms, the inability to sign global SCs, the prohibition of percentage-based contracts, and restrictions on modifying contracts. Conferences viewed SCs as a mixed blessing. While opposing mandatory independent action on SCs, they favour retaining public availability of essential terms as it is consistent with common carriage principles.

Regarding relations of conferences with shippers and transportation intermediaries, intermediaries have differing views regarding the conference system. NVOCCs have expressed concern that they have not been granted antitrust immunity despite the fact that they also are common carriers. This enhances conference market power making it more difficult for NVOCCs to enter into contractual arrangements with ocean carriers. Further, NVOCCs are not given the discounted rates provided to 'similarly situated shippers' as they are not 'beneficial owners' of the goods shipped. Furthermore, some NVOCCs feel

that they should be allowed to sign service contracts. Freight Forwarders pointed out that artificial distinctions between various kinds of forwarders be removed for purposes of determining carrier compensation.

A number of Bills were introduced to revise or repeal the *US Shipping Act of 1984*. The first attempt to repeal the *Shipping Act of 1984* was Bill H.R. 5841 introduced in Congress by Thomas R. Carper entitled the "Shipping Act of 1992". This Bill was strongly opposed by carriers and died on the House floor. The second attempt was a Bill introduced by Senator Metzenbaum that would repeal antitrust exemption for ocean carriers.[33] Unfortunately, the Metzenbaum Bill died due to lack of support. The third attempt was made by the National Industrial Transportation League (i.e., NITL) in January 1995, when it introduced a plan entitled the "Shipping Deregulation Act of 1995". The NITL Bill attempted to remedy some of the deficiencies of the Carper Bill.

Simultaneously, in January 1995 Congress appointed a Subcommittee chaired by Representative Howard Coble to look into the matter. In March 1995, the House Transportation Committee, introduced its own Bill known as the 'Ocean Shipping Reform Act'. On May 1, the House Transportation Committee passed the Bill. This initial success was however shortlived as the Bill was blocked by the Senate. To salvage what was left of the attempts to introduce regulatory reforms three US Senators - Larry Pressler, Trent Lott and John Breaux - introduced their own Bill (known as the Senate Bill). The Senate Bill could be viewed more as a deregulation Bill, as it favours shippers, considers filing of individual contracts and retention of their confidentiality, and endorses closed conferences.

In 1996, the House voted for a 'second' time to overhaul the Shipping Act of 1984. However, given the problems of reconciling views and the lack of time in the 1996 session, attempts to reform shipping legislation failed. Prospects of introducing reform in 1997 initially appeared bright when the Senate introduced a Bill in March 1997, which included several refinements to the previous Bill. This Bill provides for individual confidential contracts, protection to US flag ships from foreign predatory pricing, merger of the FMC and the DOT, elimination of tariff filing, tariff enforcement by the Intermodal Transportation Board and the reduction of the notice period on independent action to five days from ten days.[34] After a one day hearing in April and the markup in May, efforts to find common ground of interest were not successful. In mid July 1997, maritime officials reported that the reform Bill before the Senate was dead as the International Longshore and Warehouse Union (i.e., ILWU) would not support the Bill and political support was not forthcoming.

Late in 1997, hope was once again rekindled as a compromise Bill was agreed to between Senator Trent Lott and Senator John Breaux to deal with

some of the criticisms. The three major revisions were with regard to service contracts, standalone FMC retention and permitting the ILWU to obtain some of the information it needed to ensure that collective bargaining contracts will be enforced. Regarding service contracts, the Bill would now also permit these contracts between the conference and shippers, and confidential multiple carrier and shipper contracts on segmented services besides the confidential contracts between a shipping line and shippers in the earlier Bill.[35] Initial concerns about the lack of uniform treatment on the confidentiality aspects of the two types of service contracts in the proposed revision has now been resolved. But freight consolidators are still unhappy. However, enthusiasts hope for a solution. The Bill is expected to be pushed forward in 1998 especially as everyone believes that some reform is necessary.[36] The latest news indicates that the Senate will vote on the Bill before April 1998.

B. A Few Major Ensuing Issues From the above debate, the ensuing issues that have arisen are on: intermodal rates, service contracts, independent action, tariff filing and antitrust immunity.[37] These issues will be examined as their significance has been accentuated not only because of the recent changes in the industry but also because of their potential impact on competition.

a. Intermodal Rates:[38] Intermodal rates set by a *conference* in the US, that are filed and accepted by the FMC, are granted immunity from the US antitrust laws.[39] Antitrust exemption does not cover 'agreements' between a conference and other transport modes.[40] Similarly, in Canada the conference loses its exemption if the multimodal rate is set by 'agreement' between the conference and 'another mode'. In the U.S., a member of a conference (or a consortium acting as a single entity) can negotiate with another mode and offer multimodal rates, if approved. In Canada, such an agreement also does not lose its exemption. In the EEC, intermodal rates set by the conference (or an individual line) are not granted an exemption. This is the interpretation of Regulation 4056/86 by the Commission, a matter being contested in the Court of Justice. Intermodal rates 'agreed' to between a conference (or individual shipping line) and another mode are not permitted.[41] However, intermodal agreements in the EEC can be exempted under section 85(3) of the *Treaty*.

It is believed that the provisions on intermodal rates in Canada and the EEC are more conducive to a competitive market environment than those in the US.[42] This has also been indicated in submissions to the US Advisory Commission. It appears that the preference for intermodal conference rate making is their lower cost and convenience. However, this must be weighed against the disdvantages of less competition, the potential for technological change and the threat of collusion. An example of the latter is the FEFC complaint to the Competition Directorate in the EEC, where intermodal rates

were agreed to between the conference and its own trucking lines depriving shippers of the choice of alternative trucking.

b. Service contracts:[43] Service contracts are agreements between a shipper and a conference for the transportation of a minimum quantity or a proportion of a shipper's goods, over a specified period of time, at a specified rate and level of service. In the United States, service contracts on a minimum quantity are permitted. The US *Shipping Act of 1984* permits the *conference* to regulate or prohibit the use of service contracts and can decide whether to permit individual members to contract with a shipper (i.e., to take independent action). In Canada, filed service contracts between conferences and shippers are exempt from the provisions of the *Competition Act*. Service contracts are for a minimum quantity and conferences determine the terms and conditions of service contracts. Further, loyalty contracts are permitted in Canada, but they must not specify all or 100% of the goods of a shipper. The EEC regulations on service contracts are more liberal. Shippers can enter directly into contracts with the shipping line of their choice. In other words, IA on service contracts is permitted. There is no requirement that the service contracts be kept confidential. The regulations also provide for loyalty arrangements (that could be less than 100%) and deferred or immediate rebates. The terms of these arrangements are matters for consultation between the conference and transport users' organization.

The potential benefits of service contracts have been highlighted not only by the Canadian Conference Board study and the submission of the Canadian Manufacturers' Association to the National Transportation Act Review Commission but also by various studies in the US. As a result, there have been proposals in Canada and the USA to ensure that the conditions applicable to service contracts are more conducive to a competitive environment. For example, in the US, a private Bill has proposed the alternative of a percentage to the existing minimum quantity requirement to increase their use. And one of the conditions for accepting the TAA by the FMC was that the minimum TEU requirement for service contracts be dropped and that the notice period for service contracts be reduced to 3 days from 5 days with a provision for a 15-day window for unilateral action. Similarly in Canada, the National Transportation Act Review Commission has suggested that the definition of a service contract be amended to permit a shipper to contract a proportion of his business as an alternative to a specified volume.

Even the FMC has shown a preference for the EC provision by stipulating the requirement that service contracts be entered into by individual member lines of the TACA (i.e., Trans-Atlantic Carrier Agreement) as a condition to accepting the proposed settlement by the TACA to end the FMC

investigation into the TACA.[44] These developments suggest a preference for the treatment of service contracts as is currently the situation in the EEC.

c. Independent Action:[45] Independent Action enhances the competitiveness of intra-conference competition and also permits the members of a conference to compete with independents. In the United States, conferences must permit member lines to take independent action within 10 days notice to the conference, on any rate or service item in its filed tariff. Members may adopt the same rate or service on the same day or after it becomes effective. Independent action on service contracts (i.e., service contracts between an individual shipping line of a conference and shippers) is within the *jurisdiction of a conference*. It is also permitted on inter-conference agreements, an action that was available even under the US *Shipping Act of 1916*. In Canada, members of a conference are permitted to take independent action within 15 days notice to the conference on any filed tariff or service item. Similar adopting action on the same day is also permitted after written notice is given to other members of the conference. *SCEA* does not permit independent action on service contracts. In the EEC, members of a conference may take independent action on any tariff and no notice period is required. Independent action on service contracts is also permitted.

Of the three jurisdictions, the legislative provisions on independent action in the EEC appear to be the most pro-competitive. The US provisions are considered to be more competitive than the Canadian provisions because these provide for a shorter notice period. A shorter notice period discourages the conference from persuading their members to refrain from taking independent action and also gives greater flexibility to the conference to react spontaneously to changes in the market situation and to external competition. Most studies on the effect of independent action have indicated that it has positive benefits in that it has brought about lower rates. As a result, the NTARC has recommended that the notice period for independent action be reduced to 10 days, similar to the notice period requirement in the USA.

d. Tariff Filing:[46] In the United States, tariff filing by conferences and ocean carriers is required under the provisions of the US *Shipping Act of 1984* with exceptions for a few commodities. Service contracts, except for certain commodities, are also required to be filed; their essential terms, together with the filed tariffs, are available to the public. The FMC enforces the filed tariffs and service contracts. In Canada, only conferences are required to file their tariff rates, which are not enforced by the government. A copy of every service contract is required to be filed, this however is not available to the public. In the EEC, conferences and shipping lines are not required to file tariffs, service contracts and loyalty contracts.

The requirement to file and enforce tariffs is considered to be anti-competitive by the administrative authorities in the EEC. Tariff filing and enforcement in the US has also been severely criticized by a number of prominent witnesses - DOJ, FTC, and Prof. Butz - before the Advisory Commission, who have indicated that the disadvantages appear to outweigh any possible advantages.[47] It is doubtful whether tariff filing in Canada, in the absence of enforcement has any advantages, especially as carriers can provide rebates (except on loyalty contracts). The present sentiments, in the USA and Canada, suggest a potential move towards the existing regulatory regime in the EEC on tariff filing and enforcement.

e. Antitrust immunity:[48] Of all the issues considered, the antitrust issue appears to be the most contentious. In the three jurisdictions US, EEC and Canada the scope of the exemption granted to the liner industry varies considerably. In the US, all filed agreements that are not disallowed between liner carriers and conferences are exempt from the provisions of the antitrust laws. As a result, the exemption is applicable to conference agreements and agreements between conferences and independents. The exemption is narrower in Canada and in the EEC. In both Canada and the EEC, the exemption is applicable only to agreements between conference liners. As a result, agreements involving independent liners and conferences are not exempted in Canada and the EEC. Further, whether other types of agreements are exempt, unlike the situation in the US, depends on the existing legislation. In Canada, the exemption status of these other types of agreements requires the consideration of other legislation and their exemption status is therefore a matter for the Court to decide. In the EEC, these types of agreements have to be considered under the exemption applicable to agreements in the competition laws or other regulations on block exemption.

Whether the antitrust exemption should be continued has received increased attention recently. In the US, two major agencies - DOJ and the FTC - have called for an abolition to conference immunity. However, the Advisory Commission has not made any specific recommendations to bring about any change. In 1993, a private Bill in the U.S. and other proposals have sought to terminate anti-trust immunity to conferences, however, subsequent Bills have not adopted this proposal. In Canada, both the CSC and other academic submissions have also called for an end to the exemption. This view is also held by the VP of the European Communities for Competition Policy.

The legislative developments regarding some of the major issues in Canada, EEC and the USA suggest that the three jurisdictions are gravitating towards introducing more competition either through adopting more competitive provisions or through consideration of removing the antitrust immunity that the conferences enjoy. Perhaps, the development of uniform regulations on some of

the major issues is a stepping stone to obtaining consensus on the fundamental issue of whether antitrust immunity should be continued or repealed multilaterally. The harmonization of laws in various jurisdictions could lead to less international tension, reduce uncertainty, increase competition, reduce rates and create the potential for increased world trade.

V. Conclusion

In a period when promoting international competition and facilitating the role of market forces have become the cornerstone of government policy in the industrialized world, it is appropriate to consider whether the present philosophy towards liner conferences is appropriate. Providing clear-cut uncontroversial policy proposals are often not easy, especially when different interests groups have different views. Yet some change is needed. The question now is what and how much?

In an attempt to shed some light, the basic rationales for liner shipping were examined. An examination of the instability rationale under various theoretical models indicates that the weight of evidence does not support the claim of the proponents who argue that the exemption is needed because the shipping industry is unstable. As a supporting argument for the exemption, the international comity rationale has also been put forth. While there are differences in shipping practices and regulations among different nations the overall goal is the same, to bring about stability in rates and service and an increase in trade. International comity may be served as well by joint consideration between trading nations to repeal outdated laws that are not beneficial to their welfare.

Quite apart from the above, fundamental changes have been occurring in liner shipping which some observers have termed the 'new paradigm'. The most important of these are fundamental technological changes, new forms of organization, new forms of agreement and new forms of service. The confluence of all these developments have increased the potential for market control and abuse which could enable conferences to exercise too much power now with existing antitrust immunity. It has also opened up the possibility of relying more on market forces and competition enforcement.

The above developments have implications for the applicability of competition law. First, both consortia and global alliances are not given explicit exemption in SCEA from the *Competition Act*. They may be exempt if they are between members of a conference. However, in the majority of cases, these agreements are between conference and non-conference members for which exemption is not provided. As a result, these consortia or alliances lose their exemption. Second, a number of new types of agreements have been filed by the conferences which have not been given explicit exemption under SCEA. Third,

collectively determined multimodal agreements between the conference and inland carriers are not provided exemption under the *Competition Act*. In all the above cases, these agreements are subject to the provisions of the *Competition Act*. The most applicable sections of the *Competition Act* are the sections concerned with conspiracy, abuse of dominance and mergers or joint ventures.

It is important to note that though the above sections of the *Competition Act* are most applicable, it does not mean that these new agreements or arrangements are necessarily illegal. As noted in the Director's submission to the NTARC "It should also be emphasized that stabilization or other agreements in the liner industry will not necessarily be deemed to be illegal, even in circumstances where they are subject to the provisions of the *Competition Act*. As noted ... the conspiracy provision of the *Competition Act* applies to agreements that lessen competition unduly. ... Other types of arrangements such as consortia that are not explicitly exempted under SCEA also are not necessarily in violation of the *Competition Act*. ... Factors that could be taken into consideration in assessing consortia include the market share of consortium members, the terms on which members may withdraw from the arrangement and provide service independently and any specific advantages for users created by the consortium."

In the case of the abuse of dominance provision, a number of factors such as whether the consortium or alliance has substantial or complete control, whether it has engaged in a practice of anti-competitive acts, and whether these acts have had the effect of preventing or lessening competition substantially in a market will have to be considered to determine if the actions of these new organizations have run counter to this specific provision.

As the conference laws in the major jurisdictions are becoming more outdated and inapplicable, various attempts are being made to bring about legislative changes. For instance in Canada, the NTARC has expressed opposition in principle to the intent of SCEA and has called for its repeal as soon as the US withdraws its antitrust immunity for shipping. In the EEC too, serious problems have arisen regarding the applicability of the EEC regulation granting immunity to conferences and a OECD Report indicates that some of the important definitions no longer reflects the reality of ocean container shipping industry. Even in the US, numerous attempts are being made to revise the shipping laws granting antitrust immunity to conferences.

The new developments in the industry are also having an effect on shippers. Shippers in the major jurisdictions are calling for a repeal of the conference laws. In Canada, the Canadian Shippers' Council called for the outright abolition of SCEA, claiming that it "...represents a clear trade hindrance and a tariff barrier..." and that "...conferences have done everything

possible to negate whatever few pro-competitive modifications were made to the Act in 1987." In Europe too, the European Shippers' Council called on the European Commission to withdraw the automatic, open ended antitrust immunity enjoyed by liner conferences serving the European Union. Even in the US, the President of the NITL indicated that shippers and carriers realize that reform is needed and that some form of shipping deregulation is going to occur. This is also having its effect as far as Japan, as the Japan Shippers' Council began lobbying its Ministry of International Trade and Industry to review its regulation and end anti-trust immunity.

These events have not gone unnoticed by the Competition Authorities in major jurisdictions. In Canada, the Director in his submission to the NTARC stated "...the Commission might wish to consider whether Canada should explore possibilities for mutual withdrawal of competition law immunity for conferences with our major trading partners, before considering unilateral action." In the EEC, "...neither Van Miert nor other EU competition agencies have left any doubt they would prefer to see 4056/86 disappear." Similarly in the US, the Department of Justice has explicitly recommended the abolition of existing immunity for conferences from the US antitrust laws, a view also shared by the Federal Trade Commission.

In light of the above, it appears that the time has come to eliminate the privilege of antitrust exemption that conferences have enjoyed for nearly half a century. Facilitating and encouraging the role of market forces by eliminating the exemption could lead to greater competition among ocean liner carriers and ultimately to increased efficiency, lower prices, improved services and perhaps greater international trade. If such action is not feasible immediately, perhaps action could be taken to reduce the scope of the exemption in each country and to bring about an increasing convergence of conference laws among the major jurisdictions so as to enable antitrust immunity to be withdrawn later.

Endnotes

1 One final attempt by the government to control rates on shipping grain in the Great Lakes also failed because of the withdrawal of American carriers. This withdrawal was due to the control of rates by the Board of Commissioners.

2 See "The EC's Competition Policy for Liner Shipping set in its Commercial and Political Context," Address by the Right Honourable Sir Leon Brittan QC, European Maritime Law Organization (EMLO) London, 23rd Oct., 1992, pp. 3-6.

3 See Regulation (EEC) No.4057/86, No.4055/86 and No. 4056/86.

4 This is the short title of the *Act* see section 44 of the *Shipping Act, 1916.*

[5] The RTPC stated: "The public interest would not be served by excessive rate competition and instability in the liner trades," See ***Shipping Conference Arrangements and Practices***, R.T.P.C., Department of Justice, Ottawa, 1965, p. 100. See Sletmo, G. K., and Williams, E. W., ***Liner Conferences in the Container Age***, Macmillan Publishing Co. Inc., N.Y., 1981.

[6] In the earlier stages of conference development this led to the formation of closed conferences and the erection of other barriers for example denial of use of infrastructure owned or leased by conference carriers. The exemption of conferences from competition enables the trade to form conferences which can self-regulate the industry ensuring stability and provision of rationalized high quality service. The monopoly-cartel theory emphasizes certain structural characteristics such as a single supplier or a few suppliers who jointly act as a single supplier and entry barriers. These structural characteristics lead to certain types of performance such as higher prices, reduced output and supranormal profits. Where there is collusion among suppliers, part of the supranormal profits often is wasted in excessive service competition forcing up costs.

[7] ***Report of the Federal Trade Commission - An Analysis of the Maritime Industry and the Effects of the 1984 Shipping Act, 1990.***

[8] "Statement of John L. Peterman, Director, Bureau of Economics, FTC," Before the Advisory Commission on Conferences in Ocean Shipping, Sept. 13, 1991, p. 5.

[9] See ***FTC Report***, 1990, p. 20. Also see Davies, John, ***Legislative Change On The North American Liner Trades: A Study Of Causes And Consequences***, TP 10639, Transport Canada, October 1990, p. 185.

[10] "Cooperation, Competition, and Efficiency," by Telser, Lester G., ***Journal of Law and Economics***, Volume 28, May 1985, pp. 271-295.

[11] "Collusion in Ocean Shipping: A Test of Monopoly and Empty Core Models," Sjostrom, W., ***JPE***, 1989, v. 97, No. 5, pp. 1161-62.

[12] ***The Department of Justice Analysis of the Impact of the Shipping Act of 1984***, U.S. DOJ, Antitrust Division, March 1990, pp. 31-32.

[13] Of the eighteen trades analyzed in the U.S., six trades were significantly more unstable in the post 1984 period. *Id*, p. 204.

[14] The comity of nations is the courteous and friendly understanding, by which each nation respects the laws and usages of every other, so far as it may be without prejudice to its own rights and interests. See Sletmo, G. K., and Williams, E. W., p. 269.

[15] See "Statement of James F. Rill, Assistant Attorney General, Antitrust Division, United States Department of Justice," Before the Advisory Commission on Conferences in Ocean Shipping, September 13, 1991, p. 10.

[16] "No nation is under an unremitting obligation to enforce foreign interests which are fundamentally prejudicial to those of the domestic forum." Laker Airways v. Sabena, 731 F 2d 909, 937 (D. C. Cir 1984).

17 "Trends - 1994: Incredible Year for Intermodal," ***Intermodal Shipping***, February 1995, p. 10.

18 Economies of size are basically achieved through savings on labour costs, not only through fewer crew but perhaps more as TEU per crew member. The larger containersize ships have also succeeded in maintaining their speed.

19 The well known superconferences that have been formed are the US Atlantic-North Europe Conference, Asia North America Rate Agreement, and Transpacific Westbound Rate Agreement. The FMC indicates that this development is the most apparent structural consequence of the *U.S. Shipping Act of 1984*. Prof. Butz attributes it to extended immunity to intermodal rate making which greatly increased competition.

20 Of the 57 consortia operating worldwide, 40 consortia operate in Community liner trade. "Report on the Possibility of a Group Exemption for Consortia Agreements in Liner Shipping," ***Commission of the European Communities***, COM (90) 260 final, Brussels, 18 June 1990.

21 Damas, Philip, "Global Alliances, The scramble for position," ***American Shipper***, March 1996, p. 36.

22 One study describes it as "In its most common usage, however, the word intermodal has been generally understood to mean the movement of unitized freight, whether by steel container or by highway trailer, on one bill of lading, by more than a single mode of transport in a (relatively) continuous operation." ***Towards A Canadian Intermodal System: Recommendations For Change***, The Final Report of the Container Competitiveness Committee, Canada Ports Corporation 1991, p. 7.

23 ***Competition in Transportation***, Policy and Legislation in Review, NTARC, Minister of Supply and Services Canada, 1993. See V. I, pp. 28-29, 106-110, 136-142 and pp. 242-243, and V. II, pp. 105-121.

24 The recommendations are in line with the proposals put forward by the Director of Investigation in Research other than the one pertaining to conference agreements with other transport modes.

25 These pertain to a definition of a "conference", "service contract", the nature of the information conferences must supply for the satisfactory conduct of the meeting, and filing of tariffs by non-vessel operating carriers and independent action on service contracts.

26 ***Report on the Recommendations of the National Transportation Act Review Commission,*** Report of the Standing Committee on Transport, Robert A. Corbett, M.P. Chairman, June 1993.

27 While the EC views that an agreement that provides for total pricing flexibility does not qualify for exemption (as it could be viewed as eliminating competition through attracting non-conferences lines and as it serves no benefit to consumers in the form of

meaningful and stable prices) there appears to be some continuum where some flexibility is compatible with present day commercial practices and EEC Regulation 4056/86.

[28] Damas, Philip, "Are conferences obsolete?," ***American Shipper***, July 1996, pp. 12-13.

[29] Canna, Elizabeth, "Global pressure for regulatory reform," ***American Shipper***, January 1996, pp. 13-14.

[30] Other discussions such as U.S. Vice President's, Al Gore's, report entitled ***Congress Should Deregulate the Maritime Industry***, and the FMC discussion of section 6(g) of the US Shipping Act of 1984 have been excluded.

[31] Under the TFE provisions, conference members must be permitted to take IA on ten days notice, however, it does not require independent action on service contracts. Tariff rates and essential terms of service contracts are published and must be made available to similarly situated shippers.

[32] These principles include: (1) non arbitrary refusal of a carrier; and, (2) same compensation for the same service under similar conditions.

[33] An "Act to Restore Fair Competition in the Ocean Shipping Industry."

[34] The bill received mixed reviews. The FMC chairman supported the bill, however labour opposed it. One of the major criticisms of the bill was that it did not permit confidential contracts between shippers and conferences and confidential contracts between shippers and consortia. Some of the key players in the reform bill were: Sen. Kay Bailey Hutchison, sponsor of the bill and chairman of the subcommittee; Sen. Trent Lott; Sen. John Breaux; Sen. John McCain; Rep. Bud Shuster; and Rep. Tom Delay. See "New bill afloat," Roberts, W. and Nall, Stephanie, ***Journal of Commerce***, March 7, 1997, p. B1.

[35] It is worthwhile noting that the Administration is opposed to the bill's provision that allows service contracts between shippers and conferences or multiple carriers due to the possibility of undue discrimination against small shippers, allows conferences the right to restrict individual confidential shippers contracts and would require the merging of the FMC with the STB. See "Shipping reform gets boost from DOT," ***American Shipper***, November 1997, p. 16.

[36] Beargie, Tony, "Ocean Shipping Reform Act of 1995, 1996, 1997, 1998?" ***American Shipper***, December 1997, pp. 10-11.

[37] See ***Report of the Advisory Commission on Conferences in Ocean Shipping***, April 1992, pp. 37-39, and Anderson, R. D., and Khosla, S. D., "Canada's New Shipping Conference Legislation: Provision for Competition within the Cartel System," ***Canadian Competition Policy Record***, V. 9, No. 1, March 1988, pp. 8-10.

[38] In the US, intermodal rates are covered under section 7; and, in Canada it is covered under section 5(2). Intermodal rates are not covered under ECC Regulation 4056/86. Application for such exemption must satisfy Article 85(3) of the Treaty of Rome.

[39] Section 10 of the Shipping Act of 1984 specifies that 'no conference or group of two or more ocean carriers may ... negotiate with a non-ocean carrier or group of non-ocean carriers (for example, truck, rail or air operators) on any matters related to rates and services provided to ocean common carriers within the U.S.' However, it concludes with 'For purposes of this section, a joint venture or consortium of two or more common carriers but operated as a single entity shall be treated as a single carrier.'

[40] A distinction is often made between joint intermodal operations, joint intermodal pricing, and intermodal contracting with other modes and whether they are all granted immunity. In the US, joint intermodal **operations** between an ocean line or lines (acting as a single entity) and a railway is permitted. However, it should be noted that this does not apply to the operation by several ocean carriers. In Europe, joint operation is illegal, unless specifically exempted from the competition laws.

[41] "FEFC under attack as Europe outlaws inland rate fixing," ***Lloyd's List***, Thursday, December 22, 1994, p. 1.

[42] In the US whether an individual shipping line can offer intermodal rates is within the jurisdiction of the conference. In Canada, the offering of rates agreed to by an individual carrier or more than one (but not the conference) and other modes are encouraged. The recent recommendation of NTARC that *SCEA* be amended to permit intermodal rate making between a conference and other transport modes appears to be heading in the opposite direction. It appears that the NTARC's view is based on the belief that the gains from efficiency of such arrangements and the demand of shippers outweigh the potential benefits from competition.

[43] In the US, service contracts are covered under sections 8(c) and 5(b)(8); and, in Canada it is covered under section 4(1)(c).

[44] "TACA Lines get Thursday FMC Deadline," ***The Journal of Commerce***, N.Y., Monday, March 6, 1995, p. 1A; and, "TACA Agrees to FMC terms; Inquiry dropped," ***The Journal of Commerce***, N.Y., Monday, March 10, 1995, pp. 1A-10A.

[45] In the US, independent action is covered under section 15; and, in Canada it is covered under section 4(3)(a) to(c).

[46] In the US, tariff filing is covered under section 18; and, in Canada it is covered under sections 6 and 10.

[47] The basic reason for tariff filing and enforcement is that it provides protection to the small shipper against possible discrimination.

[48] In the US, antitrust immunity is covered under section 7; in Canada it is covered under sections 4 to 5; and, in the EEC it is covered under sections 3 to 5.

ALLIANCES IN THE AIRLINE MARKET: AN EMPIRICAL PERSPECTIVE

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1 – Preface

The implementation of deregulation processes in major airline markets (US, Canada, Australia and Europe) and the inherent, slow path of liberalisation in the entire industry, have led to focused competitive answers to match newly established rules of conduct.
One of the most prominent and clear trends has dealt with alliance agreements signed by pairs or groups of carriers.They have basically permitted the constitution of "seamless" integrated networks between medium-sized and large partners. This path has been adopted as a means to upgrade service quality through an extension of the options offered to customers as to reach economies of scope. Other advantages seem the linking of Frequent Flyer Programs, Computer Reservation Systems and points of sale. In other words, while customers benefit from better networks, frequencies, products and services, the airlines'gains consist of revenue enhancements and cost savings through shared facilities and resources, thus meaning also economies of density and scale. This strategic conduct seems today deeply followed in the airline industry. A recent survey from Airline Business showed that 389 alliances, concerning 171 carriers, were operating in 1996, 60% of them signed after January 1992. Table 1 shows some of the evidences.

Table 1 - Evolution of airline alliances

	1994	**1995**	**1996**	**% increase 1994-1996**
Existing alliances	280	324	389	38.9
***Of which*: with equity stakes**	58	58	62	6.9
Without equity stakes	222	266	327	47.3
New alliances	Na	50	71	Na
No. Of airlines involved	136	153	171	25.7

Source: Airline Business, 1996 and The Economist, June 15th 1996.

In latter times, however, these kinds of agreements have been under focus of increasing interest, either by academics and consultants and by the main national Civil Aviation Authorities. Both of them are willing to investigate the real advantages of alliances for partners, checking they don't drive to dominant market positions or monopolies. Local Civil Aviation Authorities are eager to look for reciprocal deals in the opening of their markets, too, as to protect the interests of the single national carriers. For instance, the US Department of Transportation has ultimately granted anti-trust immunities only to alliances concerning carriers from countries that had previously signed an "open skies" agreement with the US Government.
This paper would like to deal with the analysis and discussion of the main types of alliances in the airline industry, on the basis of an empirical research concerning all major competitors.

2 – The birth of alliances

The widespread diffusion of types of alliances, dealing with pairs or network of firms, has deeply connaturalized the economic contexts in the last years. This trend has included virtually all market fields, from the electronic to the pharmaceutical and aircarft industries, till to reach service fields, as in the case of airlines. This strategic conduct has become preminent since the globalization of the major spheres of the economy. This market turmoil has not only increased the level of competition. It has dramatically changed the same dynamics of conduct, forcing many firms to start a resolute as fixed turnaround, the possible choices being:

1) grow in critical mass, by acquisition of other firms, possibly competitors;
2) grow in critical mass, by signing arrangements with market leaders or innovators;
3) maintain the current conduct, with great future risks to loose critical mass, strongly marginalizing its own position in the arena and being confined in restrict contexts, like the domestic market.

In their first wave, alliances were an unreplaceable and rapid tool for gaining a transfer of knowledge between partners, at a smaller cost than the one deriving from an internal process of building. Thus, these agreements would give precious support to paths of learning and comprehension in many firms, cutting cost figures tipically arising from the development of a new business or when restructuring an existing one.

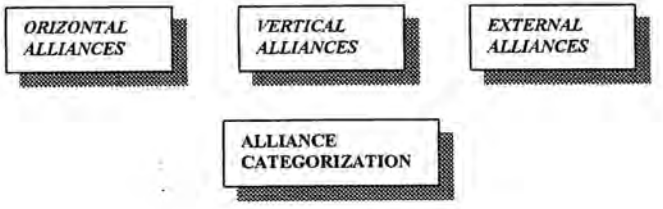
This observation seems still more significant in mature industries, or in contexts undergone from external factors to a sudden and drastic alteration of rules of the game like the airline industry in the adoption of laissez-faire approaches. The end of protectionist tactics and of financial supports from States would solicit competititors to invest in the developing of deepen customer-oriented policies. This would mean a process of reengineering the competitive strategy as to increase the scope of activity or break the entry of new and forceful competitors like low cost and low fare carriers.

In recent times alliances, under a juridical point of view, have been implemented not only through joint venture and licence agrements, but also involving forms of cooperation in research and development, personnel training and management, franchising and assembly contracts.

In some ambits, the tenure of alliances has been strenghtened by majority or minority equity acquisitions. This conduct seems, sometimes, justified from the will to start a strong and authoritative role inside the partnership, or, more often, to let the external audit understand the commitment towards profound long-term linkages.

Basically, there appear to exist three catogories in which to include virtually all kinds of alliances. These are named orizontal, vertical and external alliances (Figure 1).

Figure 1 – A theorical classification of alliances



Orizontal alliances are signed by firms acting in the same industry, either in the manifacturing or service context. Firms so far tend to develop an evolved form of trust in the industry, that may permit to rationalize the capacity offer and prevent macho fare wars. Vertical alliances deal, instead, with agreements between partners acting in different, but related, industries. These arrangements work on a quasi-vertical integration, regarding channel or supply-value chain partnerships, like in the

hospitality industry when dealing with hotel chains, tour operators and travel agents (e.g. the TUI-RIU alliance). Widely speaking, the same Japanese economic system is historically based on long-term supplier-buyer contracts and relationships. Eventually, external alliances clarify the will to diversify the range of activities as a strategic rather than financial investment. This type of alliance actually seems to be implemented when there is a goal to open "strategic windows" in a new industry showing high rates of return on investment.
Focusing on the airline industry, the first category hosts not only the major number of agreements between firms, but also appears the most significant under a qualitative view which we would enlight. Thus, the paper, from here onwards, will shift its focus on orizontal alliances' analysis.

3 - The airline industry: technological vs. commercial alliances

The trend towards cooperations and agreements in the airline industry is really not a recent output. Since the beginning of commercial aviation operations, more than 76 years ago, airlines have studied some sort of cooperative arrangements to provide a more efficient use of their assets and better services to passengers and cargo clients. This trend became evident in the '60s and '70s, when many carriers started to sign partial agreements regarding technical support and minor aspects in the marketing field.
Regarding marketing and commercial efforts, before the deregulation of the industry airlines were used to sign so called "pooling agreements" under the auspices of IATA boards. These agreements provided that all revenues generated on involved routes would be shared according to a specific algorithm, considering capacity offered, percentage of seats sold, and sometimes even more complex data. Pooling agreements, in some cases, would have even involved flight interlining. This sort of arrangement was, at those times, perfectly coherent with the rigid bilateral agreement system regulating traffics between pairs of countries. But pooling agreements would also induce carriers to implement similar strategic choices, mainly in terms of capacity, as not to indirectly favour a competitor-third State. This, at first sight, contradictory policy is broadly understandable if dated back to the Cold War process and the geo-political situation acting before the fall of the Berlin Wall.
Concerning technological aspects, instead, incentives for cooperation arised from know-how needs in the management of sofisticated and

expensive assets, like aircraft, and from the inherent search for scale economies under the cost-structure side. These aspects led in the '60s, starting in Europe, to the creation of consortia for the conjoint handling of partners' jet fleets. In 1968, KLM, SAS, Swissair and UTA constituted the KSSU consortium, which was responsible for the maintenance of DC10s and B747s aircraft and engines. In 1972, this path was imitated by Air France, Alitalia, Lufthansa and Sabena, which created the ATLAS consortium on the same basis as KSSU.

Deregulation of the major airline markets (US, Canada, Europe) and relaxation in some cases of bilateral ASA structures significantly touched the tenure and quality of alliances. From one side airlines began to study deeper forms of cooperation, involving more areas of responsability through the development or wider use of some devices like code-sharing between two or more carriers. This trick would enable to link schedules and selling tickets on one another's flights, boosting earnings without additional costs and disruptive competition increases. Table 2 shows some of the main code-sharing arrangements working in the airline industry, either they do or do not underline an alliance agreement.

Table 2 - Examples of major alliances concerning the airline industry.

Carrier	Country of origin	Alliances with
Adria Airways	Slovenia	Air France, Lufthansa
Aeroflot	Russia	Delta, other former CIS carriers
Air Canada	Canada	Lufthansa, United Airlines, SAS, Thai, Varig, Swissair, Iberia, Korean, Finnair, Royal Jordanian, British Midland
Air Madagascar	Madagascar	Air France, Air Mauritius, Air Austral, Air Comores
Air New Zealand	New Zealand	Canadian Airlines, JAL, Korean Air, Ansett, Air Pacific, Polynesian, Royal Tongan
Air Seychelles	Seychelles	Iberia
KLM UK (former Air UK)	UK	KLM, Northwest, CSA, Air One
Alitalia	Italy	KLM, Northwest, Continental, British Midland, Finnair, Malev, Minerva, Azzurra Air, Meridiana, LOT, CSA, Maersk Air, Canadian Airlines
All Nippon Airways	Japan	Austrian Airlines
American Airlines	USA	British Airways, SAA, Gulf Air, Canadian Airlines, Singapore Airlines, Qantas, JAL
Austrian Airlines	Austria	Swissair, Delta, Sabena and other 16 minor agreements

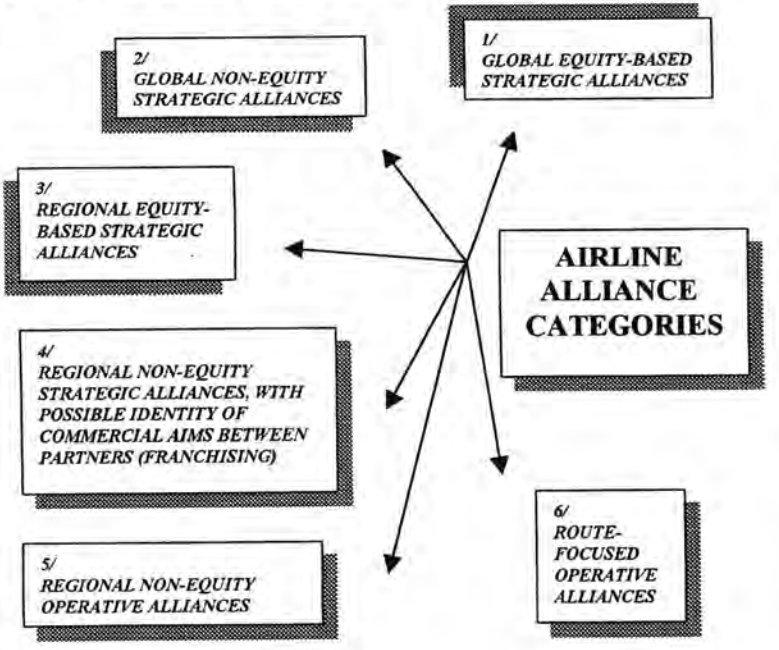
British Airways	UK	American Airlines, Qantas, DBA, TAT, JAL, British Airways Express carriers
British Midland	UK	SAS, United, American Airlines, Air Canada, TAP, Austrian Airlines, Alitalia and other 7 minor agreements
China Airlines	Taiwan	Garuda, Vietnam Airlines, Japan Asia, Martinair
Continental Airlines	USA	Northwest Airlines, America West Airlines, Alitalia, Air France, Virgin Atlantic.
Delta Air Lines	USA	Swissair, Austrian Airlines, Sabena, VASP, Air France, Delta Connection carriers
Eurowings	Germany	Air France, KLM, Northwest Airlines
Finnair	Finlandia	Air Canada, Alitalia, Air China, Austrian Airlines, Transwede
Icelandair	Iceland	SAS
JAL	Japan	Air France, KLM, British Airways
KLM	Netherlands	Alitalia, Northwest, Continental, KLM UK, Eurowings, Tyrolean, Maersk Air, Austrian Airlines, Cyprus Airways, ALM, Air Exel
LanChile	Cile	Air New Zealand, Ladeco
Lufthansa	Germania	SAS, United Airlines, Thai, Varig, Air Canada, SAA, Singapore Airlines, Air Dolomiti, All Nippon Airways, Team Lufthansa carriers
Malev	Hungary	Alitalia, Austrian Airlines, Delta, CSA, Air France
Olympic	Greece	VASP, Saudia
Portugalia	Portugal	TAP, Varig
Qantas	Australia	American, British Airways, Emirates, Canadian Airlines, Air Caledonie, Air New Zealand, Air Pacific, Air Zimbabwe, Air Niugini, Air Vanuatu
Sabena	Belgium	Swissair, Austrian, Delta
Singapore Airlines	Singapore	American Airlines, Lufthansa, Star Alliance carriers (pending)
Swissair	Switzerland	Delta, Air Canada, Austrian Airlines, Sabena
Thai	Thailand	Lufthansa, SAS, United Airlines, Air Canada, Varig
Trans World Airlines	USA	Philippine Airlines, Royal Jordanian, Air India
United Airlines	USA	Lufthansa, SAS, Thai, Varig, Air Caanada, All Nippon Airways, Iberia, United Express carriers.
Virgin Atlantic	UK	Continental, British Midland

Source: Air Transport World, june 1996, and Author's information.

From another point the adoption of a longer-term, customer-focused corporate philosophy implied the look for one or more partners with no more similar, but complementary route networks, as to increase the scope

of operations and quality of service. A multi-regional or global route network was able to provide partners with a major ability in attracting demand without needing to increase the number of directly served destinations. This condition would cut marginal operating costs thanks to route density economies. New kinds of alliances were, then, created by carriers. We can try to classify them basically concerning their different strategic aim. It seems possible to identify 6 categories of airline alliances. These categories are obviously able to include the major part, but not all, of airline alliances. In fact there are some arrangements that have to be considered in more than one categorization. Figure 2 shows the six categories of alliances found in the analysis of the world airline industry.

Figure 2 – The six categories of alliances.



The following paragraphs will examine each one of the categories of airline alliances identified.

4 - Global equity-based strategic alliances

Global equity-based strategic alliances appear the most difficult topic of arrangements to study and implement. This is due, first, to the great deal of money involved, with direct impacts on financial ratios and balance sheets of buyer-carriers. Thus, under this view, this typology seems eligible only to "rich" carriers. In 1992, British Airways spent $400 million USD to acquire 24,6% of USAir equities. In fact, this partnership may assure a better allocation of financial resources through a merger of route networks. Eventually, this agreement may include a strict integration of price policies, service, brand and crew management, fidelity schemes, reservation systems and points of sale rationalisation, as in the Delta-Swissair-Sabena-Austrian Airlines Atlantic Alliance. These alliances tipically work on an "open-skies" agreement basis between carriers'countries of origin, thus allowing the best of cooperation under all marketing aspects.

Global equity-based strategic partnerships are, however, in many cases able to lie a great number of ambushes for their fair management. From one side, the financial investment in the partner could result seriously compromised in case may it have troubles, such as in the SAS-Texas Air business. SAS was forced to write off its investment in the US carrier due to its severe losses in the post-deregulation environment. From another point of view, substantial savings and revenue gains might have a counterpart in producing various grades of difficulty in coordination processes, appearing very hard to manage in case they explode in Board of Directors.

We just have to look at the Northwest-KLM partnership. This equity-based global alliance has been, and still is, widely recognized as the most successful in the industry. The US Department of Transportation showed that this arrangement has produced savings plus productivity and revenue increases in an order between 125 and 175 million of USD for NWA, and in roughly 100 million for KLM. At the same time, the two partners' market share concerning Atlantic operations has increased from 7% in 1989 (year of start-up of the alliance) till to 11,5% in 1994. But these glorious results have not prevented a large number of underground conflicts, mainly in the Northwest Board. KLM showed interest to increase its equity share well above that 25% limiting foreign

investments in US carriers. US Northwest investors wanted to buy back this equity part, sold in 1989 when the US carrier was in troubles and now is one of the most profitable ones, as to regain some sort of freedom from the Dutch close control. The end of this conflict was the decision of KLM to sell back its equities to Northwest and transform the alliance into a global not-equity based one, including new common partners Alitalia and Continental, too.

5 - Global non-equity strategic alliances

This kind of agreement doesn't regard as before, at least ab initio, a transaction of equity stocks between partners involved. Moreover, there can be two kinds of global, non-equity, strategic alliances. A multi-actor alliance, like the Star Alliance involving Lufthansa, United Airlines, SAS, Air Canada, Thai International Airways, Varig and probably SIA and All Nippon Airways, looks for a global coverage through linking various medium sized competitors, and it seems the most profitable one. Multi-actor alliances, thanks to their critical mass, are likely to rapidly produce large density, scope and scale economies from joint passenger and aircraft handlings. A two-actor alliance, like the forthcoming British Airways and American Airlines, is a more ambitious one. It tries to drive emphasis, in consumers' eyes, on the global role already played by carriers before reaching the partnership. This consequently implies they don't necessarily need to create a new brand (like in the Star Alliance case), but just connect their strong ones. That is, however, true only in part, because the two-actor alliance tipically works also thanks to the operative help of other minor carriers already linked by regional agreements, like Qantas for BA and Canadian Airlines for AA, which are not strongly mentioned to public when presenting the alliance.

The main goal of global equity-based alliances, namely the creation of integrated and seamless route networks for economic reasons, seems reached even in this kind of partnership. The basic difference between equity and non-equity partnerships lies in the fact that latters are supported only by a will and commitment to the reach of commercial goals of common interest in terms of revenues and market dominance.

The depth of this commitment will be the final judge for the duration of these arrangements. In case of scarse engagement of one or more partners towards medium-long term objectives or of a newly-come different market vision, these arrangements tend to finish rapidly and in a very easy way. For example, the global non-equity alliance signed by

British Airways and United Airlines in 1987 broke rapidly when the US carrier, acquiring route authorities for European destinations, came to compete with its British partner directly in its home market and hub. However, this alliance is less and less risky, under financial and managerial matters, that the precedent one. It doesn't either exclude, under a theorical point of view, future moves towards equity partnerships, mainly minority ones, whanever proving to be fairly efficient in the market.

6 - Regional equity-based strategic alliances

This third topic of arrangement deals with alliances built on a regional scope of operations and supported by an equity participation of one partner in the other. Table 3 shows some examples of this kind of agreement.

Table 3 – Some examples of significant regional equity-based alliances

Carrier	Acquired by (carrier)	Percentage of equities bought
Aeroperù (Perù)	Aeromexico	47%
Air New Zealand (New Zealand)	JAL	5%
Air One (Italy)	Swissair	30% (estimated)
Air Pacific (Fiji)	Qantas	17,5%
Ansett (Australia)	Air New Zealand	50%
Austrian Airlines (Austria)	Air France	1,5%
Austrian Airlines (Austria)	Swissair	10%
British Midland (UK)	SAS	40%
Canadian Airlines (Canada)	American Airlines	33%
KLM UK	KLM	100%
Luxair (Luxemburg)	Lufthansa	13%
Malev (Hungary)	Alitalia	30%
Royal Air Cambodge (Cambodge)	Singapore Airlines	40%
Sabena (Belgium)	Swissair	49,9%
TAT/ Air Liberté (France)	British Airways	100%

Source: Hanlon, 1996, and Author's information

This sort of alliance usually clarifies a proactive, and often aggressive, path by the acquiring carrier. From one side, this attitude may be explained by the attempt of draining long-haul traffic from a major rival, as to compromise its share of dominance of that market. This tipically

happens when a national airline acquires a participation in a carrier which operates in the home market of its major competitor or of the major competitor in the region, as in the KLM/Air UK and SAS/British Midland cases. Other motivations arise when a carrier seeks to broaden its operations towards or inside countries for which present legislations, in terms mainly of bilateral agreements, don't permit an autonomous increase in the range of routes and capacity. Alitalia chose to acquire a stake in Malev to develop its Hungarian activies and, broadly speaking, to obtain some sort of induced market penetration in many East European markets. Swissair, too, decided to acquire 49,9% of Belgian national carrier Sabena and 30% of Italy's Air One to strenghten its position in the European Free Market where it still faces close bilateral contraints. Eventually, this strategic move seems to be implemented when a major airline seeks a smaller partner with lower operative costs. The aim is to shift routes that, due to the number of competitors or scarse demand, no more support direct services from the major carrier. For example, Lufthansa originally acquired the Austrian carrier Lauda Air to subcontract low-density routes that needed a fairer cost structure to have an economic sense.

7 - Regional non-equity strategic alliances, with possible identity of commercial aims between partners (franchising).

Regional non-equity strategic alliances seem, at first sight, an unexpensive tool to reinforce the regional networks of carriers involved through linkages with partners of roughly the same size, in terms of revenues, aircraft and destinations served. This path appears evident in case of attack in major markets, like the US or Europe, of low-cost operators, implying a need for a rapid answer in terms of route flexibility, cost cuttings and price flexibility. The America West Airlines-Continental Airlines alliance fixes perfectly to this kind of agreement. The main scope of the alliance was to contrast Southwest Airlines' price offers between the two airlines' main hubs, namely Phoenix for AWA and Houston for Continental. The airlines succeeded in their scope, forcing Southwest to cut 10% of its capacity along the Houston-Phoenix route and divert its market attentions to the Florida market.
Serious problems in the implementation steps, however, boom even in this case. It took two years for Continental and AWA to work the operational kinks out of their linkage. But the biggest problems arose in terms of cross-employee relations. In Houston, Continental ground

workers were often used to give their flights preferential treatment over planes from AWA, and the same happened for AWA workers in Phoenix. Thus, when airlines operating in the same markets link in a non-equital mode, some sort of spirit of competition seem very difficult to contrast and make it cease. Most of all, it appears hard to make workers understand why they would have to treat like a friend a carrier that has been targeted for many years as a bandit.

Regional non-equity strategic alliances may, however, also search a closer identity of commercial aims between partners. This arrangement seems, today, mostly based on the use of the franchising device. These arrangements provide that a medium or large sized carrier, usually a so-called "megacarrier", acting as a franchisor, grant a minor operator, namely a franchisee, the chance to use its livery and flight code. The minor carrier will commit in paying a certain percentage of money (fee) according to its gross revenue, and a fixed royalty when entering the commercial organisation of the franchisor.

The development of franchising tactics in the airline industry dates back to early '80s. At those times, most of majors started to rationalise their network structure and exit from minor routes, where under the CAB authority they had been forced to operate, even under loss. The process led to the redesign of networks based on hub & spoke systems. Soon, however, megacarriers'interest to acquire a continued increase in their amount of passengers for feedering hubs led to explore various forms of arrangements with the regionals still existing after the bloody fare wars.

The franchising device assured megacarriers to retain, and possibly multiply, their presence even in low-demand markets with no direct service and without assuming any sort of cost, except perhaps advertising ones. Regional carriers, instead, obtained a far larger visibility, thanks to the halo effect stemming from the use of a well-known brand. Franchising, then, born in the US, was rapidly exported in Canada and Australia, and eventually in Europe, when this market was finally deregulated, too. Here the major user of franchising is British Airways, that under the British Airways Express umbrella program embraces seven British carriers, one Scandinavian operator and one South-African airline.

The advantages of franchising in the airline industry seem clear and not regarding the sole aspect of costs. Franchisors virtually cancel any form of direct or incumbent competition on some routes, having the chance to redeploy scarse assets where they need without losing market power. Franchisees are, instead, assured a long-term perspective and the chance

to appear on reservation systems thanks to the partner's code avoiding to be ejected from the industry.

8 - Regional non-equity operative alliances.

Regional non-equity operative alliances seem basically an evolved form of those interlining agreements we spoke about earlier in this paper and that connaturated the pre-deregulation environment. These arrangements have been often signed even without the use of code-sharing, sometimes due to partners' choice or to political and law constraints that prohibit its use. For example, some years ago Alitalia and Iberia reached an arrangement like that. Iberia carried its Far East passengers to Alitalia's Rome hub, where they would board an Alitalia non stop flight. Alitalia used the Iberia's Madrid hub for all its South-American passengers. This agreement didn't provide, for their own choice, any form of code-sharing use on the two European carriers' flights.
The goal of carriers that choose this type of alliance seems defensive. The partners try to prevent a severe loss of market share due to the attack of carriers as part of alliances of the first two types described. However, if the partners don't succeed in communicating directly to customers these agreements, they will gain few economic results, thanks to rivals' ability to better reassure of the quality of their seamless networks, meaning faster connection times, check-in procedures, and so on. Thus, they will loose a significant part of the market which is demand-pull and on which there's also strong pressure from the wild use of Frequent Flyer fidelity schemes. These considerations allow to identify this kind of alliance as a more operative and short-term one, linked to a "laze and blaze" conduct. This one may often underlie an absence of a clear strategical view or management fears towards serious long-run decisions in case the wrong partners' choice.

9 - Route-focused operative alliances.

This sort of arrangement concerns airlines seekings way of cooperating only on a specific route. For example, we may consider the Canadian Airlines-Alitalia agreement on the Toronto-Rome route, or the Alitalia-Air France arrangement working on some French-Italian destinations.
Partners seem forced to deal with this basic form of alliance when looking for rapid tool to rationalise capacity, either for low and diminishing demand trends or for shortage of planes in fleet. Airlines

code-share their flights, obtain a certain amount of seats to sell on this virtually common flights, and maintain this service indirectly increasing the number of frequencies per week, too. Route-focused operative alliances appear a clear defensive tactic, too. They are, with few exceptions, an imitation of pooling agreements, so friendly in '60s and '70s, as even here airlines appear to share costs, through coordination of flight activities per die, and thus revenues. They usually have a limited time duration, roughtly six months. If, at the end of this period, carriers don't find to manage better competitive solutions, they will likely maintain this type of low-profile alliance.

10 .Future scenarios involving airline alliances

The outcome of some sort of forecast concerning the airline industry seems really hard. Many theories involving the evolution of the industry have been invalidated by evidence. At the beginning of '90s, for example, Jan Carlzon, former Scandinavian Airline System's CEO, explained that with the implementation of the Third EU Package for the deregulation of the European market only 5 major airlines would survive. This concept appears now fairly wrong.
Today's evidence, however, doesn't explain this sort of result has been achieved thanks to a continue flux of subsidies from Governments to national airlines. They have fairly prevented any sort of real competition and a wave of new entries, exits, failures and mergers in the local industry as a real laissez-faire approach should provide. By the way, in the case of Europe these subsidies have been approved by the EU Commission that would have had to prohibit and investigate any form of State interference in the newly deregulated market and in its competitive conducts. Despite these clear obstacles, all major airline speakers today affirm that the increasing power of alliances and their strategic role will conduct, in a reasonable short number of years, to market concentration on a global scale. The industry will become dominated by macro-groups of competitors with the death or the marginalization in short geographical and economical contexts of carriers that will choose to stay independent or will not find any reasonable partner due to poor economic conditions.
Major doubts come to mind when dealing with the legal environment which will drive to this change. Will alliances remain dominant or will we assist at processes of merging?

These questions need an answer first at political level, from ICAO officials and, broadly, from bilateral and multi-lateral arrangements, as in the European Union, NAFTA, ASEAN cases.
If the airline industry gives the chance to realize not only an "open skies" policy, but a real global liberalization, we will probably look at the death of the country-of-origin concept and the built-up of those macro-carriers with global networks directly controlled and with a market presence and relevance in all major economic areas.
At this point, some doubts seem to come when dealing with market concentration, as this could drive to a damage of the welfare of passengers and customers due to significant tariff increases and poorer service offers. In fact, a decrease of the number of competitors is usually linked with higher collusion risks between operators, with chances to fix high margins of return as in a quasi-monopolistic view. The present trend of alliance, which mostly provides for a search of partners with complementary and not xeroxed networks, seems to suggest that the economic contest will start between actors that will show scarse incentives to collusion tricks, at least in first times. They, on the contrary, will be forced to conquer new spaces of action through the acquisition of minor profitable independent carriers. However, it appears otherwise clear that competition will be seriously cut or cancelled along routes that connect two hubs of the same macro-competitor, for example. According to the US experience, hub dominance has increased tariffs from a minimum of 15% till 28% on average in the case of Charlotte, NC. It would be highly suggested, thus, together with the relaxation and exit of the actual regulation activity, the implementation of some sort of rules that would prevent from the real beginning violations of what economists call "public interest".

11 - Reference

Ansoff, H.I. (1980), Marketing strategico, Etas Libri, Milano;
Caves R. (1962), Air transports and its regulators, Harvard University Press, Cambridge;
Contractor F.J., Lorange P. (1988), Cooperative strategies in international business, Lexington Books, Lexington;
Feldman, J. (1996), Some call it oligopoly, Air Transport World, May;
Fredricksen, J. (1990), Perspectives on strategic management, Ballinger, Cambridge;

Hamel G., Pralahad C.K., Doz Y.L. (1989), Collaborate with your competitors - and win, Harvard Buiness Review, January-February;
Hamel G., Pralahad C.K. (1994), Competing for the future, Harvard Business School Press, Cambridge;
Hamill, J. (1993), Competitive strategies in the world airline industry, European Management Journal, Vol.11, Issue 3;
Hanlon, P. (1996), Global alliances, Butterworth Heinemann, Oxford;
Jarach, D., Valdani E. (1996), La deregulation del trasporto aereo in Europa: il caso Italia, Economia & Management, September;
Jarach D., Valdani E. (1997), Compagnie aeree e deregulation, strategie di marketing nei cieli senza frontiere, EGEA, Milan;
Kaynak E., Orsay K. (1993), Successful marketing for survival: the airline industry, Management Decision, Vol.31, Issue 5;
Porter, M. (1986), Competition in global industries, Harvard Business School Press, Cambridge;
Valdani, E. (1992), Marketing globale, EGEA, Milan;
Valdani, E. (1995), Marketing strategico, Etas, 2nd edition, Milan;
Yoshino M., Srinivarasa Rangan U.(1995), Strategic alliances, Harvard Business School Press, Cambridge.

An Analysis of Profitability of the World's Major Airlines

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ABSTRACT: Airline profitability depends on airlines' cost competitiveness and their ability to price above costs. And the ability to set prices above cost depends on market power and the firm's ability to make use of innovative pricing techniques and market information. In the past, some carriers have been profitable without being cost competitive because they were able to charge exorbitant prices to consumers. Increased competition in the international air transport markets have put pressures on carriers' ability to raise prices. At the same time, input prices have been increasing continuously. To counter-act such trends, airlines have made tremendous efforts to improve efficiency and productivity in order to cut cost. Using a yearly panel of 22 major airlines over the 1986-95 period, this paper examines airlines' profitability changes by examining changes in productivity and their ability to price above cost. The study found that European and Asian carriers consistently improved productivity throughout the period even during the time of rising profitability, achieving higher productivity growth than North American carriers. However, European and Asian carriers experienced much faster decline in price recovery ability than North American carriers, because their input prices have increased rapidly and airfares have declined under the pressures of increased competition. Overall, airline profitability have improved during the 1990s.

INTRODUCTION

International skies have been substantially liberalized since the early 1980s. Like many other industries, the international airline industry is becoming increasingly exposed to the pressures of the market-place as deregulation and liberalization processes advance. Increased competition generally has two conflicting effects on the firms: it creates downward pressures on output prices, and it creates incentives for improving

productivity and efficiency (Spence, 1986). In the international air transport market, the increased competition (together with increasing input prices) has in many cases led to decline in firm profits, as carriers' monopoly positions are challenged. Profitability is an important factor contributing to airlines' survival. Many airlines have been forced to undertake major restructuring in order to reverse the declining profit by improving productivity and efficiency.

A number of studies, such as Bailey, Graham, and Kaplan (1985), Morrison and Winston (1986, 1995), Bruning and Hu (1988), and Antoniou (1992), have addressed the issue of airline profitability,. These studies either posit possible relationships between profitability and a number of potential pertinent variables, or test such relationships through regression analysis. In this study, we take a somewhat different approach to examine the underlying dimensions of airline profitability. In particular, the American Productivity Center (APC) model is used to decompose changes in airline profitability into two components capturing changes in productivity and price recovery ability (Miller, 1984, Banker, Chang, and Majumdar, 1993, 1996). The APC model is gross-profit oriented and focuses on total factor productivity. Profitability is defined as the function of productivity and price recovery.

The paper is organized as follows: Section 2 describe the APC model; Section 3 briefly describes the sample airlines and the data; the APC model is applied to explain changes in the performance of the world's 22 major airlines in Section 4; Section 5 contains a summary and concluding remarks.

THE APC MODEL

The APC model is based on actual quantities and prices of outputs and inputs over a period of time. Changes in profitability are defined as the product of changes in productivity and changes in price recovery. The total dollar effects of both productivity and price recovery are used to explain changes in profitability from one period to another. For outputs and inputs, dollar values are determined by multiplying a physical quantity by unit price. Change in profitability is measured by the comparison between relative changes in values of outputs and inputs.

A profitability change ratio is defined as the ratio of profitability for period t to profitability for base period 0. It can be expressed as:

$$lity(PFTBLT) = \frac{\pi^t}{\pi^0} = \frac{p^t y^t / w^t x^t}{p^0 y^0 / w^0 x^0} \qquad (1)$$

where

y^t is the output quantity at period t, t = 0, 1, 2, ... T
p^t is the price per unit of output at period t, t = 0,1,2, ..., T
x^t is the input quantity at period t, t = 0, 1, 2, ..., T
w^t is the price per unit of input at period t, t = 0,1,2, ..., T.
t = 0 is the base period.

This profitability change ratio can be decomposed into changes in productivity and changes in price recovery. The APC productivity change ratio (APRDT) is the ratio of the values of current period outputs to base period outputs, divided by the ratio of the values of current period inputs to base period inputs. It is expressed:

$$APRDT = \frac{p^0 y^t / p^0 y^0}{w^t x^t / w^t x^0} \tag{2}$$

Equation (2) holds output prices constant at base period levels while capturing changes in output quantities, and holds input prices constant at current period levels while capturing changes in input quantities.

The APC price recovery ratio (APRCR) is the ratio of value of outputs at current period prices to the value at base period prices, divided by the ratio of the value of inputs at current period prices to the value at base period prices. It is expressed:

$$APRCR = \frac{p^t y^t / p^0 y^t}{w^t x^o / w^0 x^0} \tag{3}$$

Equation (3) holds output constant at current period level while output prices are allowed to vary, and inputs are held constant at base period level while input prices vary.

Equation (1) is the product of equations (2) and (3). Improvement in productivity performance and/or price recovery ability will lead to improvement in profitability. This decomposition is useful for identifying to what extent the change in profitability is influenced by changes in output and input prices and by changes in productivity.

SAMPLE AIRLINES AND THE DATA

Sample Airlines

The selected airlines are all international carriers, and have significant involvement in scheduled passenger services. Some of the airlines are 100 percent state owned, some are private companies, while others have mixed ownership. For example, Air France, Iberia and Thai

International are government owned, while the US carriers are all private companies.

Exhibit 1 provides some recent descriptive statistics of the airlines[1]. The size of the airlines, as measured by revenue tonne-kilometres (RTK) in 1995, ranges from 2.2 billion RTK for Scandinavian Airlines Systems (SAS), to 19.6 billion RTK for United Airlines. In terms of number of passengers carried in 1995, it ranges from 8.3 million (8.6 million in 1996) for Canadian Airlines International (CAI), to 87 million (97 million in 1996) for Delta.

Aside from US carriers, most of the sample airlines provide mainly international services, some do not provide domestic services at all. Qantas, Singapore Airlines (SIA), Cathay Pacific and Japan Airlines (JAL) serve mostly inter-continental traffic, while US Air and SAS have a large proportion of their business in domestic or intra-continental traffic.

Profitability performance varies greatly among the sample airlines. British Airways, SIA and Northwest Airlines were the most profitable in 1995, with net income of US$740 million, US$622 million (US$624 million in 1996), and US$ 506 million (US$536 million in 1996), respectively. Air France suffered the biggest loss, a net loss of US$581 million, in 1995. Iberia and Canadian Airlines International (CAI) also suffered losses in 1995, at a net loss of US$361 million and US$143 million (US$137 million in 1996), respectively. CAI is the only airline in our sample that incurred an operating loss[2] in 1995. All of the Asian carriers were able to achieve a positive net income in 1995.

Data Sources

A panel of 22 airlines over the 1986-1995 period forms the primary data base for this study. The annual data were compiled mainly from **Digest of Statistics** published by the International Civil Aviation Organization (ICAO), in particular, the annual series on **Traffic**, **Fleet-Personnel**, and **Financial Data**. Additional data were obtained directly from airline companies, airlines' annual reports, the **Airline Monitor**, **IATA publications**, **Statistics Canada** publications, and other sources.

Outputs

Five categories of airline outputs are considered: scheduled passenger service (measured in revenue tonne kilometres or RTK), scheduled freight service (measured in RTK), mail service (measured in RTK), non scheduled services (measured in RTK), and incidental services (non airline businesses). Incidental services include a wide variety of non airline businesses such as catering services, ground handling, aircraft

maintenance and reservation services for other airlines, sales of technology, consulting services, and hotel business.

A quantity index is constructed for the incidental output in order to include the incidental services in our analysis. The index is computed by deflating the incidental revenues by a general price index constructed using the Purchasing Power Parity (PPP) index for GDP obtained from the Penn World Table (Summers and Heston, 1991) and U.S. GDP deflator. The PPP index adjusts for changes in market exchange rates and changes in real price levels of various countries relative to the U.S., and the US GDP deflator ensures that the quantity index is comparable over time.

A multilateral output index was formed by aggregating the five categories of outputs using the multilateral index procedure proposed by Caves, Christensen, and Diewert (1982). Output price was then computed by dividing total revenues by the aggregate output index.

Inputs

We distinguish five categories of input: labour, fuel, materials, flight equipment, and ground property and equipment (GPE). Labour input is measured by total number of employees. Fuel input is measured in gallons of fuel consumed. For flight equipment, a fleet quantity index is constructed by aggregating different types of aircraft using the translog multilateral index procedure proposed by Caves, Christensen, and Diewert (1982). The leasing price series[3] for these aircraft types are used as the weights for aggregation. The annual cost for each aircraft type is estimated by the product of the lease price and the number of airplanes. Total annualized aircraft cost is then computed as the sum across all categories of aircraft. The real stock of ground properties and equipment (GPE) is estimated using the perpetual inventory method. Under the assumption that the flow of capital service is proportional to the capital stock, the annual cost of using GPE is computed by multiplying the real GPE stock by a GPE service price. The GPE service price is constructed using the method proposed by Christensen and Jorgenson (1969) which accounts for interest, depreciation, corporate income and property taxes, and capital gains or losses. Since the GPE costs are small relative to the costs of flight equipment, these two categories of capital inputs are further aggregated into a single capital stock series using the translog multilateral index procedure. The materials input contains all other inputs, not included in any of the input categories discussed above (labour, fuel, and capital). As such, materials cost is the catch-all cost category, and thus includes numerous items including airport fees, sales commissions, passenger meals, employee travel, consultants, non-labour repair and maintenance expenses, stationery,

and other purchased goods and services. The materials cost is computed by subtracting labour, fuel and capital input costs from the total operating cost reported in ICAO's **Financial Data**. As in the case of incidental output, it is necessary to construct a materials quantity index in order to include the materials input in our analysis. Since the materials cost also includes numerous items and activities, the same general price index is used to deflate the materials cost to compute the materials quantity index.

As in the case of output, the five categories of inputs were aggregated to form a multilateral input index using the translog multilateral index procedure proposed by Caves, Christensen and Diewert (1982)[4]. Price per unit of input was then calculated by dividing the total input cost by the aggregate input index. Note that total input cost here includes costs of labour, fuel, materials, flight equipment, and ground property and equipment (GPE).

Airline profit is calculated by dividing total revenue by total input cost. This measure reflects economic profit rather than operating profit, since the costs of aircraft and GPE are included in the total input cost.

PROFITABILITY, PRODUCTIVITY AND PRICE RECOVERY PATTERNS

This section examines the changes in airlines' profitability in relation to productivity change ratio and price recovery ratio.

North American Carriers

Exhibits 2-9 present the APC ratios for the eight North American carriers. Between 1986 and 1995, Northwest (NW), United Airlines (UA), Air Canada (AC), American Airlines (AA), Delta, and Canadian Airlines International (CAI) increased profitability by 12%, 11%, 8%, 5.5%, and 2%, respectively. In contrast, US Air experienced about 6% decline in its profitability. There were some fluctuations in Continental's profitability performance during the sample period, but not significant.

Most North American carriers improved their productivity during the period, with Delta achieving the highest productivity growth at 34%, followed closely by CAI at 29.8%. On the other hand, the carriers' price recovery ratios generally declined during the period, with the exception of Continental. Delta and CAI experienced substantial decline in their price recovery ratios, both at 21%. Profitability improvement from productivity growth was off-set by the negative impact of falling price recovery ratio. As a result, only modest profitability improvement was observed at Delta and CAI during the period. Northwest, United and Air Canada also achieved considerable productivity growth, 21%, 25% and 19%, respectively, but experienced less decline in price recovery ratio (7%, 11% and 9%,

respectively). As a result, they were able to achieve higher profitability improvement, 12%, 11% and 8%, respectively. American Airlines improved productivity growth by 12%, and endured 7% decline in its price recovery ratio. The net result was a 4.7% increase in profitability. Continental is the only North American carrier which experienced a negative productivity growth (7%) during the sample period. It is also the only North American carrier which improved its price recovery ratio (7%). As a result, there was little change in Continental's profitability between 1986 and 1995. US Air achieved a 16% improvement in productivity, but suffered a 20% loss in its price recovery ratio. Consequently, it experienced a 6% decline in its profitability. It is the only North American carrier which experienced falling profitability during the sample period.

Overall, the improvement in productivity growth was due to enhanced efficiency and changes in airlines' network characteristics (Oum and Yu, 1995). For example, average stage length of the carriers generally increased during the sample period (Oum and Yu, 1997), leading to higher observed productivity level. The declining price recovery ability could be attributed to the fact that input prices have been rising faster than airline yield (in nominal term) in North America[5]. Continental was the only carrier in North America which saw its yield rose faster than its input prices, thus improvement in its price recovery ratio.

European Carriers

Exhibits 10-16 present the APC ratios for the seven European carriers. Among the European carriers, KLM and BA made the most significant profitability improvement during the period, 15% and 14%, respectively. Their profitability improvement was achieved through significant productivity improvement of 43% and 36%, respectively, despite the considerable loss of their price recovery ratio (20% and 17%, respectively). The declining price recovery ability was caused mostly by input prices rising substantially faster than airline yields. Swissair and Lufthansa also suffered 17% decline in price recovery ratio, same as BA. Their productivity improvement (28% and 24%, respectively), however, was not as significant as BA's. Consequently, Swissair and Lufthansa were not able to achieve as much profitability improvement as BA. SAS and Iberia increased their profitability by 8% and 9%, respectively. This was a result of productivity growth of respective 13% and 16%, and a decrease in price recovery ratio of 8% and 9%, respectively. Air France appears to have made substantial improvement in productivity, but it also experienced significant decline in its price recovery ratio. The result was a mere 2.5% increase in its profitability. While most European carriers suffered loss in

price recovery ability because of yield increases not being able to keep up with increases in input prices, Air France's average yield actually declined in nominal term between 1986 and 1995.

Asian Carriers

Exhibits 17-23 presents the APC ratios for the Asian carriers. Qantas made the most significant profitability improvement at 23%. This is a result of 32% productivity growth and 7% decline in price recovery ratio, which was due mostly to the fact that input prices were rising faster than average yields. Singapore Airlines and Thai Airways also improved profitability considerably. Again, this is attributable to high productivity growth, 20% and 48% respectively, after compensating for losses in price recovery ratio, 9% and 23%, respectively. Korean Air achieved the most significant productivity growth during the period at 53%. However, it also suffered the largest decline in price recovery ratio (34%), which was a result of 65% increase in input prices overpowering the 10% increase in average yields. Consequently, Korean Air was not able to make any significant profitability improvement. Japan Airlines (JAL) was able to make modest profitability improvement (4%) despite a modest productivity growth (7%), because it was able to maintain its price recovery ratio during the period.

All Nippon Airways (ANA) and Cathay Pacific suffered considerable losses in profitability despite productivity growth of 9% and 14%, respectively. Again, this was caused by input prices rising faster than yields. This was particularly true in the case of Cathay Pacific: 50% increase in input prices versus 13% increase in average yields.

Comparison among North American, European and Asian Carriers

To compare across carriers in different continents, average change ratios for North American, European and Asian carriers are reported in Exhibits 24, 25 and 26, respectively. North American carriers, on average, saw their profitability improved between 1986 and 1988 despite of a slight decline in productivity. This was a result of improved price recovery ratio. Since 1988, however, North American carriers' price recovery ratio has been consistently declining. On the other hand, productivity change ratio rose monotonically from 1991 to 1995. The combined effects of lower productivity ratio and lower price recovery ratio led to lower profitability during 1990-1992. Between 1992 to 1995, the positive impact of productivity improvement was able to over-power the negative impact of falling price recovery ratio, resulting in profitability improvement for the carriers.

European carriers also experienced improved profitability between

1986 and 1988. However, this improvement was a result of improved productivity despite of a slight fall in price recovery ratio. In general, European carriers consistently achieved significant productivity growth during the period, except for a slight stumble during the 1990-1991 recession. At the same time, their price recovery ratio dropped substantially. Profitability was at the lowest point in 1990, remained essentially unchanged between 1990 and 1993, then improved noticeably thereafter.

Asian carriers followed a similar changing pattern to that of European carriers. They achieved significant profitability improvement between 1986 and 1988, higher than their North American and European counterparts. Like the European carriers, this was mostly attributed to productivity growth. Asian carriers also consistently improved their productivity during the period, while suffering significant fall in their price recovery ability. Profitability peaked in 1988, then dropped considerably between 1988 and 1990, and had generally improved since 1990.

SUMMARY AND CONCLUDING REMARKS

This paper examines changes in the profitability, productivity and price recovery of the world's 22 major airlines over a ten year period. The increased competition in the international air transport markets have put pressures on carriers' ability to raise prices. However, input prices have been increasing continuously, especially in traditionally low-cost countries. Consequently, the overall results show that airlines have experienced continuing significant drops in their price recovery ratios during the ten-year period. To counter-act such trends, airlines have made tremendous efforts to improve efficiency, as borne out by the steady increasing trend in productivity change ratio during the period. As a result, overall profitability of the airlines have improved in the 1990s.

The results further show that European carriers and Asian carriers consistently improved productivity throughout the period even during the time of rising profitability. This is particularly true for European carriers. The liberalization measures undertaken in Europe via package #2 (1990) and #3 (1993) appear to have made significant impact on carriers' performance. As a result, European carriers have achieved higher productivity growth than Asian and North American carriers. North American carriers, on the other hand, experienced a rather "flat" period in productivity growth between 1986 and 1991, then started to exhibit significant productivity improvement after incurring losses in profitability during the recessions. This "flat" period may be explained by the fact that the US carriers achieved tremendous productivity growth immediately

following the US domestic deregulation in 1978, then entered a "plateau" period in the late 1980s.

European carriers and Asian carriers experienced considerable losses in price recovery ratio, much more than North American carriers. This is because their input prices have increased rapidly, while air fares have declined due to increased competition.

Although overall impacts have been positive, the study shows that different dynamics at work at the firm level. Some carriers seem to have had difficulty adjusting to the deregulated environment and improving their profitability and productivity in a sustained manner, while others are consistent in the patterns of improvement of the various components of their performance. It is important for carriers to achieve high efficiency and productivity, thus lower cost. It is also important for carriers to price intelligently and properly manage yields in order to maintain and enhance their price recovery ability.

REFERENCE

Antoniou, A. (1992), "The Factors Determining the Profitability of International Airlines: Some Econometric Results", *Managerial and Decision Economics*, Vol. 13, 503-514

Bailey, E.E., Graham D. R. and Kaplan D. P. (1985), *Deregulating the Airlines*, Cambridge, MA: MIT Press

Banker, R. D., Chang H-H. and Majumdar S. K. (1993), "Analyzing the Underlying Dimensions of Firm Profitability", *Managerial and Decision Economics*, Vol. 14, 25-36

Banker, R.D., H-H Chang, and S.K. Majumdar (1996), "Profitability, Productivity and Price Recovery Patterns in the U.S. Telecommunications Industry", *Review of Industrial, Organization*, 11, 1-17

Boeing Commercial Airplane Group (1997), *Current Market Outlook, World Air Travel Demand and Airplane Supply Requirements*, Seattle, Washington, USA

Bruning, E.R. and Hu M. Y. (1988), "Profitability, Firm Size, Efficiency and Flexibility in the U.S. Domestic Airline Industry", *International Journal of Transport Economics*, Vol. 15, No. 3, 313-327

Caves, D.W., L.R. Christensen, and W.E. Diewert (1982), "Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers", *Economic Journal*, 92, 73-86

Christensen, L.R. and D.W. Jorgenson (1969), "The Measurement of U.S.

Real Capital Input, 1929-1967", *The Review of Income and Wealth*, Series 15, No. 1, 293-320

Daniels, A. (1998), "First Phase of Plan Works as CAI Wings into Black", *The Vancouver Sun*, February 26, D1.

Miller, D. M. (1984), "Profitability = Productivity + Price Recovery", *Harvard Business Review*, 3, 145-153

Morrison, S. and Winston C. (1986), *The Economic Effects of Airline Deregulation*, Washington, D.C.: The Brookings Institution.

Morrison, S. and Winston C. (1995), *The Evolution of the Airline Industry*, Washington, D.C.: The Brookings Institution.

Oum T.H. and Yu C. (1995), "A Productivity Comparison of the World's Major Airlines", *Journal of Air Transport Management*, **2**, 3/4 (September/December), 181-195.

Oum, T.H., and C.Yu (1997). *Winning Airlines: Productivity and Cost Competitiveness of the World's Major Airlines* (Kluwer Academic Press, New York, London), December, 1997.

Spence, A.M. (1986), "Cost Reduction, Competition and Industry Performance", in J.E. Stiglitz and G.F. Mathewson eds. *New Developments in the Analysis of Market Structure*, (The MIT Press, Cambridge, MA)

Summers, R. and A. Heston (1991), The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988, *Quarterly Journal of Economics*, Vol. 106, Issue 2, May, 327-368.

NOTES

1. More discussions on the airlines can be found in Oum and Yu (1995).

2. CAI earned a modest C$5.4 million profit in 1997, its first since 1988 (Daniels, 1998).

3. The aircraft leasing price data were kindly supplied to us by **Avmark, Inc.**.

4. Revenue shares (cost shares) are used as the weights in aggregating outputs (inputs). As a result, higher weights are given to outputs with higher yields. Similarly, more expensive input factors are given higher weights in aggregating inputs.

5. Note that airline fares in real terms have been consistently declining over the last three decades (Boeing, 1997).

Exhibit 1 Descriptive Statistics of Sample Airlines, 1995

Airline	Total Revenue (Million US $)	Revenue Tonne-km (millions)	Number of Passenger (thousands)	Number of Employees (units)	% Int'L RTK	Stage Length (km)	Passenger Load Factor (%)	Weight Load Factor (%)	Rev/Exp Ratio (%)
				North America					
American	15,610	17,660[1]	79,389[1]	90,980	36.9	1,799	69[1]	52	106.6
United	14,895	19,637[1]	81,945[1]	80,902	42.3	1,683	72[1]	59	105.9
Delta	12,557	15,168[1]	97,271[1]	62,832	30.7	1,224	70[1]	55	109.0
Northwest	8,908	12,821[1]	52,722[1]	44,682	47.8	1,362	73[1]	60	111.4
US Air	6,985	5,949[1]	56,893[1]	43,614	7.4	904	69[1]	52	103.5
Continental	4,919	6,009[1]	35,986[1]	32,272	20.0	1,315	68[1]	61	105.1
Air Canada	2,532	3,453	12,801	20,503	67.3	1,536	63	53	106.9
Canadian	1,938	2,948	8,578[1]	13,228[1]	70.1	1,681	71[1]	68[1]	98.6
				Asia-Pacific					
Japan Airlines	10,884	10,204	28,880	20,482	85.6	2,348	68	66	101.5
All Nippon	8,737	4,583	37,870	14,649	41.2	1,112	64	51	103.3
Singapore	4,440	9,512[1]	12,022[1]	13,258	100.0	4,300	74[1]	71	113.3
Korean Air	4,362	8,261	21,422	16,478	93.9	1,714	65	56	108.7
Cathay	3,696	7,092[1]	10,985[1]	15,657[1]	100.0	3,283	74[1]	71[1]	118.4
Qantas	5,063	6,603[1]	15,551[1]	24,429[1]	79.5	2,064	72[1]	64[1]	106.6
Thai	2,926	3,795	12,821	20,718	92.0	1,559	67	69	114.7
				Europe					
British Airways	10,716	12,215	35,000[1]	50,477	98.1	1,863	72[1]	71	116.6
Lufthansa[2]	9,231	12,205	32,599	26,578	95.2	1,131	70	71	100.8
Air France	6,510	9,701	14,498	36,384	91.1	1,846	71	71	103.2
KLM	5,547	8,630[1]	12,285	26,385[1]	99.9	1,748	76[1]	73[1]	105.1
SAS	4,597	2,195	19,828[1]	21,348[1]	83.1	728	64[1]	61	108.4
Swissair	3,483	3,574	8,826[1]	16,520	99.0	1,268	64	69	101.2
Iberia	2,902	2,850	14,600[1]	22,500	79.6	1,194	70	61	107.5

[1] 1996 data; [2] Lufthansa were through dramatic restructuring during 1994-1995. Its Technical Services and Cargo divisions became independent public limited companies on January 1, 1995. The parent company Lufthansa AG is now purely a scheduled passenger airline company.

Exhibit 2 Profitability Analysis Ratio - American Airlines
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 3 Profitability Analysis Ratio - United Airlines
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 4 Profitability Analysis Ratio - Delta Airlines
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
X-Axis
Profit
Productivity
Price

Exhibit 5 Profitability Analysis Ratio - Northwest
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 6 Profitability Analysis Ratio - USAir
Ratio
1.7
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 7 Profitabiltiy Analysis Ratio -Continental
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 8 Profitability Ratio Analysis - Air Canada
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 9 Profitability Ratio Analysis - Canadian Airlines
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 10 Profitability Analysis Ratio - British Airways
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 11 Profitability Ratio Analysis - Lufthansa
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994
Year
Profit
Productivity
Price

Exhibit 12 Profitability Ratio Analysis - Air France
Ratio
2
1.5
1
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 13 Profitability Analysis Ratio - KLM
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 14 Profitability Analysis Ratio - SAS
Ratio
1.7
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 15 Profitability Analysis Ratio - Swissair
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
X-Axis
Profit
Productivity
Price

Exhibit 16 Profitabiltiy Analysis Ratio -Iberia
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 17 Profitability Analysis Ratio - Japan Airlines
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 18 Profitability Ratio Analysis - All Nippon Airways
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 19 Profitabiltiy Analysis Ratio -Singapore Airlines
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 20 Profitability Analysis Ratio - Korean Air
Ratio
1.7
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 21 Profitability Analysis Ratio - Cathay Pacific
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 22 Profitability Ratio Analysis - Qantas
Ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
Year
Profit
Productivity
Price

Exhibit 23 Profitability Analysis Ratio - Thai Airways
ratio
1.5
1.3
1.1
0.9
0.7
0.5
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
X-Axis
Profit
Productivity
Price

Exhibit 24 Average Profitability Ratios - North America
ratio
1.3
1.2
1.1
1
0.9
0.8
1984
1986
1988
1990
1992
1994
1996
Year
Profitability
Productivity
Price

Exhibit 25 Average Profitability Ratios - Europe
ratio
1.4
1.2
1
0.8
0.6
1984
1986
1988
1990
1992
1994
1996
Year
Profitability
Productivity
Price

Exhibit 26 Average Profitability Ratios - Asia-Pacific
ratio
1.4
1.3
1.2
1.1
1
0.9
0.8
1984
1986
1988
1990
1992
1994
1996
Year
Profitability
Productivity
Price

The Public Policy Problem of Grain Transportation

Introduction

Grain transportation is a vital component of the western Canadian grains industry. Canada exports 60 per cent of its grain production, almost all of which needs to be transported to port position. Since Canadian producers are as far or further from tidewater than producers in any other grain exporting nation, transportation to port is a costly proposition. The current cost of transporting grain is roughly 17 per cent of the price received for the grain in port position.[1]

Because of the long distances to port and the lack of a western inland waterway, Canada relies on rail transportation to move grain to port. Historically, Canada has had legislative restraints on the railway industry, particularly as it applied to grain. These regulations have included legislated freight rates for grain and mandatory service provision. Recently Canada has moved towards deregulating its grain transportation system. The *Western Grain Transportation Act* (WGTA), which set freight rates along with service and infrastructure levels, was ended in 1995. The federal government is currently conducting a review of grain transportation and handling in 1998 which may result in further changes to the grain transportation system.

The purpose of this paper is to analyze the likely impact of deregulation on the grain industry. The following section examines the problems facing potential railway companies and discusses some of the public policy questions raised in this context. The paper then outlines how governments have historically addressed these public policy questions in the United States and in Canada. It reviews the role of government in the development of the railway industry. The history of government regulation of railways is then presented to identify possible results of deregulation. Recent moves towards deregulation in both countries are discussed. A conceptual model is then presented and used to analyze the impact of rail deregulation on the grain freight rates.

The Railway Policy Problem

Railways pose regulators with two key difficulties: (1) How to get firms started in the industry; and (2) How to ensure that the firms that are created do not act monopolistically. Both problems stem from the fact that

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[1] The freight rate cost from Saskatoon to Vancouver is $36.08 per tonne for 1997. The estimated pool return as of March '98 for No. 1 CWRS 13.5% protein for the 1997-98 crop year was $208 per tonne.

it can be prohibitively expensive for a firm to build a railroad. Fulton and Gray (1997) note that a potential rail company needs to purchase all the land along a continuous corridor where the track will be built. If the original landowners have knowledge of the profits the railways can earn, the landowners will attempt to extract a share of these profits when negotiating the sale of the land. Since each landowner will try to obtain a share of the profits, the railroad firm will not be able to afford to purchase the land if it has to bargain with even a few landowners.

Because of this problem of entry into the industry, governments have responded by assisting firms to enter the industry. As will be seen in the sections below, this assistance has taken numerous forms, including the granting of land to the railways, public investment in railways, loan guarantees, and expropriation. The problem of lack of entry into the rail industry has also created another problem, namely that those firms that have been given assistance to enter the industry have the potential to exert market power. Without the threat of entry, there is no threat of competition from emerging firms. In addition, because the incumbents have usually dealt with their rival firms for many years, they are often able to anticipate their rival's actions, thus diminishing the chance of competition even among existing firms.

Grain transportation also poses a special problem for policy makers in that it is one of the few bulk products where the producers of the commodity have very little bargaining power. This lack of bargaining power comes from the fact that producers are geographically dispersed, produce a homogeneous product, and are not the ultimate shippers of the commodity. In the transportation of other bulk goods, there are few enough shippers that each may have a degree of bargaining power. The threat to withhold their use of rail service may have an impact on rail revenues; therefore this threat is taken seriously. An individual grain producer cannot control enough volume to make an impact on rail revenue or to interest an alternative carrier to give them special treatment to get their business. This lack of bargaining power is made worse by the fact that grain producers produce a product indistinguishable from that produced by his/her neighbour. Although some shippers may have a degree of bargaining power with the railway, these same shippers will have market power vis-a-vis farmers. Thus, even if a break on rates can be negotiated, this break may not get passed back to the farmer.

Public policy has long grappled with both the problem of lack of entry in the rail industry and the potential for market power of existing firms. This public policy concern has particularly been the case in grain transportation where farmers have little bargaining power and thus little chance of mitigating the market power of the railways through negotiations. The next section will outline the history of government intervention in grain transportation in the U.S. and Canada to address these problems. The discussion begins with the early days of railway construction and ends with the recent deregulation of the industry.

History of Government Intervention in Rail

The U.S. and Canadian governments have tried many different forms of intervention to overcome the problems associated with an industry with large barriers to entry. Both governments began by funding firms starting in the industry, attempting to lower the barriers to entry. Once the firms were established, the government faced the second public policy problem outlined above, namely how to ensure the firms did not use their protected place in the industry to charge excessive freight rates. Numerous forms of regulation were tried. In both the US and Canada, rail rates were directly regulated and independent arbitration was adopted. Both countries have now moved toward less regulation.

U.S. Rail History

In the early days of the rail industry, the U.S. government provided funding to help the construction of railroads. Although private capital was inadequate, the federal government was reluctant to directly invest in the railroads. It was both philosophically opposed to the idea of direct government intervention after recent large expenditures into the construction of canals and roads. Instead the government granted land amounting to about 131 million acres to the companies and loaned them public credit (Benedict).

Once the rail firms were in place, concern arose over the level and equity of rates charged by the railroads. As Benedict outlines "faced with the necessity to earn money every possible way, the railroad companies charged exorbitant rates wherever other lines were unable to compete and, on the other hand, unfairly low rates where competition was keen" (p.70). Because of the differential in rates, transport between large centres would often be cheaper than a shorter haul on the same line. Other factors also focused attention on railway activities. Incidences of corruption of officials and dishonest manipulation of railroad finances were well known and widespread. This was aggravated by the appropriation of public land and generally bad railway public relations.

In 1887 the *Interstate Commerce Act* was enacted. The Interstate Commerce Commission (ICC) was created for the purpose of regulating freight and passenger rates, setting both maximum and minimum rates for different groups of commodities. It required that rates be 'just and reasonable' and prohibited discrimination. Specifically the legislation disallowed discrimination between shippers, locations and the practice of charging more for a short haul than a long haul over common line (Benedict).

Not all price discrimination was outlawed, however. Value of service pricing, or the charging of different rates for hauling goods of different value, was allowed by the ICC. This price discrimination was sanctioned because it was seen as a way of fostering the development of the West. By hauling the agricultural and natural resource products more cheaply and the

manufactured goods more expensively, the railways were encouraging the growth of the western natural resource industry while protecting the fledgling manufacturing sector in the East. At the same time, this form of price discrimination worked well for the railways. It allowed them to have higher rates on products with a more inelastic demand for freight, that is, where freight made up less of the total cost of the product, and lower rates where the demand curve facing the railways is more elastic, where freight was a higher fraction of the product price (Friedlaender). The ICC freight regulation also helped eliminate price wars (Carlton and Perloff). As will be noted below, regulation was often used to provide benefits to the industry being regulated.

In 1920, the railways were in financial difficulty, and the ICC was ordered to raise the allowable rates. It was directed to fix rates that would give a reasonable return to fixed cost (Carlton and Perloff). The railways continued to have difficulty turning a profit. Railways were unable to abandon unprofitable services and mergers of railroads were controlled under the ICC. This continued until the Railroad Revitalization and Regulatory Reform Act of 1976. The Staggers Act in 1980 furthered the deregulation of the rail industry.

The Staggers' Act

In the 1970s US railways were experiencing financial problems due to the lack of pricing flexibility and inability to abandon branch lines (Fulton and Gray). Regulation had led to a pricing structure which did not take into account trucking competition and different costs of rail haulage (Boyer).

One of the key provisions of the *Staggers' Act* was the removal of the minimum rate. This removal allowed railways to engage in variable pricing in an attempt to recapture some of the traffic they had lost to the waterways and to trucking. As noted above, in large part it was this variable pricing which had led to calls for rail regulation in the first place. However, it was felt that over time, the ICC, due to its concern about cross-subsidization, had forced the minimum rail rates to be so high as to be non-competitive with other modes of transportation.

There are a number of studies that have examined the impact of U.S. rail deregulation on freight rates. Elliot (1994) notes that from 1981 to 1991 US rail rates fell by one-third and 77 percent of productivity gains were passed on to shippers in the form of reduced rates and improved service. Although the exact amount differs, other studies also noted that there was a decrease in rates after the *Staggers' Act* for the period up through the mid-1980s. MacDonald, Fuller et al., and Wilson found that deregulation reduced freight rates in the Plains region of the U.S. where intermodal competition was limited. Deregulation appeared to have little effect on rates in eastern Corn Belt areas where barges provided competition. The general conclusion is that the railways were able to use regulation to form effective cartels, which were broken up with

deregulation. The view that regulation had allowed the railways to monopoly price where intermodal competition did not exist is also echoed by Friedlaender.

Railways have also moved to discriminating between shippers in the provision of service. With different systems for railcar allocation, railways are able to extract rents from shippers willing to pay for a higher level of service.

In summary, there is general agreement that deregulation was followed by a decrease in many freight rates for agricultural commodities. This is in part due to the fact that a regulated minimum rate was removed and in part due to the fact that the railways have been able to influence the regulatory agency in ways that the industry found desirable. This last observation is a common one in the literature on regulation (Stigler, Posner, Carlton and Perloff).

The current situation sees the return of some potential monopolistic pricing behaviour. Different rates are being charged for different routes of the same length (and presumably same cost) and for crops of different value. Ely, Perlich and Fulton examined three different points, all approximately the same distance from port, served by BN. They found that the points which had competition from barge and other railways had significantly lower rates than the point where BN was the sole bulk carrier. Their study notes that the rates at the points with alternative bulk carriers have remained relatively constant over time whereas those captive point have raised considerably from 1990 to 1995, where the rate now closely reflects the cost of trucking. As well, the authors discuss the differences in price of movement of different crops. They compare freight for corn and wheat from one point and barley and wheat at another. In both cases, the price charged to move the higher-value product, wheat, was higher than that charged to move the lower value products, corn and barley. This would indicate that the carriers are pricing to value.

Canadian Rail History

Unlike the U.S., grain transportation was given special treatment in Canada, due in part to the importance of the grain economy to the young nation and the development of its west. Farmers and government have made many attempts to deal with the large barriers to entry and market power in this industry. To overcome the barriers to entry, the railroads were constructed with a large degree of public money and regulatory support. Through regulation and alternative ownership, producers and government have tried to mitigate some of that market power and recapture some of the rents.

Shortly after confederation in 1867, the Dominion of Canada decided it needed to construct an east-west railway quickly. The impetus to build the railway came, in part from the west. The construction of a western railroad was a bargaining chip being used to encourage British Columbia to join confederation. But the urgency to complete the railway came from

the south. The dominion government was worried about the United States gaining an upper hand in western transportation which might threaten Canadian national development. Two U.S. railroads, the Union Pacific and the Central Pacific were linked to form a line to the pacific coast in 1869, and there were threats of a second transcontinental railway in the offing. The Northern Pacific was chartered in 1964 by the U.S. and targeted hauling products from British territory.

With this policy interest in completing a Canadian east-west link, there was an argument for government assistance in the construction of the Canadian Pacific Railroad. This support translated into both resources and regulatory provisions. The Dominion government supported the CPR construction with $25 million, substantial land grants in western Canada and tax exemptions (Kulshreshtha and Devine). As well, the Dominion government agreed to fund the completion of lines under construction in 1881, a commitment amounting to 713 miles and a further $37.8 million (Fowke). The transcontinental railway was finished four years later in 1885.

The CPR was granted a charter by the Dominion which gave it protection against the construction of other rail lines in certain areas. The monopoly was primarily an attempt to halt the construction of connecting lines to the U.S. mainline system. This clause came under attack by Western interests when the legislation was under discussion in 1880. When Winnipeg then chartered six railways after 1881, the Dominion disallowed the charters at the urging of the CPR. After continued pressure from the Manitoba Legislature, the monopoly was canceled by agreement between the federal government and the CPR in 1888. In return, the government agreed to issue bonds for the CPR in the amount of $15 million.

In the early years of the rail industry, shippers felt that the best way to keep the railway market power in check was to encourage the construction of competitive lines. This was not always successful. Often these lines were constructed with the help of large sums of public funds, but instead of acting as competitors to the existing railway, they either colluded or outright amalgamated with the existing structure (Cruikshank).

Pressure from shippers culminated in *The Railway Act* of 1903, which included the introduction of a federal railway commission to enforce and adjudicate freight rate regulations. The Board of Railway Commissioners was not dissimilar from the ICC in the U.S. The commission acted primarily as an arbitrator of disputes, trying to find solutions which would alienate neither of the two powerful interest groups – the shippers or the railways.

During the WWI, as occurred in the US, shippers became increasingly dissatisfied with their respective commissions. Due to the war, there was a great degree of upward pressure on prices, which caused the railways to go to the commission asking to increase their freight rates.

The approval of this and subsequent increases heightened shippers' concerns. Regional concerns began to bypass the commission and be directed towards parliament, via federal rate agreements such as the Crow's Nest Pass.

In 1897 the federal government had entered into agreement with the CPR to construct the Crow's Nest Pass, and in return, the company agreed to reduce freight rates on wheat and flour moving east, and agricultural implements and settlers' effects moving west. In 1925, the federal government changed the legislation to remove the statutory freight rate on settlers' effects and expand the rate for wheat and flour to all existing western rail lines and to cover wheat and flour being exported through the west coast (Kulshreshtha and Devine).

Throughout the 20th century, the railways have been trying to argue that the rate regulations were unfair. A large number of reviews and commissions were held on the Crow rates and other regulated freight rates. In 1961 the MacPherson Commission recommended that freight rates not be directly regulated (West), although it did not recommend suspending the Crow rates. These ideas around non-grain traffic were implemented in the *National Transportation Act* of 1967 (NTA '67). This deregulated the non-grain freight rates with the only stipulation being that the freight rates were compensatory. If the shipper was 'captive' there was also a maximum schedule set (roughly variable cost plus 150 per cent). As well, rates had to be published. By 1984, no shipper had been granted captive status, and no rate had been investigated as being below cost. In 1987 the Act was changed to allow for more pricing flexibility. This revised *National Transportation Act* (NTA '87) allowed for confidential contracts and intermodal competition (as did the *Stagger's Act* in the US). The NTA '87 also allowed for some shipper relief provision which will be detailed later. These provisions have not been much used.

While freight rates for other commodities were being deregulated by the NTA '67, the Crow rates were still in place. By the 1960s the railways were arguing for financial assistance in moving grain. They lobbied for a subsidy to cover what became known as the 'Crow gap', the difference between the cost of moving grain and the statutory rates.

Events came to a head in the 1970s when the railways stopped reinvesting in capital equipment designed to move grain. Grain dependent branch lines were deteriorating and numbers in the box-car fleet were rapidly falling. This caused the federal government to invest $891 million to upgrade a number of prairie branchlines. Along with the Alberta and Saskatchewan provincial governments and the Canadian Wheat Board, they purchased a fleet of 13,000 grain hopper cars.

By 1977 the Crow rates were covering only 32 per cent of the variable costs of movement, while another 18 per cent was covered by the federal government branch-line subsidies (Economic Council of Canada). Because the rates were no longer compensatory, they helped lead to problems of under investment as discussed above. The low rail rates also

encouraged rail use over road use, resulting in delivery points than would otherwise be optimal (West). Further, because the Crow rates were limited to grain and flour, they also acted to make the production of non-covered specialty crops relatively more expensive (Rosaasen).

In 1984 the federal government replaced the statutory freight rates with a rail subsidy. The *Western Grain Transportation Act* (WGTA) was introduced which contained a series of regulations around the rail traffic in grain. The WGTA set freight rates for grain, charged shippers with about half of the cost, and covered the other half with a subsidy to the railways. Over time the shippers' share of the cost would rise. As under the Crow rates, freight rates continued to be set on a distance-related basis. Railways were to submit to a costing review every four year, upon which the new freight rates would be set. This meant that any cost savings from productivity gains were passed along to producers in the form of lower freight rates every four years. As well, the Grain Transportation Agency (GTA) reviewed the railway's grain movement quarterly, and had the ability to fine the railways ten percent of the Crow benefit if they were not meeting standards.

In 1995, due to budget considerations and the need to comply with the GATT/WTO agreement, the federal government ended the WGTA subsidy. It also merged the WGTA with the NTA '87 to create the *Canadian Transportation Act* (CTA). The passage of the CTA marked the end to grain's special regulatory treatment and moved it toward the deregulated environment faced by other bulk commodities since the NTA '67.

The Canadian Transportation Act

Although the CTA represents a move towards a deregulated grain transportation system, it still contains a number of regulations pertaining to grain movement. There is currently a cap on grain freight rates which keeps some of the pricing dictates of the WGTA. The new legislation also contains a number of shipper provisions first introduced in the NTA '87. Like the NTA, the CTA is an attempt to allow freight rates to be determined by a market mechanism, while allowing some government intervention to try to encourage competition.

The grain freight rate cap is based on a 1992 railway costing review and is designed to cover the railways' variable costs, plus a return on capital. Like the WGTA before it, the cap applies to both high and low-cost movement of grain, thus generally keeping rates distance-related. As well, the cap applies equally to all crops covered under the WGTA, thus limiting value-of-service pricing. After some negotiation, it was agreed that there should be some productivity sharing measure, such as existed under the WGTA with the four-year costing reviews. It was suggested that the first half of a percent reduction in operating cost go to the railways. Any cost savings above that first half percent are to be split among the

railways, elevators (in the form of incentive rates), and producers (in the form of reductions in the freight rate cap).

The CTA still contains the shipper relief provisions – Interswitching, Competitive Line Rates (CLRs) and Final Offer Arbitration (FOA) – originally put in place under the NTA '87. These provisions were meant to encourage competition between the two railways.

There are limits to the use of Interswitching and CLRs and barriers to accessing these provisions added in the CTA. To access these shipper relief provisions, the shipper has to be under threat of 'substantial commercial harm' if relief is not given. In a change from the NTA '87, all interswitching rates and CLRs must be deemed to be commercially fair and reasonable.

Under the CTA, freight rates for bulk commodities with the exception of grain are deregulated. Increases in grain freight rates are still limited, but the future of this cap is uncertain. The CTA, like the NTA before, attempts to mitigate railway market power through encouraging competition. Shipper relief provisions and short-line railways are seen as means through which shippers may be able to reduce their reliance on a single main-line carrier, and thus be able to negotiate lower freight rates. Both these avenues to competition have barriers to access, whether legislative of economic. Lastly, there is particular concern as to the utility of these options for grain producers who will not negotiate over freight rates with the railways because they are not the shippers of their product.

The Canadian government has long been involved to various degrees in grain transportation. Rail transportation has barriers to entry, as well as the potential for market power. This has lead to government intervention, both in terms of aiding entry, and then regulation after the firms have been established.

In both Canada and the United States, government intervention in rail has been a mixed blessing for the industry. In both countries, the railways were constructed with a high level of government financial support to overcome the large initial costs in the industry. In Canada, early regulation created a monopoly for the new Canada Pacific Railway (CPR) in the name of nationalism. In the U.S., although freight rates were regulated, the railways were allowed to price discriminate on the basis of value of the product hauled, which improved their profits while serving the U.S. interests of developing the West. In both countries, regulation over freight rates also allowed railways to put a stop to rate wars that bit into their revenue.

Recently both countries have deregulated their rail industries. In the U.S. there is some evidence of a return to monopoly pricing by the rail industry. In Canada there is still a regulatory freight rate cap in place, constraining differential and monopoly pricing. The next section introduces a model that will be used to illustrate what might occur with the removal of the freight rate cap for western Canadian grain.

Model

In this section a model is presented of how the rates charged by the railways and elevator companies are determined in a deregulated environment. The model is based on the assumption that grain handling and transportation services, from local elevation, rail transport and terminal elevation, are needed in equal proportions with physical grain located on the prairies to produce an end product of export grain at port position.

The model allows for various levels of market power within and between the sectors. The services provided by the different firms in each of the sectors (e.g. the country elevator companies, the rail companies and the terminal elevator companies) are assumed to be heterogeneous. Because of the spatial differences among country elevators and railways, as well as brand loyalty to certain elevator companies, the model assumes firms have the ability to set a price different from their competitors. Thus, the firms are assumed to choose price when maximizing profit, as opposed to choosing quantity. Although the model assumes that any given firm can choose a price for its services that is different than its competitors, in equilibrium all firms providing the same service are assumed to set the same price.

Grain production is split into a number of regions across the prairies. The regions are defined so all production from that region is shipped to the port that will deliver the highest price less basis. Each region is assumed to have its own supply curve for grain, allowing the model to take different local costs of production into account. There is also assumed to be a local demand for grain in each region. The supply of grain for export is the local supply less the local demand.

The price at port position, p_w, is assumed to be unaffected by the quantity exported. Local elevators charge a price t_i to handle and remove dockage in region 'i'. Railways charge a price r_i to move the grain from region 'i' to port. Grain terminals at the port are assumed to charge a price T. For region i, the sum of these charges – i.e., $T + r_i + t_i$ – make up the export basis. Thus a grain farmer delivering his/her grain for export in region 'i' will receive a price $p_i = p_w - T - r_i - t_i$; the world price less the basis.

Prices are determined in a two-period game. In the first period the railways and terminals simultaneously choose their prices to maximize profits. The prices chosen represent a Nash equilibrium in prices, in that at equilibrium no firm finds it optimal to change the price it is charging. Knowing the freight rates and terminal charges, the local elevators then set their prices in the second period.

The model assumes that the railways and terminals know how the local elevators will react to freight rates and terminal charges, and take this reaction into account when making their pricing decision. Formally, the railways and terminal elevators are leaders in the two period game, with the local elevators being the followers. All railway, local, and terminal

elevator firms are assumed to have the same cost structure. Therefore in equilibrium, each firm in the same region will charge the same price.

The model incorporates the vertical integration found in the elevator industry. All the firms that own terminal elevators also own some local elevators, but not all local elevator companies own a terminal. The extra competition that results because of the presence of independent local elevator companies is taken into account in the model. As well, the model recognizes that terminal elevator companies do not have to compete with each other for most of the business they do, since grain that is sourced in their local elevator system is funneled through the terminal elevator.

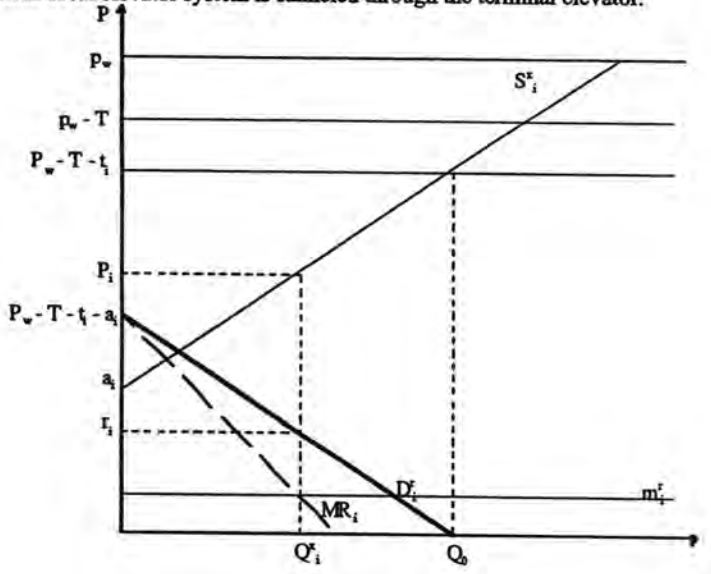


Figure 1 Derived Demand Curve for Rail

Figure 1 illustrates how a railway firm in region 'i' would set its freight rate. The analysis begins with the derivation of the derived demand facing a single railway in region 'i'. The railway's derived demand curve, D^r_i, is given by the vertical distance between $p_w - T - t_i$ and the export supply curve S^x_i. The intuition is as follows. If the railways set rail rates equal to zero, the farm level price in region i would equal $p_i = p_w - T - r_i - t_i$. With this farm level price, farmers would export quantity Q_0. Thus, the point (Q_0, 0) represents one point on the derived demand curve. A second point on the derived demand curve can be found by noting that farmers in region i would export nothing if the rail rate were set equal to $p_w - T - t_i$ less a_i, the intercept of the export supply curve. Thus, the point (0, p_w - T

$- t_i - a_i$) represents another point on the derived demand . Connecting these two points gives the derived demand facing the railway. Given this demand curve, to maximize revenue, the railway sets its rail rate price r_i, where r_i is determined by the intersection of the railway's marginal revenue curve (MR_i) and the railway's marginal cost curve (m_i). This assumes that the railway has some market power to set price above marginal cost.

If more than one railway was operating in the region, the determination of price is slightly different, although the principle is the same. The demand curve facing all the firms operating in the region is derived first – this demand curve is curve D^r_i in Figure 1. From this curve, the demand for an individual railway can be determined, which in turn allows the construction of the marginal revenue curve facing an individual railway. Determination of local and terminal elevator charges is done in a similar fashion to that of the railways. For instance, the demand facing the terminal elevators is found by vertical distance between a vertical line at $p_w - r_i - t_i$ and the export supply curve S^x_i.

Because of the time lag between planning and resulting production, the supply curve for grain at any specific point in time is completely inelastic. However, this curve is not used for the determination of the export supply curve. Instead, the relevant supply curve is the ex ante or planning supply curve. The argument goes as follows. If the railways price off the highly inelastic actual demand, they will drive the price down below the point where producers would have chosen to produce. Assuming producers are rational, if the railways force their price below their shut-down point, they will expect this behaviour to occur again, and therefore will not produce. This model of behaviour is not dissimilar from the old adage, "fool me once, shame on you, fool me twice shame on me." Thus it is assumed that the railways and elevators will use the planning supply curve to set their prices, even in a fully deregulated environment.

The model is used to illustrate what might occur to the different basis components with rail deregulation. Two scenarios will be explored: (1) what will be the change in freight, elevator and terminal rates with the removal of the freight rate cap?; and (2) what would happen to rates if railways are allowed to price discriminate on the basis of crop value?

Results

For the purpose of this model, the prairies are split into ten regions. Consistent with the current catchment areas for wheat, all regions west of approximately Regina are assumed to deliver to the west coast, while all points east are assumed to deliver to Thunder Bay. The amount of elevator and rail competition existing in each region was estimated. The number of firms assumed to be active in each region is detailed in Table 1. As well, export supply curves were developed using cost of production figures by soil zone and current domestic demand. Approximate marginal costs for elevators, terminals and rail were also found. Appendix A provides a detailed list of the costs used in the model.

Table 1 Elevator and Railway Market Structure By Region

Regions	# of Local Elevators	# of Railways	# of Elevator Co.'s with Terminals
South Alta.	4	2	3
Peace River	3	1	2
North-East Alta.	4	2	3
West Sask.	5	2	4
South-West Sask.	5	1	4
North-East Sask.	5	1	4
South-East Sask.	5	2	4
East Sask./West Man.	4	2	3
South-West Man.	4	2	3
Southern Man.	4	3	3

Table 2 shows the simulation results when the freight rate is removed and the railways are able to set prices to maximize profits. The model calculates the removal of the freight rate cap in two steps. Because there is limited capacity at the west coast ports, the Canadian Wheat Board (CWB) currently rations that capacity through subsidizing the use of the seaway, and pooling the extra costs to all grain producers. With a deregulated freight rate, railways would have to ration the use of westbound rail cars. This would be reflected in a higher rail rate to the West Coast. The model shows the effect of the capacity constraint at the West Coast port if the railways allocated the capacity through rail rates, but the exercise of market power was not allowed[2]. The second step shows the change in rates if the railways used their market power.

The model is solved for two crops: (1) where the world price of grain is relatively low ($200 per tonne); and (2) for a crop such as canola with a relatively higher world price ($420 per tonne). Because canola is not under a central desk marketer, its restricted use of the west coast ports is already reflected by the West Coast basis. Therefore in table 3, the removal of the freight rate cap is represented in one step.

[2] This could also occur if there was a continued cap on rates, but a bid-system for hopper cars.

Table 2 Simulation of Freight Rates and Elevator Charges for grain, Before and After Removal of the Freight Rate Cap

Regions	Scenarios	Elevator Tariffs	Rail Rates	Rates to E. Coast[3]	Total Basis[4]
			($/tonne)		
South Alta.	*with cap*	*10.90*	*25.43*		*55.52*
	WC constraint	10.37	33.62	N/A	58.16
	without cap	8.96	44.14		65.21
Peace River Alta./B.C.	*with cap*	*11.43*	27.20		*57.83*
	WC constraint	10.90	35.39	N/A	60.47
	without cap	9.33	46.89		68.34
North-East Alta.	*with cap*	*10.97*	*29.97*		*61.14*
	WC constraint	10.44	38.16	N/A	62.78
	without cap	9.55	45.57		67.23
West Sask.	*with cap*	*9.27*	*35.13*		*63.60*
	WC constraint	8.75	43.32	N/A	66.24
	without cap	8.22	48.60		68.92
South-West Sask.	*with cap*	*8.97*	*31.98*		*61.14*
	WC constraint	8.44	40.16	N/A	62.78
	without cap	7.62	47.18		66.91
North-East Sask.	*with cap*	*9.06*	*32.02*	*43.57*	*69.70*
	WC constraint	8.52	31.75	51.75	72.40
	without cap	7.59	38.63	58.63	77.06
South-East Sask.	*with cap*	*9.21*	*26.10*	*37.65*	*63.93*
	WC constraint	8.67	25.83	45.83	66.63
	without cap	8.06	30.80	50.80	69.70
East Sask./ West Man.	*with cap*	*9.98*	*26.48*	*38.03*	*65.09*
	WC constraint	9.44	26.21	46.21	67.78
	without cap	8.67	32.15	52.15	71.66
South-West Man.	*with cap*	*10.91*	*21.85*	*33.40*	*61.38*
	WC constraint	10.26	21.59	41.59	63.97
	without cap	9.38	27.28	63.97	67.49
Southern Man.	*with cap*	*12.39*	*19.44*	*30.99*	*60.45*
	WC constraint	11.74	19.18	39.18	63.05
	without cap	11.01	24.10	44.10	65.97

[3] The Rates to the East Coast are (1) a sum of the rail rates plus the CWB freight adjustment factor (FAF) under regulation, and (2) a sum of the rail rates and the total seaway costs under deregulation.

[4] Total Basis is a sum of the local and terminal elevator tariffs, rail freight rates plus (1) CWB freight adjustment factors and pooled cost under the current situation, or (2) total seaway charges under deregulation.

		Terminal Charges		FAF/ Seaway	CWB Pooled Cost
West Coast	*with cap*	*15.19*			*+ 4.00*
	WC constraint	14.17	N/A	N/A	0.00
	without cap	12.11			0.00
Seaway	*with cap*	*13.07*		*11.55*	*+ 4.00*
	WC constraint	12.13	N/A	20.00	0.00
	without cap	10.87		20.00	0.00

Source: Authors' Calculations

Table 3 Simulation of Freight Rates and Elevator Charges for Canola, Before and After Removal of the Freight Rate Cap

Regions	Scenarios	Elevator Tariffs	Rail Rates	Rates to E. Coast	Total Basis
			($/tonne)		
South Alta.	*with cap*	*13.36*	*25.11*		*73.00*
	without cap	11.07	45.27	N/A	85.85
Peace River Alta./B.C.	*with cap*	*21.08*	*27.70*		*83.26*
	without cap	16.52	55.99	N/A	102.02
North-East Alta.	*with cap*	*17.03*	*30.75*		*82.33*
	without cap	14.70	51.24	N/A	95.46
West Sask.	*with cap*	*10.59*	*35.20*		*80.33*
	without cap	9.66	47.71	N/A	86.89
South-West Sask.	*with cap*	*11.78*	*32.30*		*78.62*
	without cap	9.97	50.21	N/A	89.69
North-East Sask.	*with cap*	*13.41*	*42.31*		*90.27*
	without cap	10.96	67.21	N/A	107.69
South-East Sask.	*with cap*	*11.84*	*35.13*		*81.52*
	without cap	10.75	47.38	N/A	87.65
East Sask./ West Man.	*with cap*	*13.77*	*39.45*		*87.76*
	without cap	12.06	58.28	N/A	99.86
South-West Man.	*with cap*	*11.99*	*22.76*	*42.76*	*80.70*
	without cap	10.76	33.91	53.91	87.58
Southern Man.	*with cap*	*16.64*	*21.94*	*41.94*	*84.53*
	without cap	15.19	34.60	54.60	92.69
		Terminal Charges		Seaway Costs	
West Coast	*with cap*	*34.54*			
	without cap	29.52	N/A	N/A	N/A
Seaway	*with cap*	*25.95*		*20.00*	
	without cap	22.90	N/A	20.00	N/A

Source: Authors' Calculations

At least three conclusions can be inferred from the results presented in Tables 2 and 3. First, under the specified assumptions, freight rates are expected to increase in the grain price scenario by anywhere from slightly over $5 per tonne to $20 per tonne. The freight cost to the west coast increases far more than the rates to the east coast. This is indicative of the fact that some of this increase is due to the west coast capacity constraint, part due to railway market power. At the same time, the elevator tariffs and terminal charges fall. However, under deregulation the overall basis is predicted to increase.

Secondly, freight rates are expected to increase more in regions where one railway has a monopoly. For instance, compare the expected change in freight rates for north-eastern Alberta, where both railways have lines, to Peace River, where CN has a monopoly. Grain freight rates are expected to increase $15.60 per tonne for north-eastern Alberta, and $19.69 per tonne in Peace River. Thus a corollary is that railways will price discriminate by route and region.

Third, freight rates and handling tariffs are expected to be larger for a higher value crop, such as canola. Because there is a greater margin between the port and regional, the railways and elevator companies will attempt to extract some of that margin in the form of higher prices. It should be noted that even these higher freight rates are still in line with the current rail rates for wheat from Montana.

These results are sensitive to the assumptions made about the elasticity of supply and domestic demand, and the amount of market power held by firms. The results are meant to be viewed as a yearly average, and therefore do not take intra-year variations into account.

In conclusion, the model shows the potential of railway market power to increase the freight rates for grain under deregulation. It further illustrates the potential of railways to engage in forms of price discrimination, including value-of-service pricing. Elevator companies, however, face decreases in tariff rates in the low wheat price scenario. It is only when the world price rises significantly that the elevator companies can be expected to raise their tariff rates.

Summary

In this paper, the public policy problems associated with an industry with large barriers to entry are discussed. Governments face the difficulty of first getting firms into the industry, and then trying to limit their use of market power once the firms are established. The history of regulation in Canada and the U.S. grain transportation industries is then reviewed to give an idea of how governments have grappled with these problems in the past. The history in both Canada and the United States is peppered with attempts by government to develop the rail industry while constraining this market power. These regulations have met with mixed success. More recently, governments in both countries have began to return these

industries to a more market-based framework. The current regulatory regimes in both countries are described.

The U.S. deregulated its rail industry in 1980, which gives some evidence of what can occur without rate regulation. Although freight rates have fallen overall, railways are returning to some forms of monopoly pricing. There is evidence that railways are price discriminating between routes and commodities.

A model is then presented in the paper. It is first calibrated for the current year and is then used to anticipate what might occur without the freight rate cap on western grain. The model illustrates that railways would be expected to engage in various forms of price discrimination under deregulation. It is anticipated that railways will price discriminate by route and by value of commodity.

There are several caveats to this research. This model assumes linear supply and domestic demand curves, and assumes that the quantity exported will not affect the world price. The model is based on a planning supply curve, and does not take intra-year variations into account. Thus results should be viewed as long-run. The model is equally unable to consider variations in service which might occur under deregulation.

However, the model illustrates interesting interplay between local and terminal elevator tariffs and rail rates in determining the basis under deregulation. While the rail rate increases produced by the model are large, they should be considered relative to the U.S. experience.

After helping to establish the rail industry, governments have attempted a number of different forms of regulation to restrict the market power of the railways. The results of these regulatory attempts have been mixed. Now governments are hoping that competition can be encouraged, and are turning the industry back over to the market. Although the overall result of this deregulation is unknown, the potential for railways to re-exert some of their market power is a critical determinant to the outcome.

References

ATKearney. September 1994. *Grain Logistics Strategy, Final Report.* Prepared for Saskatchewan Highways and Transportation.

Benedict, Murray R. 1953. *Farm Policies of the United States 1790-1950.* New York: Twentieth Century Fund.

Canada Grains Council. 1995. *Canadian Grains Industry Statistical Handbook.* Winnipeg: Canada Grains Council

Carlton, Dennis W. and Jeffrey M. Perloff. 1994. *Modern Industrial Organization.* New York: HarperCollins College Publishers.

Cruikshank, Ken. 1991. *Close Ties: Railways, Government and the Board of Railway Commissioners, 1851 - 1933.* Montreal and Kingston: McGill - Queens University Press.

Eley, Ron, Murray Fulton and Ken Perlich. 1997. "Market Power in the Provision of Rail Services for Grain Transportation." Paper for the CAEFMS/AAEA Joint Meetings, Toronto, July 27-30.

Elliot, Andrew. November 1994. "Deregulating Grain Transportation in Canada: Lessons from the U.S. Experience, 1980 - 1994."A Paper for Transport Canada

Fowke, Vernon C. 1957. *The National Policy and the Wheat Economy.* Toronto: University of Toronto Press, reprinted in 1973.

Friedlaender, Ann E. 1969. *The Dilemma of Freight Transport Regulation.* Washington D.C.: The Brookings Institution.

Fuller, S., D. Bessler, J. MacDonald, and M. Wohlgenant. 1987. "Effect of Deregulation on Export-Grain Rail Rates in the Plains and Corn Belt." *Journal of the Transportation Research Forum* 28(1),160-67

Fulton, Murray and Richard Gray. 1997. Railways, Competition and the Hold-up Problem, University of Saskatchewan.

Kulshreshtha, S. N. and D. G. Devine. 1978. Historical Perspective and Propositions on the Crowsnest Pass Freight Rate Agreement. *Canadian Journal of Agricultural Economics* Vol. 26, No. 2. (July) 72 - 83.

MacDonald, J.M. 1989. "Railroad Deregulation, Innovation, and Competition: Effects of the Staggers Act on Grain Transportation." *Journal of Law and Economics* 32(April), 63-95.

Posner, Richard A. 1975. "The Social Costs of Monopoly and Regulation." *Journal of Political Economy.* Vol. 83. 807-27.

Rosaasen, Ken A. 1983. "The Pepin Plan - Its Impact on Saskatchewan Farmers for The Potential Impact of the Pepin Plan on Saskatchewan Communities." Paper for the SCRAD Symposium, Saskatoon.

Saskatchewan Agriculture and Food. 1997. *FarmFacts; Crop Planning Guide.* Regina: Saskatchewan Agriculture and Food.

Saskatchewan Highways and Transportation and Saskatchewan Agriculture and Food. December 1992. *A Description of the Grain Handling and Transportation Industry.*

Skogstad, Grace. 1987. *The politics of agricultural policy-making in Canada.* Toronto: University of Toronto Press.

Sorenson, L. Orlo. 1984. "Some Impacts of Rail Regulatory Changes on Grain Industries." *American Journal of Agricultural Economics* Vol. 66, No. 5 (December) 645 - 56.

Stigler, George J. 1974. "Theories of Economic Regulation" in the Bell Journal (Autumn); reprinted in Stigler, George J. 1975. *The Citizen and the State: Essays on Regulation.* Chicago: University of Chicago Press.

West, Douglas S. 1994. *Modern Canadian Industrial Organization: A Supplement to Carlton and Perloff Modern Industrial Organization.* New York: HarperCollins College Publishers.

***Western Producer.* 1998.** (April 2)

Wilson, Wesley W. 1994. "Market-Specific Effects of Rail Deregulation." *The Journal of Industrial Economics* 42(1), 1-22

Appendix A

- World Price of Grain (FOB Position) = $200/tonne
- World Price of Canola (FOB Position) = $420/tonne
- Marginal Cost of Local Elevator Operations = $5.00/tonne (Saskatchewan Highways and Transportation 1992, AT Kearney 1995)
- Marginal Cost of Rail Transportation = $0.03/tonne mile (current cap)
- Marginal Cost of Terminal Operations = $6.00/tonne (Saskatchewan Highways and Transportation 1992, AT Kearney 1995)
- Regional Export Supply Curves are a combination of cost of production by soil zone (Saskatchewan Agriculture and Food 1997), regional demand price (Western Producer 1998) and export quantities (Canada Grains Council 1995)

Saskatchewan Area Transportation Planning

by
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Saskatchewan Highways and Transportation

1.0 INTRODUCTION AND OVERVIEW

A number of Area Transportation Planning Committees (ATPC's), comprising representatives from rural and urban municipalities, have been formed in Saskatchewan in response to the dramatic changes that are taking place within their local transportation systems. This paper examines the factors and issues that led to the creation of these area transportation planning committees. These include changes in the grain transportation system, rural demographics, health and education systems, rail versus road modal shares, as well as transportation policy, jurisdiction, and finances.

The creation of the ATPC's is an attempt by both the Provincial and the municipal governments to move transportation planning closer to the people directly affected by the decisions, as well to develop a more coordinated approach. The province and the municipalities have responded to the realization that the historical divisions of transportation planning responsibilities are no longer appropriate. In the past, there was a clear distinction between the local needs served by the municipalities and the regional and provincial needs served by the provincial government. The consolidation of rail branchlines and elevators means that much of the grain is hauled through several municipalities on both municipal and provincial roads. This change as well as a number of others are generating new transportation patterns. This has led to the conclusion that transportation planning should be done on a system wide basis and not independently by each of Saskatchewan's 1,020 municipalities and the provincial government.

This paper documents the approaches that have been taken by the various area transportation planning committees to identify and address the challenges facing each distinct area. The organization and operation of each committee is unique as are the priorities and analytical approaches. The area transportation planning initiative is examined from both the Department of Highways and Transportation and the municipality's perspective. The final area that the paper examines is the major achievements and remaining challenges. The individual committees have had considerable success developing common understandings of the transportation issues and concerns facing their areas. The greater

challenge for the committees will be developing comprehensive plans to improving the transportation systems. The plans will need to address key issues such as jurisdiction, priorities, sources of funding, inter-jurisdictional cooperation, federal transportation policy, and the realities of private sector business operations.

2.0 BACKGROUND TO THE AREA PLANNING INITIATIVE

2.1 Saskatchewan's Road Network

Saskatchewan has the largest road network in Canada. A Transportation Association of Canada report calculated the road lengths for the ten provinces and two territories[1]. The unit of measurement was two-lane equivalent kilometres. Saskatchewan's 201,903 km exceeds all other Canadian jurisdictions including much more populous provinces such as Ontario, Quebec, Alberta and British Columbia. In fact, Saskatchewan accounts for 22 percent of all roads in Canada while only accounting for a little over 3 percent of the population. This comparison of roads and population is illustrated in Exhibit 2.1.

Exhibit 2.1
Kilometres of Road Per Person by Province

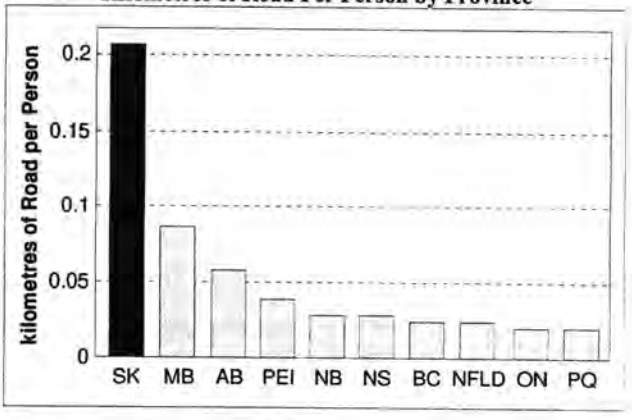


Exhibit 2.2 summarizes the road length by province and territory, including a breakdown by federal, provincial/territorial, and local. From this table we can see that the majority of Saskatchewan's roads are local or municipal roads, which are generally gravel or earth roads. However,

[1] **Transportation in Canada: A Statistical Overview,** Transportation Association of Canada, 1995.

Saskatchewan still has one of the larger systems of paved and surface treated roads, similar in size to Alberta and British Columbia's.

Exhibit 2.2
Road Network by Jurisdiction

	Provincial/ Territorial	Local	Federal	TOTAL
Newfoundland	8,747	4,127	207	13,081
P.E.I.	5,128	502	56	5,686
Nova Scotia	23,371	2,330	291	25,992
N. B.	18,480	3,185	218	21,883
Quebec	29,344	90,000	534	119,878
Ontario	28,458	137,087	2,346	167,891
Manitoba	21,628	64,500	1,740	87,868
Saskatchewan	26,200	172,522	3,181	201,903
Alberta	18,292	159,172	3,973	181,437
B. C.	42,279	21,399	2,050	65,728
Yukon	4,697	278	94	5,069
NWT	4,307	790	390	5,487
TOTAL	230,931	655,892	15,080	901,903

Source: Transportation Association of Canada

2.2 Changes in Rural/urban demographics

Exhibit 2.3 illustrates the shift in population from rural to urban areas over the period 1951 to 1991. The Saskatchewan population has shifted from a predominately rural population to one where 63 percent of the population lives in urban areas. All indications suggest that this trend will continue.

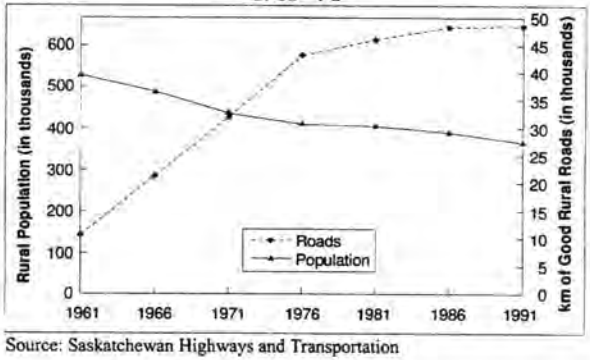
Exhibit 2.3
Rural and Urban Population in Saskatchewan 1951 - 1991

Year	Population	Rural %	Urban %
1951	831,700	69.6	30.4
1956	880,700	63.4	36.6
1961	925,200	57.0	43.0
1966	955,300	51.0	49.0
1971	926,200	47.3	52.7
1976	921,300	44.5	55.5
1981	968,300	41.8	58.2
1986	1,009,600	39.0	61.0
1991	988,900	37.0	63.0

Source: Statistics Canada 1951-1991

Exhibit 2.4 compares the rural population trend with the rural road trend. Despite a decline in rural population we have seen an increase in the rural municipal road infrastructure investment. Today, the rural road system has an increased emphasis on the movement of goods and providing land access. This trend raises the question of what type of system is best to meet these needs given that the system was primarily developed to move people.

Exhibit 2.4
Rural Road Infrastructure and Rural Population
1961 - 91



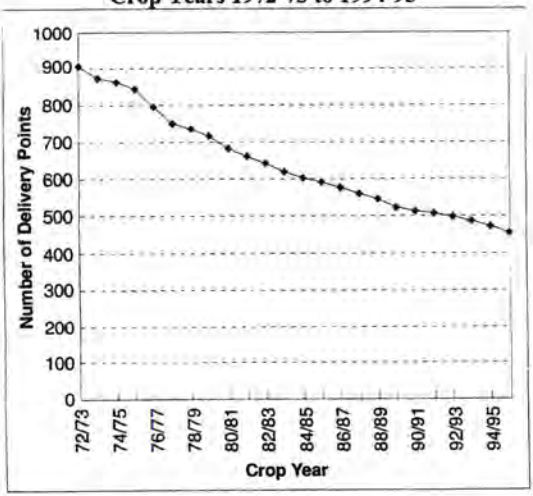
Source: Saskatchewan Highways and Transportation

2.3 Changing Transportation Patterns

The nature, location, and level of demand for transportation is changing rapidly in Saskatchewan. The changes taking place in grain production, marketing and transportation are dramatic examples. Exhibit 2.5 illustrates the consolidation of grain delivery points (i.e. closure of elevators) over the past few years. In 1972 there were over 900 delivery points compared to approximately 400 today. This dramatic consolidation is actually expected in accelerate in the next few years to the point where there could be as few as 50 - 75 within the next five to ten years.

The reduction in grain delivery points is being accompanied by the abandonment of rail branchlines. Saskatchewan has lost over 3700 km of branchline over the past 20 years. The Canada Transportation Act (1996) has made it easier for CN and CP to close branchlines. Thus, it is expected that this trend will accelerate resulting in the loss of possibly another 3700 km of branchline.

Exhibit 2.5
Grain Delivery Points in Saskatchewan
Crop Years 1972-73 to 1994-95



The most obvious implication of the closure of local grain elevators and branchlines is the requirement to truck grain farther. Farm to elevator hauls are increasing in length every year. At one time the average haul distance would be just a few km as elevators were spaced every 10 - 12 km along an extensive rail network. Now, with the closure of hundreds of delivery points and the aggressive marketing by the new inland grain terminals, truck haul distances for farmers are steadily increasing. The development of local processing of grains such as canola, durum and barley has been welcomed as it results in more local value-added. However, this domestic grain all moves by truck to processors, often from distances up to 100 km or more.

The increased market share of the trucking industry at the expense of the rail industry is occurring in other sectors as well. The branchline rail system in Saskatchewan is used almost exclusively for grain, potash and other export commodities. Truck transport accounts for almost all other commodities moving into and out of the rural areas including, fuel, fertilizer, general freight, and aggregates. Increased development in the oil and gas industry in many parts of Saskatchewan has also resulted in major increases in truck transportation.

Exhibit 2.6 shows the increase in road traffic by various classes of vehicles. This illustrates the traffic growth that is occurring for both private passenger and commercial vehicles. Total travel by passenger cars and pick-ups increased by 47% between 1975 and 1990. Total travel by commercial vehicles increased by 28%. Travel by heavy truck (ie: 3 or more axles) increased by 69%. Again, this growth translates into greater demand for all types of roads and highways.

Exhibit 2.6
Travel in Saskatchewan by Vehicle Type

Vehicle Type	Total Highway Travel (millions of vehicle-km) 1975	1980	1986	1990
Passenger Cars & Pick-Ups				
Passenger Car	2,801	3,061	3,559	3,725
Pick-Up	877	1,501	1,602	1,676
Sub-Total	3,678	4,562	5,161	5,401
Commercial Vehicles				
Straight Duals	208	243	237	155
Straight Tandems	49	63	59	93
3-Axle Combinations	11	16		
4-Axle Combinations	44	21	475*	559*
5+-Axle Combinations	322	381		
Sub Total	634	724	771	807
Grand Total	**4,312**	**5,286**	**5,932**	**6,208**

Source: Travel on Saskatchewan Highways (for years indicated)
Note: ** 1986 & 1990 combinations figures are composites.*

Transportation patterns are also affected by the changes occurring in our health and education systems. These systems are also experiencing extensive rationalization resulting in new and more intense traffic patterns. The need to provide adequate road networks to serve school buses, ambulances, fire trucks etc. is a major challenge for both the Provincial and municipal governments.

2.4 Financial Constraints

The under-funding of public infrastructure in all areas has been well documented. This includes health, education, recreation, municipal services, research and development, and transportation. Governments at all levels in Canada accept the fact that taxpayers are at their limit in terms of level of taxation. There are simply a lot more needs than there are available funds. Governments are faced with difficult choices between

these different areas. Transportation is recognized as an important area, but is by no means the only high priority investment option for governments. The current transportation budget and those in the future fall well short of meeting all the identified needs. The challenge facing all levels of government is to do more with less and to maximize the benefits from each dollar expended.

2.5 New Demands on the Municipal Road System

The development of the various municipal and provincial road systems were generally based upon the different transportation needs. Regional provincial and inter-provincial road needs were the responsibility of the provincial government. Local needs such as farm, residential, and commercial access roads were met by the municipal governments. Municipal roads were all directed towards the nearest community or grain elevator. Today, that clear division of responsibility and function between the municipal and provincial road system has disappeared. The main reason for this is the changing travel patterns discussed above. The loss of grain delivery points and branchlines and the emergence of major inland grain terminals is resulting in longer truck hauls for grain which are impacting significantly on both the municipal road systems and the provincial secondary highway system. The same or similar routes are used for inbound truck hauls for commodities such as fuel and fertilizer. Increased domestic processing of grains and specialty crops also results in increased use of municipal roads for more than local transportation. This means that in some cases, a significant portion of the traffic on a particular municipal road system may not originate or terminate within that municipality. In short, there is still a requirement for the same size of rural road network but some segments are experiencing increased demands from trucking while other segments, due to decreased population, are actually experiencing declining demands.

3.0 SASKATCHEWAN'S AREA TRANSPORTATION PLANNING COMMITTEES

3.1 History of ATPC in Saskatchewan

The Department of Highways and Transportation (DHT), Saskatchewan Association of Rural Municipalities (SARM), and Saskatchewan Urban Municipalities Association (SUMA) took the initiative to establish the Southwest Transportation Planning Council (SWTPC). This area transportation planning pilot project started in March 1995 when 38 rural municipalities and 24 urban municipalities held an organizing meeting in Swift Current. The organizing municipalities set the following goal for the SWTPC:

To have elected municipal representatives, producers and business stakeholders gain a greater knowledge of regional transportation issues and become involved in regional transportation issues.

The agreed upon purpose of the SWTPC is to:

- *actively involve stakeholders in a cooperative and interactive process for regional transportation planning*
- *develop a transportation plan for the Southwest region.*

The SWTPC took the position that it would be an advisory body with no decision making power. It would not become another level of government.[2] After the one year term of the pilot project, the membership voted to continue the process and the operation of the SWTPC.

Since 1995 the SWTPC's projects and activities have included:

- Evaluation of the impacts of branchline abandonment and the development of alternatives
- Short Line Rail Feasibility Study
- Road Improvement Priorities Study
- Traffic Management Project for the Oil Industry
- Short Line Rail Conference and Workshop

3.2 Current Status and Activities of the ATPC's

The SWTPC has served as a model for the development of other ATPC's. Currently (March 1998), there are four operating committees in Saskatchewan with three additional committees in the formation stage. It is expected that before the end of 1998, there will be active ATPC in all areas of the province where there are rural municipalities. There has also been an interest shown by northern communities.

3.3 Provincial Government Perspective

The 1997 Saskatchewan transportation strategy [3] identified the key transportation issues and challenges facing Saskatchewan, including:

- the need to be competitive in the international market place for such commodities as grain, potash and forest products

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[2] ***Formation, Organization and Operation of the SWTPC***, Saskatchewan Highways and Transportation , May 1996 p. 2.

[3] ***Investing in Transportation, A Transportation Strategy for Saskatchewan People,*** Saskatchewan Highways and Transportation, April 1997.

- deregulation in the rail sector leading to the loss of shipper protection and branchline abandonment
- greater emphasis on cost recovery for federal transportation infrastructure
- lack of federal funding for highways; changes in the grain transportation system and other industries leading to the need for better roads and highways
- lack of competition within rail sector
- the generally poor condition of the existing roads and highways relative to both the economic and social needs

Given these challenges and the obvious financial constraints, DHT concluded that a new approach is required. Thus, a key element of the transportation strategy is ***Shared Decision-making and Responsibility***. This is further defined to mean:

- *working together to make the fundamental decisions about the future of our transportation system requires the wisdom of cooperation and the courage to try new approaches.*
- *Governments at all levels must strive for a more coordinated approach to transportation planning.*
- *Decentralized transportation planning and management can respond better to local needs, especially in an environment of rapid change.*

The strategy states that area transportation planning is an effective mechanism to view the whole transportation system, including road and rail, and strategically invest scarce resources in transportation infrastructure. Area planning provides a forum for discussion around an expanded role for local government in the management of our transportation system.

3.4 Organization and Operation of ATPC's

DHT, in cooperation with SARM and SUMA, has encouraged municipalities to form ATPC's. DHT's approach has been to increase the awareness among municipal councils of the changes underway within the transportation sector and the potential impacts they could have on their municipalities and taxpayers. DHT clearly stated that there are some difficult decisions to make and it wants to share the decision making and responsibility with municipal governments. The Southwest municipalities, as mentioned previously, were the first to rise to the challenge when its rural and urban members set the boundaries for the Southwest transportation planning area, elected its Executive Working Committee and paid an average of $300 in annual dues. The formation process

involved a series of local meetings to discuss the regional transportation issues along with the options for an ATPC. The local meetings were followed by one formation meeting where a consensus was reached that an ATPC would be an effective vehicle to bring the urban and rural municipal governments and the provincial government together to address their common transportation challenges.

The SWTPC is comprised of all municipalities that have paid their membership dues. The SWTPC created an executive working committee (EWC) that is charged with executing the work. The actual decision making power rests with the full committee. The EWC is comprised of eight elected representatives from the member municipalities plus appointed representatives from SARM, SUMA, Southwest Region Economic Development Authority and DHT. Regional representation on the EWC was achieved by creating four sub-regions, each with an urban and rural municipal representative.

Most of the other ATPC's have followed a similar structure of having a main committee, an executive committee, as well as sub-committees for special tasks. The structure of the executive committees ensures that all parts of the planning areas are represented by both urban and rural representatives.

The ATPC's developed their own dues structures to cover day to day costs such as travel, meetings, and communications. Dues structures are based on a combination of the population and tax assessment for each municipality. Most ATPC's have also put an upper limit of $600 on the annual dues for individual municipalities. The dues structures are designed to raise $20,000 to $30,000 per annum to cover their basic operations. This allows them to be financially autonomous.

3.5 Accomplishments

3.5.1 Improved Knowledge Base and Understanding

The ATPC's are compiling transportation planning databases which typically include an inventory of infrastructure, expenditures by all levels of government, commodity movements, traffic statistics, and passenger traffic generators. These databases are available to all levels of government for the planning and operation of the transportation system.

Committees, through basic research and consultation with member municipalities and other stakeholders, have spent considerable effort to identify and analyze the key issues facing each area. These include branchline abandonment, road conditions, highway safety, public

transportation, and infrastructure funding. These issues have not changed substantially over the past few years. However, the ATPC's have gone beyond the issue identification to a quantification of the problems and concerns. It is clear that the work of the ATPC's is resulting in a greater understanding of the transportation needs, constraints, and alternatives for each area.

3.5.2 Traffic Forecasting and Road Impact Assessment

The ATPC's have undertaken a number of major impact assessment projects. These reflect the nature of the concerns or issues for each ATPC. However, the impacts of changes in the grain transportation system have generally been the first priority in terms of impact assessment. The closure of grain dependent rail branchlines and consolidation of grain delivery points are resulting in a dramatic increase in the trucking of grain. The impact on the municipal and provincial road system is a major concern. The impact assessments undertaken to date confirm that as the rationalization of the grain transportation systems continues, the various road agencies will be faced with major cost impacts.

Other types of impact assessment analysis have related to specific traffic generators such as major new grain terminals, oil and gas development, and intensive livestock operations. The objective of these projects are to reduce the impacts of increased truck traffic through such means as designating heavy haul routes, enforcing truck weights and speeds, and using new truck technology. The ATPC's are also looking at new ways of generating revenues for road preservation and upgrading.

3.5.3 Area Transportation Planning

The issue identification, research, and analysis is forming the basis for the development of short and long term transportation plans. The ATPC's are going through a process of prioritizing the issues and concerns, development and assessment of alternative strategies and actions, and finally the development of comprehensive plans.

A major focus is on setting road upgrading and preservation priorities. The ATPC's are identifying the priorities based on current and anticipated traffic patterns and road conditions. The focus is to provide the strategic transportation links that serve the prioritized social and economic needs of the area as opposed to focusing strictly on the roads in the worst condition.

Area transportation planning means that the province and the area municipalities are jointly taking a total transportation system approach instead of just considering the infrastructure within their jurisdiction. Key

transportation links for each area are being established using the most efficient routes. Road improvement priorities are being established on an area wide basis not on a jurisdictional basis.

3.5.4 Communications and Cooperation

The ATPC's are playing a key communications role in terms of allowing municipalities and other stakeholders to effectively communicate with other levels of government. Municipalities have more opportunity for cooperation among themselves and with the Provincial government. This is leading to greater cooperation in such areas as capital planning, construction, traffic management, and commercial vehicle enforcement.

3.6 Remaining Challenges

3.6.1 Establish Clear Role and Mandate

There have been a range of motivations or impetus that have led to the formation of the ATPC's. The threat or actual closure of branchlines have been one of the strongest motivators. Some see the ATPC's as an effective vehicle to identify the municipal or local concerns related to branchline closure. Thus, to some, the mandate of the ATPC's is limited to the grain transportation issues and concerns. Others believe that the ATPC's should have a much broader mandate, one that focuses on all transportation needs. Many argue that the ATPC's need to consider the other economic sectors such as tourism, manufacturing, and oil and gas. Social transportation needs such as acceptable access to education, health and recreation facilities are just as critical to many as grain transportation.

The role of the ATPC's is another area of uncertainty. There is a general consensus that the role the ATPC's is to provide advice and recommendation on key transportation issues. However, how do they do this, and who do they advise. How far does this advisory role go? For example, the SWTPC examined the feasibility of creating short line railways as an alternative to branchline abandonment. How far should the SWTPC go with this idea? Is its role just to do the feasibility analysis and expect other organizations to respond or should it proceed to promote/market the idea, identify potential operators, broker potential deals, lobby senior levels of government, assist the formation of a rail co-operative, or if all else fails, become the proponent?

In terms of the planning of the upgrading and operation of the road network, the role of the ATPC's will need to be established. Should their role be just to submit its suggested priorities and concerns or should their be a formal mechanism to integrate the Provincial and ATPC planning processes? Should the ATPC's be delegated some actual decision making

power/responsibility in terms of transportation planning and budget allocation?

3.6.2 Translate Plans into Action

The area transportation planning initiative has generally been a positive experience for those involved and has been well received by the general public. The logic of all levels of government getting together to undertake transportation planning and directly involving the people most affected by decisions is difficult to argue with and has been endorsed by most of the stakeholders.

The transportation planning and analysis is beginning to result in some consensus as to the priorities and principles that should be adopted from both a provincial and regional perspective. Examples of these include:

- The existing grain dependent branchlines, in some area, is a more economically efficient transportation system than trucking grain to mainline grain terminals.
- The planning of new facilities such as major grain terminals should consider the impact on the road network.
- Road upgrading priorities should be based on the long term strategic social and economic transportation needs of the province and its regions.

The challenge facing area transportation planning is to deliver measurable and meaningful results in terms of better transportation service. For example, the SWTPC has determined that the loss of branchlines in its area would result in a crisis in terms of increased road costs. However, it has been frustrated in its attempts to effect the creation of short line railways. So, on the one hand, the SWTPC has taken the initiative to evaluate various options to see which is the most efficient from an overall cost perspective, but on the other hand, it has not been able to alter the trend towards branchline abandonment and reduction in grain delivery points. This apparent ineffectiveness is a point of concern. ATPC's are developing long term road upgrading plans. This entails the identification and ranking of long lists of current and future road deficiencies. To some this is just confirming what all the local people already knew. ATPC's will only be judged worthwhile, by many, if they see a measurable improvement in the roads that they use. There are still others that see ATPC's as just another hoop that the Provincial government is making the municipalities jump through in order to get road improvements.

3.6.3 Develop Sustainable Operation

The ATPC's rely on three major resources. The first is the energy and enthusiasm of the executive committees and sub-committees members; second is the financial support of the member municipalities; and the third is the technical advisory services of the DHT. These resources are being voluntarily provided because there is a belief and expectation that it will make a difference. These three resources are essential to the continued operation of the ATPC's. The challenge for the ATPC's will be to continue to deliver sufficient benefits to justify the resources that are currently being allocated.

Municipalities and their representatives see area transportation planning as a means to ensure that local needs are addressed when the province does its highway and other transportation planning. This will mean that each ATPC will need to have the time and resources to do effective planning and setting of priorities. In turn, the province must find an effective process to integrate its planning process with that of the ATPC's.

The province looks at area transportation planning as a partnership with municipal governments. The province recognizes the potential benefits of this partnership and, it expects that the ATPC's will be more than well informed lobby groups. The province is prepared to make the investment required to allow the ATPC's to make informed planning decisions. It expects that ATP will be a partnership not a confrontational relationship.

The term partnership is a popular buzz word in today's economic environment. However, true partnerships appear to be few and far between. A generally accepted definition of partnerships includes the following concepts: *The parties agree that they will share both the risks and potential benefits. The parties agree: to work together; share the business risks; and expect that both parties will be better off than if they went their own way. Partnerships do not work unless both parties are better off than if they worked alone.*
Will both parties develop the trust and vision to create true partnerships?

4.0 FUTURE DIRECTION FOR ATPC'S

The first ATPC's that were formed in 1995 are approaching their third anniversary. At the same time new ATPC's are expected to form this year. In general, the newer ATPC's are taking advantage of the ground breaking work of the older ATPC's. The new ones are spending less time on organizational matters and are quickly focusing on the key transportation planning issues. Once the basic research and analysis has been undertaken to develop a database of information and strategic issues, it is expected

that the ATPC's will be focusing on the longer term issues and concerns. These are expected to include:

1. Formal Process for Providing Advice

The province, SARM, and SUMA have worked together to initiate area transportation planning. However, there has been no definitive long term vision. There was general agreement on some principles but it began as a one year pilot project that is approaching its fourth year. Each ATPC has been given its own freedom to define its own role, mandate, priorities and work plan. However, there is a consensus developing that the ATPC's main role is to provide advice to the provincial and municipal governments. The ATPC's are starting to develop very specific advice on such issues as road priorities and branchlines. The ATPC's and the provincial government will need to develop an effective process to integrate or complement their transportation planning efforts.

2. Development of Long Term Strategic Plans

The ATPC's are moving beyond simply responding to issues as they arise. They are developing proactive work plans to develop comprehensive long term strategic plans. These plans will look at the: current and future transportation needs (both social and economic); all transportation modes (road, rail, water and air); and the capability of the existing infrastructure. These plans will also identify the required financial resources and alternative sources. These plans will require significant commitment of time, energy and money on behalf of all parties. If these plans are seen to be equitable, reasonable and effective by all parties then the next stage will be implementation by the various partners.

3. Developing a Role for the Transportation Users and Providers

The transportation users and providers such as grain companies, trucking companies, and railways have had a limited role in area transportation planning. This has not been because they were not recognized as important but because the first priority was to get the municipal and provincial governments working together. Now that area transportation planning is well established and the ATPC's are becoming more knowledgeable, it is anticipated that other stakeholders will be become formally involved in the planning process. The province is already doing this with its Transportation Partnership Program which entails the province entering into partnership agreements with major shippers and carriers to improve transportation efficiencies and invest in infrastructure. This could be a model for partnerships developed by ATPC's involving all levels of government, transportation users and carriers.

Allocation System Incentives to Improve Grain Loading and Unloading Performance in Western Canada

Dr. Barry E. Prentice, Transport Institute University of Manitoba, and Doug E. Campbell, Campbell & Associates

Introduction

The performance of the Canadian grain handling system has come under increasing scrutiny since the removal of the WGTA subsidy in 1995. Increasing cost consciousness has caused the industry to look for more efficiency at all levels. The new rallying cry is "accountability." Essentially, participants want system incentives that reward good performance and issue penalties for poor performance. In response, the CWB has created a new car allocation incentive program that benefits grain handlers who have the best performance.

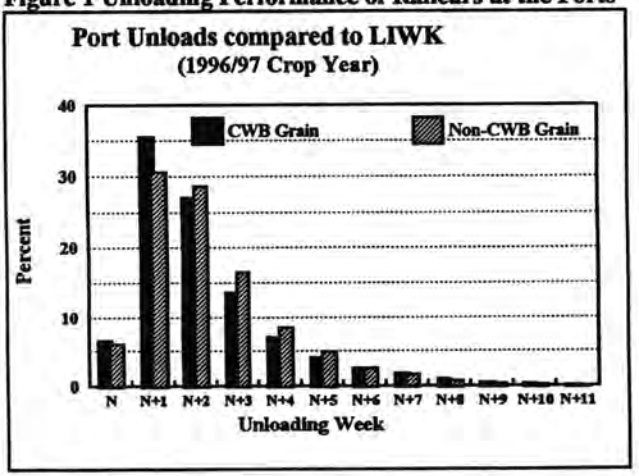
The purpose of this paper is to examine the current logistical performance of the Canadian grain handling system and to describe the CWB incentive program. In this analysis, logistical performance is assessed on the basis of loading and unloading data. The CWB incentive system works through the car allocation procedure by rewarding adherence to the plan with an increase in the number of rail cars received. A flow chart of the allocation procedure is presented to illustrate how the incentive program operates. The paper concludes with some thoughts on market-oriented means of strengthening system incentives.

Rail Car Ordering, Loading and Unloading

Variation and delay in terminal unloads reflect variation and delay in country loading patterns and railway transit time. In the 1996/97 crop year,

the system averaged over eleven weeks to unload a given week's planned orders. The performance of unload activities reflects the cumulative effect of variations in ordering, country loading, transit time and terminal unloading. Variation in transit time and loading patterns causes port arrivals to be spaced out over long periods. Poor system performance implies inaccurate order processing and faulty inventory management. Lack of precision in the delivery process causes unpredictability of carload arrivals, and results in the build-up of grain inventory not needed for

Figure 1 Unloading Performance of Railcars at the Ports



immediate sales. These are problems that may be ameliorated with the right incentives to execute the plan.

Loading Performance

Weekly car loading performance presents a measurement of the soundness of the plan and the execution of that planning or ordering process by the railways and elevator companies. Figure 1 presents a comparison of the

actual loading versus the planned loading.

The distribution of loading records for all major grains in 1996-97 shows that 51 per cent of cars are loaded in the Loading Instruction Week (LIWK), seven per cent are loaded early and 42 per cent are loaded late. Frequently, six weeks are required to complete a given week's orders, which means that many overlapping orders are being filled in any given LIWK. Non-CWB grains tend to be loaded slightly earlier than CWB grains, but loading performance for both is similar by the end of the LIWK.

The observed loading pattern implies that a significant amount of grain is loaded in other than the planned order sequence. Delayed loading over a span of many weeks causes rescheduled arrival at the destination. Any further variation in transit time can cause terminal arrivals to be spaced out irregularly over even longer periods than elevator loadings. Ideally, loading more cars in the planned LIWK would improve the accuracy of car ordering for both CWB and non-CWB grain.

Unloading Performance

Terminal unloads reflect country loading patterns, transit time and port handling. Variation in transit time and loading patterns causes port arrivals to be spaced out over many weeks. After arrival at the port, cars can spend a day or more in rail and terminal yards before being spotted at the terminal and unloaded. Figure 2 presents the pattern of unloads for CWB and non-Board grains for the 1996/97 crop year.

In 1996/97, six per cent of the cars loaded in the country were unloaded at the terminal in the same LIWK. This means the cars were loaded in or prior to the LIWK and unloaded by Sunday night of the same week, as planned. Forty-one per cent of the cars were unloaded by the end of the following week (LIWK+1), and 68 per cent by LIWK+2. It takes up to 11 weeks to unload all the cars loaded in the country in a given LIWK. Another way of looking at this is that it is common in any given week to have cars from up

to 11 different LIWKs unloading.

Logic suggests that the problem of unpredictable unloading is more acute for small, infrequent or specialized shipments of particular grades or quality separations of grain. Larger recurring shipments tend to be less affected because grain arriving in port can be applied against vessel requirements regardless of the LIWK of loading. Overlapping arrivals from many different LIWKs masks the problem of loading variation at the terminal end. The pattern of unloads at the ports appears to follow the *Pareto Rule*, in which 80 percent of the grain is unloaded within 20 percent of the allotted time. This means that 20 percent of the grain volume occupies a disproportionate number of the available railcar time.

Non-CWB grains tend to unload later than CWB grains even though they tend to load earlier in the country. This could be a result of longer time in transit due to the staging of trains to meet specific vessels. The overall objective of the system should be to reduce time span and variation of delivery by loading 100 per cent of orders in the LIWK. Improvements in loading performance, coupled with reduced variation in transit time, would result in lower rail, primary and terminal inventory. This would enhance customer service, reduce carrying costs and demurrage, and improve car utilization. Cumulatively, these measures could lower the logistical cost components of the basis.

Rewarding Good Loading Performance

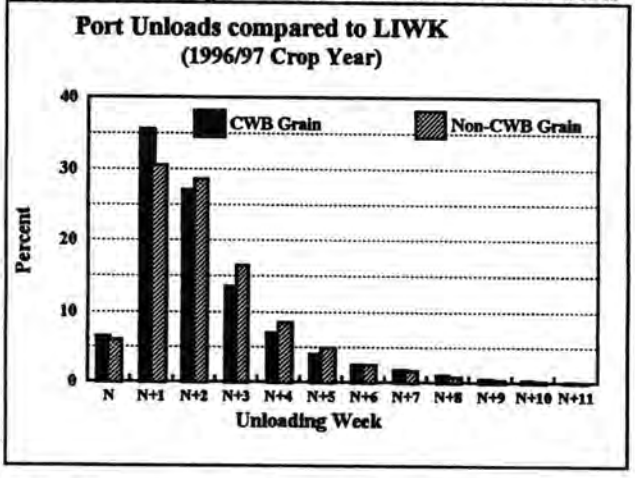
Since June 1997, the CWB has implemented a new system of car allocation designed to reward accurate loading performance. The operation of the system is based on the allocation of covered hopper cars that are under the control of the CWB. Figure 3 presents a model of the rail car allocation system used for a sample week in the fall of 1997/1998 shipping season.

At the top of the figure, the railways have announced the availability of 9,575 cars.

Railway Car Supply Offerings	
CP Car Supply	4775
CN Car Supply	4800
Total	9575

The allocation of the cars depends on the 1) destination 2) commodity 3) freight rate 4) train run. The division of the cars by the two railways begins with the non-rate regulated commodities. These "commercial" cars carry

Figure 2 Unloading Performance of Railcars at the Ports

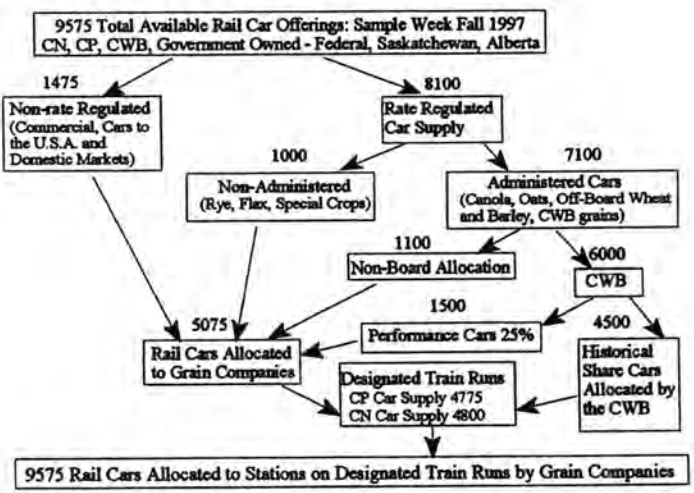


grain to the U.S.A. and to any domestic destination. These movements accounted for 15.4 percent of the total fleet in this sample week.

Commercial Cars	
CP	675
CN	800
Total	1475

The remainder of the railcars, some 84.6 percent for this sample week, are subject to the regulated rate cap on shipments to the ports and fall into two categories: administered and non-administered. "Each year, the overall rail car supply is split between CWB and non-Board (canola and oats) grains. This percentage is negotiated once a year and takes into account production and anticipated export volumes. Rail cars needed for non-administered grains (rye, flax and special crops) do not enter into the formula because their requirements are relatively small and can be otherwise accommodated." *Grain Matters (1997).* The non-administered cars are allocated first. In this example, they represent 10.4 percent of the total fleet, 12.3 percent of the noncommercial fleet.

Figure 3 Flow Diagram of Rail Car Allocation Method, Sample Week Fall 1997



Non-administered	
CP	500
CN	500
Total	1000

In this week there were 7,100 cars in the administered category, 74 percent of the total fleet, and 88 percent of the noncommercial fleet. These cars were divided between Thunder Bay, Vancouver and Prince Rupert. The non-board grains were allocated 1,100 cars, which left 6,000 cars for the CWB to allocate to wheat and barley shipments.

Administered			Non Board Allocations		C W B Allocation	
Thunder Bay	CP	1700	Thunder Bay	500	Thunder Bay	2000
	CN	800				
Vancouver	CP	1900	Vancouver	600	Vancouver	2400
	CN	1100				
Prince Rupert	CN	1600			Prince Rupert	1600
Total Ports		7100	Sub-total	1100	Sub-total	6000

Prior to the new incentive program, the CWB distributed cars to the grain companies based on a weighed average of CWB grain handled in the previous year. The new allocation procedure reduces the historical share to 75 percent of the total and allocates the other 25 percent based on performance. So in this example, the CWB allocates 4500 cars to the train runs based on the grain companies' past records, and divides 1500 cars (25 percent of 6000) amongst the companies to allocate to CWB grains on the available train runs.

The grain companies are allowed to place their "performance" cars on the train run of their choice, providing they can source the correct grade of CWB grain for the desired location and the railway service is available in the Loading Instruction Week. The grain companies are given more

flexibility to manage their inventories, but must still keep in mind the shipping costs of the CWB. They cannot allocate cars to train runs that increase CWB shipping costs.

Allocated to the Grain Companies		Allocated directly by the CWB	
Non Boards to Port	1100	Historical share cars	4500
CWB Performance Allocation	1500		
Commercial	1475		
Non Administered	1000		
Total	5075		
53.0% of the total car supply		47.0% of the total car supply	

The incentive to increase the loading accuracy of the CWB grains should improve system performance. Over time, the best handlers should be rewarded with a gradually increasing market share, but the impact is limited. LIWK loading accuracy is only one variable affecting the unloading performance. Moreover, the incentive is restricted to the CWB grains. As observed earlier, the loading and unloading patterns of non-CWB grains are very similar. Increased flexibility to load "performance cars" has no direct impact on the non-CWB handling.

A more global solution would require improved management of grain handling performance. This would entail more comprehensive industry reporting, and the development of standards that could be measured to monitor the order fulfillment process. The question however, is whether the incentives are strong enough to change behaviour. How effective would such a system be when the shipping pattern has seasonal peaks?

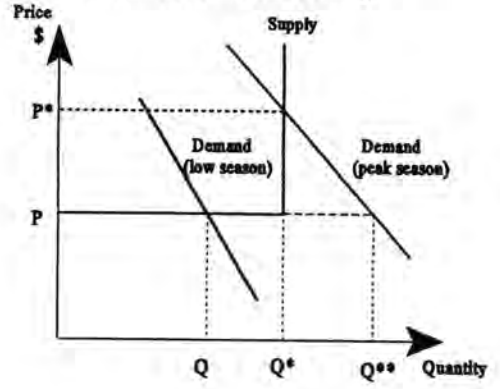
Peak Load Pricing Model

The pattern of Western Canadian grain shipping has the characteristics that apply to a peak load pricing allocation system. The supply of rail cars is very elastic up to a capacity point at which it is more or less fixed. During the October-March period the system operates near capacity, while slack is

available in the remainder of the shipping season. A model of peak load pricing is presented in Figure 4.

Two levels of demand are observed: a peak season demand and a low season demand. At the low season price P, shippers wish to move Q volume of rail cars. In the peak season, shippers would like to move Q** cars, but this volume of cars is not available. At the price P, Q**-Q* more cars are demanded than can be supplied. In an institutionalized allocation system shippers are denied cars based on some criteria, e.g., historic market shares. Under the peak load pricing system, prices are bid up to P* which rations the available supply (Q*) amongst all the market participants.

Figure 4 Model of Peak Load Pricing



Shippers have an incentive (P*-P) to try to expedite movements prior to the peak, or to delay sales until the peak has passed. This helps to spread out demand and to reduce the amplitude of the peak season.

Rail cars in the United States are allocated on a system that resembles a peak load pricing model. Individual rail companies offer a limited number of cars on an auction basis, with allowance for a secondary trading market. The premiums and discounts in the secondary market mirror the seasonal shipping pattern. Premium rates occur during the peak, while discounts are present in the off-peak period.

Market-based systems that rely on prices to allocate supply have been operating in the U.S. since 1988. Wilson and Dahl (1997) identify two forms of efficiency that result from market-based allocation: distributional and pricing. An allocation exhibits distributional efficiency if the order of service corresponds with the value of service across customers. Auction methods of allocation are effective and impartial: locations receive cars where shippers are most willing to pay. Pricing efficiency implies that carriers and shippers have information to guide provision and use of service. In other words, the consequences of delaying or expediting movements are known and a value can be placed on guaranteed access. Moreover, price signals provide an incentive mechanism to maintain an optimally sized grain car fleet.

Electronic Market for Rail Cars

Implementation of an electronic market for rail cars in Canada would help shift demand from the peak to the non-peak, and could improve efficiency. While it would require payment for the use of the railcars, it would not necessarily entail any change in the structure of freight rates. The rail rate would remain fixed, as it is at present, while fluctuating prices for the use of the railcars would encourage shippers to avoid the peak period and increase the efficiency of railcar use.

The government-owned fleet could form the core supply, but all participants would be encouraged to add railcars to the electronic market. An electronic market for railcar allocation could solve the dilemma facing the Government of Canada in the sale of its rail car fleet. The government would like to end this implicit subsidy, but concern exists about the power

that would reside in the hands of the new owners. Instead of trying to recoup this capital through an immediate sale and transfer, the government could use short-term leases to obtain payment for the outstanding value of the investment. Gradually, as the publicly-owned cars were retired, a new fleet would emerge to supply the electronic auction.

As with any market, the introduction of an electronic auction allocation system would require safeguards. Restrictions on total supply would be required to ensure that no party would be able to "corner the market" and deny access to other competitors. Many other details would have to be worked out so that the railways could operate efficiently. As the number of delivery points declines, however, the logistical problems are likely to become more manageable.

Conclusion

The CWB "performance car" program is a step in the right direction. It is unlikely however, that this incentive is sufficient to increase the efficiency of non-CWB grain forwarding. A more comprehensive solution must deal with the distributional and pricing efficiency of the allocation system for non-CWB and CWB grains. In addition to operational performance, the allocation system should encourage competition in the use of the fixed car supply to maximize revenues for the industry. A market-based allocation system modeled on the U.S. experience deserves consideration. The opportunity exists to develop an electronic market for railcar allocation using the government-owned fleet as a core. This could create a transparent market and enable a gradual transition for the industry as this implicit subsidy inherent in the provision of this fleet is removed.

References

"Rewarding good loading performance," *Grain Matters*, A Letter from the Canadian Wheat Board, November-December 1997: 6-7.

Wilson, William W. and Bruce L. Dahl. *Bidding on Railcars for Grain: A strategic Analysis.* Fargo, ND: Department of Agricultural Economics Report No. 376, May 1997.

Acknowledgments

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RAILWAY SAFETY IN CANADA, 1987-1997

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Transportation safety in Canada is regarded as a sacred trust. Governments may deregulate transport from an economic standpoint, but safety must remain sacrosanct. Virtually all politicians, regardless of political party, would agree with the views expressed by an earlier Minister of Transport, the Honourable Don Mazankowski, when he was introducing his proposals for economic reform in the transportation industry in 1985:

> Safety is also a major priority for all involved in the transportation sector. This Government's commitment to safety is clear ..... I would like to indicate unequivocally that the Government will neither propose or permit any economic regulatory reform that might be detrimental to safety standards.[2]

In terms of fatalities, road transport is by far the most dangerous transport mode, with 3,347 deaths in 1995, although road deaths have been declining significantly in recent years. Fatalities in other transport modes are much fewer: 107 railway deaths in 1997, resulting mainly from trespassing and crossing accidents; 76 aviation deaths, practically all involving privately operated or small commercial aircraft; and 24 marine deaths, with this figure including fishing vessels, but excluding pleasure boating.[3] However, accidents and fatalities affecting the mode itself are not the only concern of government. There is also the problem of damage inflicted on the community at large and, in the rail mode, this is mainly the potential results of derailments, especially when dangerous commodities are concerned.[4]

Accidents in the air and rail modes receive extensive coverage in the media, certainly compared with the attention given to the much larger number of accidents on the roads. Air and road safety also receive much analytical attention in the form of research studies, but rail transport tends to be overlooked in this regard.[5] This paper attempts to help to redress this imbalance in transport safety analysis.

Canadian Government Regulation of Railway Safety

The government of Canada has regulated railway safety virtually since Confederation itself, with the first *Railway Act* passed in 1868. At the beginning of the period covered by our paper, i.e. 1987, the Railway Transport Committee of the Canadian Transport Commission (CTC) was responsible for all Government of Canada regulation of railway safety, including not only the monitoring of railway operations and the issuance of orders and regulations binding on the railways, but also accident investigation.

During the course of 1987, the government implemented its earlier proposals for economic regulatory reform of transport through the *National Transportation Act, 1987*. This *Act* stated in section 3 (1)(a) the importance of safety in transportation, but it was not intended to address specific safety issues. The CTC was abolished at the end of 1987 and its railway safety duties were transferred intact for an interim year to the National Transportation Agency (NTA), while new legislation was being developed.

In 1988, the *Railway Safety Act (RSA)* was passed and, effective January 1, 1989, all activities relating to the safe operation of railways, other than accident investigation, were transferred to Transport Canada. Responsibility for accident investigation was left on a temporary basis with the NTA and then transferred effective April 1 1990 to the new Canadian Transportation Accident and Safety Board (TSB), created the previous year and reporting to Parliament through the President of the Privy Council and not through the Minister of Transport.

The *Railway Safety Act* does not contain any statement of the change in philosophy which it introduced, but this was fairly clearly inspired by a belief that economic deregulation should be accompanied by less hands-on government intervention in the safety regulatory process. As the 1994 report of the Railway Safety Act Review Committee stated, "Economic regulation was changing, and the structure of safety regulation had to change with it"[6]. This expectation was stated even more clearly in railway submissions to the Committee, for example that of the Railway Association of Canada (p. 1): (there) "was the need to introduce a 'Freedom to Manage' principle to counterbalance the 'Freedom to Move' concept which was rapidly evolving into the *National Transportation Act, 1987*".

The objectives of the new railway safety legislation can be summarized as follows:

- to separate the monitoring of railway safety from accident investigation;
- to have the railways and the government develop performance standards for the industry rather than have detailed regulation imposed on the railways by government;
- to streamline the administration of railway safety by allowing the Minister of Transport to issue 'rules' binding on the railways;
- to " provide railway companies with greater freedom to manage their operations efficiently and safely; and"
- to "advance rail safety in Canada".[7]

The last of these objectives is the subject of the next section and later parts of the paper address the other objectives.

Canadian Railway Accident Statistics

It is useful to commence with an overview of the accidents that occur on Canadian railways. As shown later in Table 2, there was an average of 1,236 reportable railway accidents per annum in the years 1995-97. Main-track derailments averaged 172 and these are of particular importance because of their potential impact on third parties, namely the communities adjacent to the accident sites; nevertheless it should be noted that many of these derailments are minor, involving only one or two cars. Main-track collisions can also be disastrous, but fortunately these are rare, averaging only 13 per annum in the years 1995-97.

Crossing accidents averaged 352 per annum and trespassing accidents 113, with these both major concerns because of the fatalities involved. Other railway accidents, averaging 586 per annum in 1995-97, are usually less serious. Derailments and collisions in yards, spurs and sidings, generally at low speeds, accounted for 481 of these accidents. Total railway fatalities averaged 117 per annum in 1995-97 - 45 in crossing accidents and 66 from trespassing, with only 6 attributable to all other railway operations.

If railway safety is being 'advanced', railway accidents should be declining. Table 1 shows that this was happening in the 1980s. Substantial safety improvements included much stronger tank cars for dangerous commodities, roller bearings to reduce the number of 'hot box' axle failures, track

improvements and more 'hot box' detectors, improvements in operating practices ranging from train marshalling to locomotive cab conditions, and new initiatives in railway crossing protection.

Table 1: Railway Accidents, 1981-91 -number

	Main-track derailments	Crossing accidents	Total rail accidents	Total fatalities
1981	294	763	1,430	149
1982	270	691	1,299	138
1983	202	567	1,113	121
1984	213	595	1,154	122
1985	175	606	1,128	123
1986	147	524	1,002	115
1987	130	459	956	104
1988	99	502	975	109
1989	113	469	896	140
1990	102	386	884	102
1991	107	407	963	123

Source: *TSB Statistical Summary of Railway Occurrences, 1993* for 1983-91, issue of two years earlier for 1981-82. The table stops at 1991, as a number of reporting definitions were changed effective August 1, 1992.

The improved safety performance of the 1980s has not continued into the present decade. Railway accident statistics fluctuate from year to year and it was not until 1994 that the realization came that, with the exception of crossing accidents, railway safety was on a plateau, not deteriorating but no longer improving. Thus, a 1994 TSB report concluded:

> Canadian main track derailments have declined by almost a factor of three between 1980 and 1988. Adjusted for changes in reporting requirements, the data indicate that the annual number of derailments has remained basically unchanged since 1988.[8]

Later that year, the Railway Safety Act Review Committee confirmed this view, stating that "By all accounts, the state of safety of rail operations has remained relatively constant since 1989, after a prolonged decline in accidents from 1980 to 1988". The report showed that this conclusion held for derailments and collisions on main track and in yards and for accidents involving track motor cars and maintenance of way equipment.[9]

Recent data on railway accidents are shown in Table 2. In 1992, the TSB increased the requirements for accident reporting, so the figures in Table 2 cannot be compared with those in Table 1. This limitation does not apply to fatality figures. (At the same time, the TSB reduced the requirement to report minor injuries, so no injury statistics are quoted in this paper because of lack of comparability.)

Table 2: Railway Accidents, 1991-97 -number

	Main-track derailments	Crossing accidents	Total rail accidents	Total fatalities
1991	160	449	1,275	124
1992	173	412	1,243	137
1993	144	378	1,177	116
1994	159	389	1,214	114
1995	151	380	1,277	124
1996	189	366	1,305	119
1997	176	309	1,125	107
Av1991-93	159	413	1,232	126
Av1995-97	172	352	1,236	117

Source: *TSB 1997 Preliminary Transportation Occurrence Statistics* of February 3, 1998 for 1996 and 1997. TSB has provided the most recently updated statistics for earlier years as of March 2, 1998. However, TSB has stated in its annual publications that the new reporting requirements of August 1, 1992 were not fully operational until 1993. After examination of TSB estimates of the extent to which the two reporting systems differed in the years 1994-97, we have made the following additions to the published figures - in 1991, plus 53 main-track derailments, 42 crossing accidents, 312 total accidents; in 1992, plus 44 main-track derailments, 26 crossing accidents, 274 total accidents; in 1993, plus 18 main-track derailments, no change for crossing accidents , plus 152 total accidents. No adjustments for fatalities were necessary in any years.

With the exception of crossing accidents, railway safety continues to be on a plateau. The total number of railway accidents was unchanged between the average of the three years 1991-93 and the average of the three years 1995-97. Main-track derailments showed a slight increase. Crossing accidents continued to decline and this more than accounted for the reduction in the total number of railway fatalities. Road transport deaths were declining during this period, as a result of factors such as greater penalties on alcohol use when driving, and this had an impact on crossing accidents. In addition, the regulator continued to follow the practices of the 1980s - providing government money for improved crossing protection and for public education on crossing dangers through Operation Lifesaver. Elsewhere, the new railway safety legislation has had little effect in advancing rail safety in Canada.[10]

Government Railway Safety Organization

A prime objective of the new safety legislation of 1988/89 was to separate the monitoring of railway safety from accident investigation. This was undoubtedly achieved, but the question remains as to how desirable this change has been.

The main rationale for the institutional separation is well-stated in the report of the Railway Safety Act Review Committee as "to avoid any potential for conflict of interest between rail safety regulation and rail accident investigation".[11] The word 'potential' is particularly important. The present writer recalls a conversation in 1987 with an official of Transport Canada,

who admitted that no instance of conflict of interest had ever been identified, but went on to assert that complete lack of evidence did not alter his conviction that such conflicts must have occurred. It is very difficult to argue with one who claims to be the recipient of divine revelation!

Few other reasons were given for the administrative separation, other than a belief in Transport Canada that rail safety monitoring should be located there and that it would be a pity not to include railway safety in the mandate of the new Transportation Safety Board, which was to be responsible for the investigation of air and marine accidents, in part because previous arrangements in the air mode had been singularly unsuccessful.

These reasons for institutional separation were hardly compelling and they reflected a fundamental misinterpretation of the role of the federal government in railway safety. Railway management was operating the railways, not the government. The government was attempting to obtain assurances of safe operation through monitoring railway activities, funding improved crossing protection, and investigating accidents. These government activities supplemented each other, were not in conflict, and did not need to be separated. This may have been subconsciously recognized as early as 1989 in the formal title of the TSB, which describes the new board as covering both accident investigation and safety.

The institutional separation of rail safety monitoring and accident investigation did not save any resources. Specific expertises were now needed in two different organizations, expertises which could previously be shifted between monitoring and accident investigation as different needs arose, thus assuring a more efficient utilization of resources.

Transport Canada contributed further to this fragmentation of the safety effort by an internal reorganization. The five Transport Canada field offices doing rail safety monitoring across the country had initially reported to the Director-General of Railway Safety in Ottawa. Each safety field office now reports to a Regional Director-General, a position established in each region to coordinate all Transport Canada activities there and not just safety. These Director-Generals report directly to the Deputy Minister in Ottawa. Neither the Director-General of Railway Safety nor his boss, the Assistant Deputy Minister, Safety and Security Group, has direct control over the safety field offices. It is rare for bureaucratic fragmentation to result in increased

efficiency and, while there may be reasons for this organizational structure, the benefits to rail safety are not apparent to the outside observer.

In accordance with the 1989 legislation, the Minister of Transport must respond within 90 days on action taken or proposed in respect of TSB safety recommendations. In respect of 55 recommendations on rail safety made in the period 1990-96, the TSB assessed 19 responses as fully satisfactory, one as satisfactory in intent, 21 as satisfactory in part, and 14 as unsatisfactory. Unsatisfactory response represented 25% of the rail total and unsatisfactory and partially satisfactory together 64%. The combined figures for the three other modes - air, marine and pipeline - were 15% and 36% on these two measures.[12]

While this TSB dissatisfaction with Transport Canada's reactions to its recommendations may indicate an effective separation of powers between the two organizations, the implications for rail safety are less assuring. Formerly, the Railway Transport Committee used to review recommendations outstanding from previous accident investigations on a routine basis every three months, with urgent matters dealt with virtually on an immediate basis. With responsibility for both accident investigation and safety programs, the present dichotomy between the TSB and Transport Canada did not arise. The new legislation has certainly separated railway accident investigation from safety monitoring, but at a considerable cost.

Performance Standards

It was a fundamental part of the new legislation that government should no longer impose detailed regulations on the railways by specifying, for example, maximum wear on wheel flanges, distances trains are allowed to travel between inspections, qualification standards for railway employees, fittings in locomotive cabs, and so on. Instead, performance standards would be determined for the industry by government and the railways together and the railways would have to live up to these standards. The regulator would specify broad objectives and leave the means of implementation to the railways. No longer would the regulator specify precisely <u>what</u> railways would do and <u>how</u> they would do it.

This new approach was regarded as overwhelmingly attractive a decade ago and the avoidance of excessive regulation is still quite rightly a desirable policy objective. The problem has been the nebulous nature of the concept

of performance standards. In the 1987 discussions among the stakeholders prior to the drafting of the *Railway Safety Act*, the railways volunteered that an ultimate performance standard of " thou shalt not kill more than so many people next year in railway operations" was crass. A slightly less ambitious suggestion was provided in humorous vein as light relief rather than as a policy option - to allow no more than x main-track derailments a year, no more than y yard collisions, and no more than z crossing fatalities. It was assumed that somewhere out there were workable performance standards, avoiding both the Scylla of detailed regulation and the Charybdis of permissible numbers of accidents and/or fatalities that had no hope of being politically acceptable.

Unfortunately, finding workable performance standards has proved elusive. This was recognized by the Railway Safety Act Review Committee in its 1994 comment that " Little headway has been made under the *RS Act* in replacing these outdated regulations with more modern and flexible instruments, such as performance-based rules". The Committee then went on to blame this on "the Canadian Transport Commission's (CTC) regulatory legacy", a peculiar and unconvincing explanation of influence by an agency at that time dead for seven years.[13]

Since 1994, an effort has been made to formulate a performance standard for railway crossing accidents, namely a halving of the number between 1996 and 2006. However, it is our impression that difficulties still persist in other areas. Discounting the evil influence of the CTC now dead for over ten years, the real problem is the innate difficulty in finding ground between detailed regulation and broad politically unacceptable statements implying that some accidents and fatalities are permissible. The present writer is in sympathy with avoiding excessive detail in regulation and would not wish to see a return to the past; at the same time, he does not believe that Transport Canada and the railways have succeeded in ten years in developing a workable body of performance standards; and, regrettably, he has no deus ex machina solution to offer to this dilemma.

Streamlining the Administration of Railway Safety

The *Railway Safety Act* gives Transport Canada much more flexibility to administer railway safety than that available previously to the Canadian Transport Commission. The Commission could regulate only by regulations applicable to all railways, which required approval by the Privy Council

Office and involved incredibly long delays, or by separate orders issued to each individual railway. On many occasions, the Commission was obliged to issue separate and identical orders to each railway to avoid delay; apparently, this procedure of identical orders was of doubtful legal validity, but to their credit the railways never appealed this practice, realizing that to do so would have created regulatory chaos.

Transport Canada has two new procedures under the *Act*. Firstly, it can impose 'rules' on the railways, with these developed by the railways, reviewed by the Railway Safety Directorate and issued under delegated authority by an Assistant Deputy Minister. Secondly, railway safety inspectors can issue orders to railways in respect of a 'threat' or 'immediate threat' to safe railway operations. These powers allow much greater speed than the old-fashioned regulations, which are now rarely used. Transport Canada can also impose substantial fines on the railways for safety breaches, although these powers have never been used.

The new legislation has undoubtedly given the potential to streamline administrative arrangements, but in practice there have been some areas of concern. The TSB has not been the speediest producer of reports and the Review Commission on the TSB wrote in 1994:

> Our review of the TSB's report production process convinced us that the Board has been overly cautious in writing reports because of a fear that outsiders will impute blame from its findings.....Further, we conclude that there is a vital need to streamline radically the TSB's report development process. Reports must be released more rapidly.[14]

To its credit, the TSB admits the need to improve report timeliness.[15] Nevertheless, probably its most important rail report, that on the derailment and release of dangerous chemicals at Oakville, MB on December 18, 1992 was not released until almost two years later on November 23, 1994. An even more serious complaint is the lack of opportunity for public input into railway safety matters through the public hearing process, The TSB has never held a public hearing into a railway accident and this contrasts markedly with the policies followed previously by the Canadian Transport Commission (CTC).

In order to provide increased opportunities for consultation between the stakeholders, the Railway Safety Advisory Committee (RSAC) was set up by the CTC at a date prior to 1981. This consisted of representatives of the railways, labour unions and government. Meetings were held every three months to review safety matters and proposals put forward by the various participants. Considerable documentation was provided in advance of these meetings and the deliberations proved extremely useful to all stakeholders. The RSAC was still going strong in 1987 and arrangements were made to continue this as a consultative committee under section 44 of the *Railway Safety Act.* The Railway Safety Act Review Committee pointed out in 1994 that this committee has never been established[16] and this is still the situation today. While the Railway Safety Directorate continues the CTC practice of separate consultations with railways and unions, it has not set up a forum for joint consultation comparable to the RSAC.

On the first page of its 1994 submission to the Railway Safety Act Review Committee, the Metro Toronto Residents' Action Committee (M-TRAC), a public interest group concerned with railway safety, suggested that:

> On reflection, it may have been a mistake to place the administration of the *Railway Safety Act* in the hands of the Minister of Transport and to have no appeal from a ministerial decision ..... Gradually, the impression gathering among many public groups is that ..... (the) *Railway Safety Act* was not designed to reinforce protection of the public but to protect the rail industry against public complaints. Over and over again we heard of gradual moderation of the rail safety operating rules without public consultation.

The new legislation provided for a streamlining of railway safety administration. It was not inevitable that this had to be accompanied by a significant reduction in consultation and an absence of public hearings, but this has happened.

Railway Freedom to Manage Operations Efficiently and Safely

Canadian railways have shown a remarkable turnaround in their financial performance in recent years. The operating ratio measures operating expenses as a percentage of operating revenues. In 1997, this ratio was 81.5% for CN and 81.4% for CP, vast improvements on figures of 97.1% and 95.9%, respectively, only five years ago in 1992.

It is common knowledge that this financial improvement has resulted partly from labour downsizing. In 1996, the average number of employees of all Canadian railways was 47,556 against a figure of 75,267 in 1988.[17] Labour unions claim that this rapid downsizing has had adverse effects on safety - for example, CAW-Canada, which represents a number of railway trades including carmen, stated at page 2 of its submission to the Railway Safety Act Review Committee:

> Our concern is that the greater reliance on the free market to shape transportation has put safety in jeopardy ..... we see tremendous pressure on the transportation companies to cut costs. When companies are under financial pressure, even safety costs will be under attack.

However, the railways have always laid great stress on the need for safe operations. In addition to genuine humanitarian concerns, the railways have pointed out that derailments and collisions are bad for business because they cause delays to customers and mean that track and equipment are not available to earn revenues. The *Canadian National 1996 Annual Report* (pp.10-11) contains a useful description of its safety activities stating that "as the third-safest railroad in North America, our goal is to become the safest". Although there does not seem to be a similar section in the *Canadian Pacific Railway Company 1996 Annual Report*, CP also places high emphasis on safety.

Nevertheless, there is always a danger that the degree of attention to safety considered optimal by the railways may fall short of that considered optimal by society. This thought is apparent in both the major judicial inquiries into Canadian railway accidents held in the last two decades - the Grange Inquiry into the CP 1979 Mississauga derailment and the Foisy Inquiry into the CN 1986 Hinton, AB, train collision.

Having noted that CP was initially skeptical of the merits of hot box detectors, Grange went on to state that, when a major danger existed from the absence of safety equipment , the necessary orders to install such equipment should be issued by government even if this caused economic hardship to the railways.[18] Foisy commented that:

> the style of operations and the culture of the "railroader", as it has evolved within CN, creates an environment in which otherwise well

> motivated and responsible people throughout the company place inadequate priority on safety and , in effect, give tacit acceptance to rules violations that affect the safety of CN's rail operations.....This attitude is reflected in measures related to the development, proving, and installation of safety technology, both by the railway and the CTC. There is insufficient priority given to safety technology or to its orderly and effective implementation throughout the system[19]

Sometimes the railways need pushing to implement safety initiatives and it would seem that this pushing has become more gentle over the last decade. Item, hot box detectors spaced every 25 miles are inadequate to detect the rapid failures that can occur in roller bearings, the problem is universally admitted, but solutions are slow to emerge. Item, the railways have been experimenting with defective wheel detectors for what seems like an aeon, but installation has been slow. Item, there has been a disappointing lack of progress on Advanced Train Control Systems (ATCS). A full ATCS would include a remote control that would apply an automatic and immediate brake application when a train crew failed to obey a signal or a speed restriction. Foisy believed that such a system could have prevented the Hinton collision.[20] There was little disagreement with his analysis a decade ago, ATCS was a very high profile subject, and Transport Canada put money into the development efforts. ATCS is not dead, but the speed of development has been glacial, when compared with general expectations a decade ago.

Conclusion

Since the legislative changes of 1988 and 1989, railway safety has been on a plateau, not deteriorating, but no longer improving except in the area of crossing protection. It is suggested that four factors have contributed to this disappointing overall performance and that there are several ways in which this situation could be ameliorated

1. Opportunities for input from the public and from railway unions into the regulatory process have been reduced. There are no longer any public hearings and the consultative committee provided for in the 1988 legislation has not been established. It would not be difficult to reinstate these channels of communication.

2. Government and public pressure on the railways to improve safety have been relaxed and this could have affected the priorities accorded to safety

within the railways. The changes suggested in #1 above would alleviate this. Over the years, it has been claimed that railways that are strong in economic terms will have the resources to produce strong safety performances. The Canadian railways have made remarkable financial progress over the last few years and perhaps we shall see a dividend in safety initiatives.

3. It was necessary to move away from detailed regulation of the railways, but the failure to develop a body of workable performance standards over almost a decade is worrisome. In our view, this has been due not so much to unwillingness to cooperate among the stakeholders, but rather to the inherent difficulties of the exercise. A determined effort must be made to develop these standards and, hopefully, this will be successful. Otherwise, approaches will have to be tried that are less desirable in principle but at least capable of application.

4. Government safety activities have become fragmented both between Transport Canada and the Transportation Safety Board and within Transport Canada itself. There are no strong reasons for the institutional separation of safety programs from accident investigation and the costs in practical terms have been considerable. The changes of 1988 and 1989 should be reversed and all the government's rail safety activities should be carried out within the same organization. This could be either within a revamped TSB or within Transport Canada; unfortunately, space does not allow consideration of the relative merits of these two options.

This paper has been confined to the rail mode, but a brief reference to the air mode is appropriate. Transport Canada is currently transferring major airport operations to not-for-profit airport authorities and divesting itself of smaller airports, while air navigation services have already been transferred to a not-for-profit company, Nav Canada. It was mainly the air mode that provided the original inspiration for the separation of safety programs from accident investigation and the case for separation is much less strong with reduced government operation of infrastructure in this mode. Although this paper has not discussed marine safety, it is believed that the consolidation of safety programs and accident investigation could also be advantageous for both air and marine, the two other main modes under federal jurisdiction.

Endnotes

1. John Heads retired at end-1995 from the position of Director of the Manitoba Transport Institute. In the context of the present paper, from 1981 to 1987 he was Executive Director of the Railway Transport Committee, Canadian Transport Commission. This Committee's responsibilities included all federal government activities in railway safety, both safety monitoring and accident investigation.

2. Transport Canada, *Freedom to Move*, July 1985, Preface, p. ii.

3. Transportation Safety Board, *1997 Preliminary Transportation Occurrence Statistics*, February 3, 1998. Later revisions of data should only marginally affect fatality figures. The Board is to be congratulated on releasing these preliminary data so promptly.

4. The most famous Canadian derailment in this category occurred at Mississauga, just outside Toronto, on November 10, 1979. A CP train derailed, three propane cars exploded, a chlorine car leaked, and the fear of the consequences of the escape of this deadly gas led to the evacuation of 250,000 people from their homes and businesses for up to five days. For a full account, see Honourable Mr. Justice Samuel G.M. Grange, *Report of the Mississauga Railway Accident Inquiry*, Supply and Services Canada, 1981.

5. A striking example of this is found in Leon N. Moses and Ian Savage (editors), *Transportation Safety in an Age of Deregulation*, Oxford University Press, New York, 1989. This book contains detailed analysis of the airline and motor carrier industries, including a chapter on Canada by Ramsey Withers, then the recently retired Deputy Minister of Transport, but there appears not to be a mention of rail safety in the book's 348 pages.

6. Railway Safety Act Review Committee, *On Track: The Future of Railway Safety in Canada*, Supply and Services Canada, 1994, p.2.

7. The last two objectives are quotations from, *ibid.*, p.5.

8. Transportation Safety Board, *A Special Study of Main Track Derailments*, May 1994, p.1.

9. Railway Safety Act Review Committee, *op. cit.* in endnote 6, pp.6-8.

10. The TSB relates accidents to million train miles as a measure of work performed by the railways. Using the latest available data, the railways performed an annual average of 75.1 million train miles in 1991-93 and 77.1 million train miles in 1995-97. This gives accident rates per million train miles of 16.4 in 1991-93 and 16.0 in 1995-97. However, removing crossing accidents from these figures, the numbers of accidents in the two time periods were 819 and 884, respectively, for accident rates excluding crossing accidents of 10.9 per million train miles in 1991-93 and 11.5 per million train miles in 1995-97.

11. Railway Safety Act Review Committee, *op. cit.* in endnote 6, p.34.

12. Percentages are our calculations from data in Transportation Safety Board, *TSB Annual Report to Parliament 1996*, p.6.

13. Railway Safety Act Review Committee, *op. cit.* in endnote 6, p.173.

14. Canadian Transportation Accident Investigation and Safety Board Act Review Commission, *Advancing Safety*, 1994, p.xvii.

15. Transportation Safety Board, *op. cit.* in endnote 12, p.5.

16. Railway Safety Act Review Committee, *op. cit.* in endnote 6, p.53.

17. Railway Association of Canada, *1997 Railway Trends*, p.15.

18. Honourable Mr. Justice Samuel G.M. Grange, *op.cit.* in endnote 4, p.155 and p.159.

19. Honourable Mr. Justice René P. Foisy, *Commission of Inquiry into the Hinton Train Collision*, December 1986, p.5.

20. *ibid.*, p.135 and for a useful explanation of ATCS see *ibid.*, pp.134-9.

THE INFLUENCE OF CTI ON ROAD LIFE AND VEHICLE STABILITY

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ABSTRACT

Central tire inflation (CTI) systems allow a vehicle operator to change the tire inflation pressure while the vehicle is moving. Lower tire inflation pressure has been found to reduce road wear and improve vehicle performance in areas of traction, braking, ride quality and vehicle maintenance.

The benefits of lower tire pressure on road systems have been reported in various publications and reports however, the influence of lower tire pressures (higher tire deflection) on the stability and control of heavy vehicles is not well understood.

This paper summarises the significant CTI research findings with respect to the infrastructure and explores the effects of CTI on vehicle stability and control performance. The analysis focused on a 9 axle B-train in the loaded state assuming GVW of 75,500 kg, and 69,000 kg; and in the empty state.

Much of the material reported here was the result of a study performed by Roaduser Research under contract to Consumers' Co-operative Refineries Ltd. as part of a formal research initiative with Saskatchewan Highways and Transportation Industrial Transportation and Logistics Branch.

CTI EFFECTS OF ON ROADS

In 1993, a comprehensive full-scale test was conducted by the US Army Corps of Engineers to determine the effects of CTI on road and tire life (1 and 2). Test loop roads were built under tightly controlled conditions ensuring a well defined sub grade, base course, and running surface. The loop roads were divided into sections of differing road types. The sections varied in construction from native materials to unpaved aggregate running surfaces with various base course thicknesses to high quality paved roads with various asphalt thickness. The roads had two travel

lanes, one travelled by test vehicles with high tire inflation pressure and the other with vehicles having low tire inflation pressure. Failures or distress in high tire pressure lane were more pronounced than in the low-pressure lane. When failure occurred in both lanes, the ratio of low tire pressure to high tire pressure traffic to initial failure ranged from 1.5 to 21 (sic) for unbound surfaces. There were no appreciable differences in the performance of aggregate surfaced horizontal curves due to the different tire pressures. The performance of the straight and flat aggregate sections were considerably better in the low tire pressure lane as compared to the high pressure lane.

More ravelling was observed in the low tire pressure lane in the horizontal curves of the asphaltic concrete sections than in the high tire pressure lane. Comparative pavement performance of the thicker asphaltic concrete roads is unavailable because traffic was stopped before failure occurred. This could imply that the beneficial effects of extending road life through the use of CTI may be less significant on strong roads.

A three year joint study (3) with Forest Engineering Research Institute of Canada (FERIC) and the Alberta Newsprint Company (ANC) investigated the potential for using a B-Train combination equipped with central tire inflation (CTI). Three road surfaces were studied; native earth block-entry, lightly gravelled forest access roads and asphaltic-concrete highways. The native earth thawing block-entry road was constructed as a 100m X 75m two lane oval track. The track had a low section, a level section and a 6% grade. The outer lane was used for "high" tire inflation pressure and the inner lane was used for "low" tire pressure conditions. The single test vehicle operated on one lane at high tire pressure until the road failed - defined as when ruts of 10 cm in depth occurred. It then travelled on the other lane at the low tire pressure setting until the surface failed. During the test program, the tire inflation pressure settings were as follows; high-pressure condition was set to 100 psi; low pressure ranged from 34 to 39 psi. The test vehicle was a 7-axle unit having a GVW's of 56.5 tonnes.

The tests found that tires inflated to the high pressure (normal) settings rutted the road surface approximately nine times faster than when inflated to the low pressure settings. This extreme result is due in part to the very weak structural condition of the road. It is estimated that the road had a CBR of 3, which is typical of weak, thawing conditions. In general, initial rut development decreased by 77% when low tire pressures were used.

Lightly gravelled roads were typical of forest access roads in Alberta. They were built with approximately 60 cm of native material and surfaced with 8 cm of crushed gravel. The tire pressure settings used during the test are shown in Table 1.

Table 1. Tire inflation pressures for gravelled road tests.

TEST CONDITIONS AND TIRE PRESSURES			
Tire Pressure Condition	Steer Axle (psi)	Drive Axles (psi)	Trailer Axles (psi)
Low	75	30	27
Moderate	75	55	60
High	95	90	85

From the tests, it was estimated that high inflation pressure increased rutting by a factor of two compared with moderate tire inflation pressure. Low tire inflation pressure settings were used on road previously rutted by high inflation pressure settings. The low inflation settings produced a "healing" effect on the road surface by reducing the existing ruts by approximately 10% resulting in a more uniform and compact running surface. This healing phenomenon does not occur in all cases and is diminished as tractive requirements increase. The study estimated that on lightly gravelled roads, low tire inflation pressure reduces rut development by up to 90%.

One possible explanation for the reduction in rutting associated with reduced tire inflation pressure is that vertical tire force distribution across the lateral plane of the contact patch varies significantly with tire inflation pressure. Under high tire inflation conditions, the highest contact stress is located at the centre of the contact tire patch and the stress reduces towards the shoulder of the tire. This will have the effect of manipulating the unbound road material out of the wheel path. Under low tire inflation pressure, the stresses are highest at the shoulders of the tire and are reduced towards the centre tending to capture surface material of the road. This concept is illustrated in figure 1.

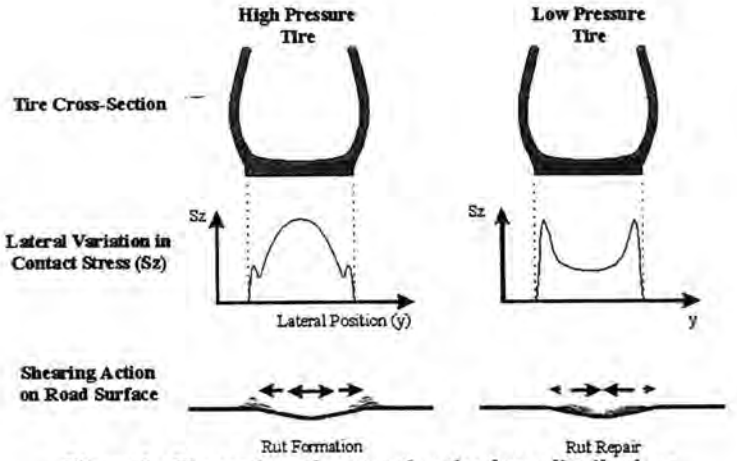


Figure 1. Illustration of contrasting tire force distributions affecting rut formation and repair.

A further study (4) showed that reducing tire pressure will reduce pavement strains and extend pavement life. This was found to be true for both fatigue and rutting failure. Pavement section stiffness is critical to determining whether to allow any heavy vehicles with or without reduced tire pressure or tire load or both. The study found the effect of reducing tire pressure to be larger on thinner pavement sections and larger for fatigue (tensile strain) than rutting failure (vertical compressive strain). Another study (5) found that a significant reduction in unpaved forest road damage occurred as tire sidewall deflection approached 20%. There was only a minor decrease in road damage as the tire sidewall deflection was increased to 30%.

TIRE WEAR, TRACTION AND RIDE EFFECTS

Tire Wear

Improvements in tire wear, ride quality and traction have all been attributed to reduced tire inflation pressure. A study (6) was conducted using the closed loop AASHTO-type circuit where road surfaces varied from pot holes to double penetration chip seal roads to type II asphalt concrete surfaces. Tests were conducted under two test conditions; high pressure (10-12% tire sidewall deflection) and low pressure (20-22% tire sidewall deflection). Over a distance of 3,600 km the reduction in tire wear attributed to reduced tire pressure was 15%. Traction was found to improve by 12-18%. A significant reduction in input road vibration to the

driver was reported resulting in a more comfortable ride with less driver fatigue.

Following the formal test program, the tires were subjected to an additional 150 km of severe rock course. The results for 36 radial truck tires from the overall tire durability test are shown in Table 2.

Table 2. Tire durability results - number of occurrences.

Type Of Tire Damage	High Tire Pressure	Low Tire Pressure
Undercut flex cracks	540	303
Rib cracks	147	49
Rib cuts to belt	5	0
Tread cut chunk-outs	171	35

Tire temperature measurements were also taken. With tire loads of 2,050 kg, and 20% tire deflection, the temperature measured in the tire is shown in Table 3.

Table 3. Tire temperature with speed

Tire Load 2,050 kg	
Vehicle Speed (km/h)	Tire Temperature (deg C)
66	88
88	99
108	116

Another study (7), examined tire wear rates and tire carcass life. The study stressed that radial tires should be used because of the flexible sidewall design. It recommended that bias ply tires should not be used (the validity of this recommendation has been questioned by FERIC on the basis of historical experience with military applications). It was also reported that the US Tire and Rim Association sets tire pressures for load and speed for all tire manufactures conducting business in North America. Individual manufacturers can provide additional pressure reduction in accordance with their own criteria but only by permission of the manufacturer on a case by case basis.

The test program chose a tire deflection of 20% for low and moderate speeds and a tire deflection of 10% for high-speed operation. The tests were conducted at the Nevada Automotive Test Center, running over a

designated test course with 12 different roadway sections including a severe rock course. The radial truck tires at reduced pressures experienced approximately 15% less tire wear than tires operated at the standard highway pressure. After the tires had finished running through their original life, they were holographed, inspected and then retreaded. The analysis revealed equivalent residual durability after running through its original life.

A second test revealed that there was no substantial difference in tire wear rate between CTI and non-CTI applications. The Goodyear Tire and Rubber Company had the following conclusions from its field evaluation.

1) Original tread wear was equivalent for tires which operated with and without CTI.

2) At the end of original tire life, CTI tires were acceptable for retreading.

3) Tread wear varies significantly from location to location, i.e., low, moderate, and fast tire wear rates; and

4) Because of many uncontrolled test variables, only tires run at the same location, using the same roads, can be directly compared.

The overall study concluded that there are no significant detrimental effects on tread wear from operating under reduced tire pressure.

TIRE PRESSURE AND TEMPERATURE

A further study (8) presented the following arguments. A truck tire operating on the highway will increase in pressure by 15 to 20% as the heat in the tire structure is transferred to the contained air over a two-hour period. Tire manufacturers take this into account in selecting inflation pressure; the cold pressure is set so that the hot running pressure will yield the optimised deflection and contact patch. Therefore, preferred running pressure for a truck tire is not the value in the published table but a "hot pressure" that is 15 to 20% higher. For this reason it is important to distinguish between CTI systems that bleed air pressure off (very unusual for North American systems) as it rises with temperature and systems that permits air pressure to build as the tire heat increases. Systems that bleed off tire pressure will run at inflation pressures below the optimum condition. Systems that permit the air pressure to build will run at the optimum pressure provided the pressure was initially set when the tires were cold. Otherwise they too will not be at the optimum pressure. For

this reason Michelin Tire recommends that selected tire pressures be set at approximately 10% above the values published in the data book. Most North American systems set the tire pressure range settings at -2 psi and + 15% of the target pressure. The upper tolerance allows the tire to heat and cool about the target pressure. Therefore the Michelin recommendation appears to be quite conservative.

The relationship between vehicle speed and tire inflation pressure is critical to tire performance. CTI systems that incorporate a "speed alert" feature that will notify the operator, or override the tire inflation system in the event the design speed for a given pressure setting is exceeded, are considered beneficial. However, for conditions of up to 20% deflation, field tests (18) have shown that tire temperature did not approach critical levels at speeds of 100 km/h for extended periods of operation. Nevertheless the speed alert feature is seen as an important safety feature especially for drivers inexperienced with CTI systems and operation.

The speed with which tire pressure can be adjusted with CTI systems is another important consideration. It is critical that tires receive 80% of the target inflation pressure within 5 minutes of the truck reaching its new operating speed and 100% of the target pressure within 15 minutes. Where handling is a concern, drivers should begin the tire re-inflation cycle at least 5 minutes prior to increasing speed to the new operating condition.

Note: It is now recommended that the SAE guidelines be revised to 70% of cold highway target pressure by 15 minutes and 100% of cold highway pressure by 25 minutes.

Traction Effects

A study conducted by FERIC (9) examined the traction effects of CTI. As the footprint of the tire increases, the traction performance of the tire increases. Traction improvements are dependent on the type of road surface. Figure 2 shows the tractive capability of a tractor on a loose gravel surface as a function of tire pressure. Axle loads used during the test were as follows; steer axle 5000 kg drive axles 600 kg each. A separate study (15) found a 34% increase in drawbar pull on sandy roads and 17% increase on clay roads when tire inflation pressures were reduced from 100 to 65 psi.

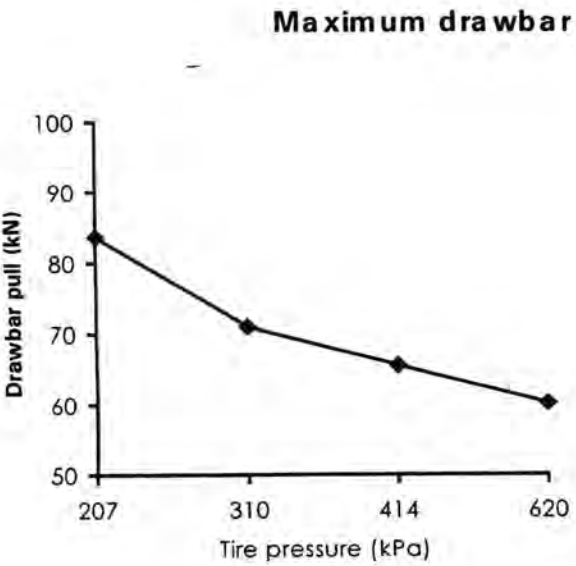


Figure 2. Drawbar pull as a function of inflation pressure.

Braking

Stopping distances for loaded logging trucks was examined at the Nevada Automotive Test Center (10). Stopping distances were reduced on both dry pavement and loose gravel surfaces as tire deflection increased. No appreciable improvement occurred on wet pavement. For dry pavement at 30% deflection (40 psi) stopping distances were 8.6% shorter than with tires at 10% deflection (95 psi). These improvements can only be realised if the wheels do not lock up. When wheels do lock up, stopping distances increase as inflation pressure is reduced (19), therefore the use of ABS brake systems on heavy trucks operating at reduced tire inflation pressure. This argues well for the use of ABS brake systems for vehicles that operate at reduced inflation pressures.

Ride Quality

The drivers of the test vehicles reported a significant reduction in input road vibration to the driver when low-pressure conditions were used. This was particularly noticeable for empty vehicle conditions. The drivers reported a more comfortable ride with less fatigue.

Economics And Environment

In a separate study (13), based on results found by users of a USDA Forest Service road design program, it was determined that the amount of surface material required for low quality forestry roads can be reduced by about 25-50% if CTI is used. This was later proven in field trials (13) and another trial in Lowell, Oregon 1994. In addition, road maintenance costs on such roads can be reduced by about 80%. Improved traction resulting from CTI also allows the tractor to haul heavier loads and reduce cycle times, which improves productivity (5,9,14,19).

Other studies (13, 14, and 21) found substantial savings in road construction and an 84% reduction in the amount of fine silty soil that reached high valued fish streams. It was reported in (13) that a 70% saving in road building and maintenance costs was attributed to the use of CTI. A reduction in road hazard damage to tires was reported as were improvements in ride quality. Shock and vibration through the suspension was reduced by up to 85% under certain conditions.

Potential cost avoidance in forest road construction and maintenance in excess of $20 million per year was reported in (14). It also reported reduced environmental impacts, lower vehicle operating costs, increased vehicle mobility and driver comfort.

STABILITY AND CONTROL ANALYSIS

General Considerations

To assess the influence of lower tire pressure/higher tire deflection on vehicle stability and control, a 9 axle B-train liquid tank vehicle was chosen as the study. The objective of the task was to determine how lower tire inflation effects vehicle behaviour with respect to the following TAC performance measures.

- Roll stability
- Lateral load transfer
- Friction demand
- Low-speed offtracking
- High-speed offtracking
- High-speed dynamic offtracking
- Rearward amplification

Steady-State Rollover
Heavy trucks can withstand limited lateral acceleration in a curve before rolling over. This rollover limit is expressed in terms of the lateral acceleration, and is given as a proportion of gravitational acceleration (g). Total rollover occurs when all the wheels on one side of the combination vehicle (on the inside of the turn) lift off the road surface.

Rearward Amplification
When articulated vehicles undergo rapid steering, the steering effect at the trailer is magnified. This results in increased side force, or lateral acceleration, acting on the rear trailer thereby increasing the likelihood of the trailer rolling over under some circumstances.

Rearward amplification is defined as the ratio of the lateral acceleration at COG of the rearmost unit to that at the hauling unit in a dynamic manoeuvre of a particular frequency. Rearward amplification (RA) expresses the tendency of the vehicle combination to develop higher lateral accelerations in the rear unit when undergoing avoidance manoeuvres..

Load Transfer Ratio
Load transfer ratio is defined as the proportion of load on one side of a vehicle unit transferred to the other side of the vehicle in a transient manoeuvre. Where vehicle units are roll-coupled - as in B-doubles - the load transfer ratio is computed for all axles on the vehicle. When the vehicle units are not roll-coupled, as with truck-trailer configurations, they are evaluated as separate units. When the load transfer ratio reaches a value of 1, rollover is about to occur. The LTR is the ultimate measure of rollover stability.

High -Speed Steady-State Offtracking
High-speed offtracking is defined as the extent to which the rearmost tires of the vehicle track outboard of the tires of the hauling unit in a steady-turn at highway speed. High-speed offtracking addresses the road width requirements of the vehicle and can be used to calculate the total swept width of the combination vehicle (that is, the extent to which the lateral excursions of the rear of the vehicle exceed those of the hauling unit in normal operation).

High-Speed Dynamic Offtracking
High-speed dynamic offtracking is a measure of the lateral excursion of the rear of the vehicle with reference to the path taken by the front of the vehicle during a dynamic manoeuvre. This expresses the amount of

additional road space used by the vehicle combination in an avoidance manoeuvre.

Low-Speed Offtracking

Low-speed offtracking represents a measure of the swept path of the vehicle and its lateral road space requirement when turning at intersections or when turning into loading areas. The offtracking of the vehicle depends on axle position, trailer tongue length and hitch location.

VEHICLE DETAILS

The objective of the study is to determine the sensitivity of general vehicle performance to reduced tire inflation pressure. A special bulk haul B-train was used as the candidate vehicle for the study. Some of the key vehicle dimensions are as follows:

- overall length 25.0 m
- lead trailer tank length 9.5 m
- second trailer tank length 10.9 m
- trailer track width 2.6 m

A drawing of the vehicle showing the axle weights used for the three loading conditions is found in Figure 3.

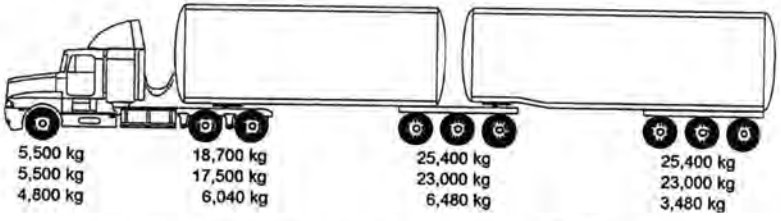


Figure 3. Drawing of vehicle examined (not to scale).

Test Conditions

The conditions of vehicle loading used were as follows:

1) Fully Loaded 75,500 kg
2) Partial load 69,000 kg
2) Empty 20,800 kg

The tire pressures selected for use in the simulation exercise were varied according to wheel load to achieve a constant 20% tire deflection. The cornering stiffness and vertical stiffness data for truck tires, as a function of tire deflection, were provided to the study by the Goodyear Technical Center in Akron Ohio.

GENERAL FINDINGS

Using the procedures developed in the RTAC Heavy Vehicle Weights and Dimensions study report (16) and other measures, the following vehicle performance attributes were examined using the University of Michigan Transportation Research Institute (UMTRI) Yaw/Roll program:

- roll stability
- load transfer ratio
- rearward amplification
- low speed offtracking
- high-speed steady-state offtracking
- high speed dynamic offtracking

Steady-State Rollover

As tire pressures are reduced, the vertical stiffness of the tires is reduced which decreases the vehicle roll stiffness. However this effect is very small, in the order of 3% for the 75,500 kg vehicle with 20% tire sidewall deflection. All vehicle options exhibited good static rollover threshold characteristics with and without CTI.

Rearward Amplification

The rearward amplification produced by the 9-axle B-train was within the TAC performance criteria for all cases. Rearward amplification increases as tire pressure is reduced. In the case of the 75,500 kg loading condition, RA increased about 8 % with 20% tire sidewall deflection.

Load Transfer Ratio

Load transfer ratio increased about 10% as the tire inflation pressure was reduced to achieve a 20% tire sidewall deflection for the 75,500 kg vehicle condition. Nevertheless, at this reduced tire pressure load transfer ratio was within the TAC guidelines.

High -Speed Steady-State Offtracking

For the 75,500 kg load condition, high-speed offtracking increased by about 18% when the tire pressure was decreased producing a 20% tire sidewall deflection. The increase in high-speed steady-state offtracking remained well within the TAC performance criteria.

High-Speed Dynamic Offtracking

High-speed dynamic offtracking increased by approximately 21% for the 75,500 kg load condition when a 20% tire sidewall deflection

was used. Nevertheless, at this reduced tire pressure high-speed dynamic offtracking was within the TAC guidelines.

Low-Speed Offtracking
Lower tire pressures do not significantly effect low speed offtracking.

CONCLUSIONS

Road Costs
The use of variable tire pressures on unsealed and thinly paved roads has proven to be very effective at reducing costs for road, vehicle and tire maintenance. The effects of lower tire pressures on strong roads with thick pavements are less clear. Lower tire pressure has also been found to increase traction and braking capabilities, and to reduce driver fatigue by isolating road vibration particularly on uneven roads.

Vehicle Stability
Heavy vehicle stability and control is significantly effected by tire pressure. The performance measures most effected by tire pressure are high-speed static and dynamic offtracking. This implies that the vehicle will occupy more road space when curving at high speed. This only becomes an issue when vehicle performance exceeds the TAC performance measures. The performance of the 9 axle B-train examined by this study was within the TAC performance measures and is judged to be a sound concept for all tire inflation pressures and load conditions studied.

Operational Considerations
The choice of tire pressure depends on vehicle speed, vertical tire load and road condition. The objective is to select a tire inflation pressure that achieves a certain tire sidewall deflection (typically ranging from about 15% to 20%). There is no evidence that sidewall defection in this range negatively effects tire wear, durability or tire recap potential.

When selecting tire inflation pressure values for specific applications, the Tire and Rim Yearbook should be used as a reference or alternatively, the tire manufacturer should be contacted.

It is important that vehicle operators receive training on the proper use of central tire inflation systems. Speed limiting or over-speed warning systems should be required for all central tire inflation systems to prevent vehicle over-speed for a given tire sidewall deflection condition.

REFERENCES

(1) GRAU, RW (1993) Effects of variable tire pressure on road surfacings. US Army Corps of Engineers for the US Department of Agriculture Forest Service Technology and Development Center.

(2) SMITH, DM (1993) Effects of variable tire pressure on road surfacings - volume II: analysis of test results. US Army Corps of Engineers for the US Department of Agriculture Forest Service Technology and Development Center.

(3) BRADLEY, AH (1994) Reducing tire pressures lessens rutting of thawing forest roads: Results of two field tests. SAE paper 942246.

(4) MAHONEY, JP; SWEET, BR; COPSTEAD, RL; KELLER RR (1994) The potential use of central tire inflation during highway load restriction periods. SAE PAPER 942245.

(5) ASHMORE, C; SIROIS, D (1987) Influences of the Central Tire Inflation System on log truck performance and road surfaces. ASAE paper 87-1057. American Society of Agricultural Engineers. St. Joseph Mich.

(6) ANON, (1987) Final report - central tire inflation. Prepared for the United States Department of Agriculture Forest Service San Dimas Equipment Development Center by the Nevada Automotive Test Center.

(7) GREENFIELD, PH; COHN, AE (UNDATED) Effects of variable tire pressure on tire life. Transportation Research Record 1291.

(8) CLARK, RB (1993) Central tire inflation from a truck tire perspective. Michelin Americas Research and Development Corporation SAE 933059

(9) BRADLEY, AH (1993) Testing a central tire inflation system in western Canadian log-hauling conditions. FERIC Roads and Transportation Technical Note TN-197.

(10) ANON, (1994) Tire test program dynamic peak and slide skid on pavement and gravel surfaces at varied tire deflections. Nevada Automotive Test Center project 20-17-584; for USDA Forest Service.

(11) ANON, (1987) Final report - central tire inflation. Prepared for the United States Department of Agriculture Forest Service San Dimas Equipment Development Center by the Nevada Automotive Test Center.
(12) BRADLEY, AH (1993) Using variable tire pressure technology to reduce forest road costs. FERIC, Canadian Pulp and Paper Association 1993 Annual meeting.

(13) KELLER, RR (1992) The results of operational testing of "CTI" systems proves benefits of low tire pressure in logging operations. Weyerhaeuser Company.

(14) POWELL, B; BRUNETTE, B (UNDATED) Reduced tire inflation pressure -- a solution for marginal quality road construction rock in southeast Alaska. USDA Forest Service, Petersburg Alaska.

(15) ANON (1988) Operation bigfoot. A plan for applying central tire inflation/variable tire pressure (CTI/VTP) technology. Ad Hoc CTI application team, USDA Forest Services.

(16) ERVIN, RD & GUY, Y (1986) The influence of weights and dimensions on the stability and control of heavy trucks in Canada. Roads and Transportation Association of Canada. Ottawa

(17) ANON (1996) 1996 year book. The Tire and Rim Association Inc. Copley Ohio.

(18) ASHMORE, C (1994) Tire test program dynamic tire temperature evaluation. USDA Forestry Service, Nevada Automotive Test Center, Carson City NV..

(19) ANON (1994) Tire test program dynamic peak and slide skid on pavement and gravel surfaces at varied tire deflections. USDA Forestry Service.
(20) BRADLEY, A (1996) Trial of a central tire inflation system on thawing forest roads. FERIC, Vancouver, B.C.
(21) FOLTZ, R; MOORE, T. (1995) Central tire inflation (CTI) reduces sediment up to 84%. Engineering Tech Tip 9577 1303 SDTDC. USDA Forest Service. San Dimas, CA.
(22) DOUGLAS, R. A. (1996) Correspondence of ongoing research into the effects of low tire inflation pressure on shallow subgrade strains - Robert A. Douglas Professor, D.C. Campbell Chair for Highway Construction and Pavement Research, University of New Brunswick.

Improving Compliance with Motor Carrier Safety Regulations

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ABSTRACT

The potential benefits of improved compliance with motor carrier safety regulations encompass reduction in highway crashes, enhanced productivity, fairness in competition and efficient utilization of agency resources. Compliance with safety regulations related to commercial vehicle operations is a complex function of a number of factors including the nature of the regulations, enforcement approaches, sanctions for violations, nature and operating characteristics of the trucking industry. Concepts to improve compliance are suggested to include improved sampling process so that representative samples of vehicles and carriers are used, identification and definition of enforcement strategies and sanctions that are effective in encouraging compliance with the safety regulations.

1.0 INTRODUCTION

Interstate and international motor carriers are subject to the Federal Highway Administration (FHWA) Motor Carrier Safety Regulations (FMCSRs). The FHWA also established a safety fitness standard, which an interstate motor carrier would have to meet to obtain a acceptable safety status. The FHWA developed programs intended to identify high risk carriers and make those carriers improve their safety performance. One program is a system of roadside inspections of vehicles and drivers and the other involves site visits to the operating bases of carriers to conduct in-depth investigations of the safety management practices (compliance reviews). The most common safety violations in compliance reviews involve driver hours of service. Common charges include excessive hours and falsified logbooks. Carriers are held responsible because they are expected to detect and prevent logbook and service hour infractions.

This paper examines compliance with safety regulations from the standpoint of a number of regulatory agency and industry factors that determine the motor carrier operating environment. The paper is divided into three major parts. The first part is a conceptualized representation of the relationships among the factors affecting regulatory compliance. The second part is an analytical examination of the relationships based on available data. The third part of the paper develops concepts for improving compliance with motor carrier safety regulations.

2.0 CONCEPTUAL FRAMEWORK

Compliance with the safety regulations can be visualized as being a function of two main groups of factors, internal or regulatory agency factors and external or industry factors. The internal factors include the nature of the regulations, enforcement and sanctions. The external factors include; (i) awareness of regulatory requirements; (ii) safety management practice; (iii) size of company and type of operation (private, for-hire); and (iv) freight characteristics (hazardous and non-hazardous materials). Other factors that may affect compliance levels include: (i) market forces of demand and supply which give rise to motor carrier operations; (ii) public perception of safe operations; (iii) level of competition between truck and rail in freight transportation; and (iv) the political environment. For the purposes of the concepts developed in this paper, the effects of these other factors on compliance levels are assumed to be minimal.

The internal factors interact in a complex and dynamic fashion to create a regulatory environment in which the industry must operate. The external factors then react to the regulatory environment creating an operating system. A change in any factor affects the equilibrium of system where the other factors readjust to generate a new system. For example, a change in the enforcement strategy, (e.g., increased visibility of enforcement officers) may affect the operating characteristics and potentially compliance. While uniformity and consistency in the internal factors across jurisdictions can be controlled to some reasonable degree, it is practically impossible to attain a comparable level of consistency or uniformity with the external factors. This is due of the complexity and diversity of the motor carrier industry. The discussions presented in this focus on the effects of internal factors on compliance with highlights of the external factors.

2.1 Internal Factors

Factors noted to influence compliance with safety regulations include: (i) nature of the regulations; (ii) enforcement procedures and (iii) consequences for infractions. The safety regulations are complex. The regulations are divided into various parts each relating with a specific aspect relating to driver, vehicle and safety management. The complexity of the regulations affects non-compliance in terms of the likelihood of misunderstanding and/or misinterpretation of the regulatory provisions. For a relatively complex set of regulations, violators are more likely to contravene out of ignorance than wittingly.

Enforcement is composed of three essential elements, (i) enforcement approach; (ii) strategy to implement that approach; and (iii) enforcement intensity. Enforcement is achieved through two complementary programs or approaches, roadside inspections and compliance reviews. Roadside inspections involve inspecting mechanical fitness of vehicles, driver logs and other documentation. Compliance reviews on the other hand, involve detailed review of samples of vehicle, driver and safety management records to establish compliance with the requirements of the FMCSRs. The overall safety status of a carrier is based on the outcome of the compliance review.

Enforcement strategy refers to decisions relating to when, what and how to conduct an inspection or investigation. For example, the strategies adopted in roadside inspections may include, random selection of vehicles, random or continuous hours of operation of an inspection site, inspections at fixed or randomly patrolled sites. The strategy largely determines the sample size inspected and therefore the level of compliance.

Enforcement intensity or inspection rate is defined as the number of vehicles inspected (roadside) or carriers investigated (compliance reviews) expressed as a percent of the number of vehicles using the highway facility or the number of carriers in the population. Enforcement intensity is a function of the enforcement strategy. Enforcement intensity is a parameter that provides an indication of carriers perception of the probability of detection when operating in non-compliance. Theoretically, low violation rate is associated with high inspection rates. Enforcement therefore greatly determines the level of compliance since the infractions detected is a function of the enforcement approach, strategy and intensity adopted.

A third major internal factor that influences compliance with the safety regulation is the sanctions (e.g., penalties and fines) applied in the event of infractions. Two elements are identified - the type and severity (or level) of the sanction. It is recognized that the levels of sanctions imposed for certain violations are subject to statutory limits that are set with emphasis on ability to pay and continue to do business. Generally, high violation rates are associated with low fine or penalty levels for the same regulations and enforcement intensity.

2.2 External (industry) factors

As noted earlier, the external factors are motor carrier characteristics that influence compliance with the FMCSRs. The effects of complexity and diversity of the motor carrier industry are reflected in carrier operating characteristics and safety management practices. Moses et al. (1994) found that certain safety management practices such as good record keeping and investigating road crashes for the purposes of education are effective in reducing crashes. Most firms that enforce maximum driver hours of service have superior safety records. The size of firm and type of operation (for-hire, private owner operated) also determine compliance. The study (Moses et al., 1994) also found that crash rates declined as firm size increases. Private carriers have strong incentives for safe operations. Carriers engaged in transportation of hazardous materials are subject to specific set of rules by virtue of the nature of freight and therefore enforcement officers view them differently. Scale avoidance practices, notoriety on the part of certain operators, the perceived economic disincentive to comply, short haul versus long haul are other operational factors that influence compliance with the safety regulations.

3.0 DEFINITIONS AND ASSUMPTIONS

This section explores the degree of non-compliance measured by violation rates based on historical enforcement data. It is important to distinguish between compliance rate and violation rate. Violation rate refers to a sample of the population inspected or investigated whereas compliance rate refers to the entire population. Violation rate is defined as the number of vehicles or carriers in violation of a given regulation expressed as a percent of all vehicles inspected or carriers investigated. Compliance rate is difficult to measure because it is not possible to inspect or investigate the entire population of vehicles and motor carriers. These terms can be used interchangeably only when it is assumed that the sample of vehicles

inspected or motor carriers investigated and the violations detected are truly representative of the population. In order words, when randomly repeated samples yield identical violation rates, then compliance rate can be adequately represented by the violation rate.

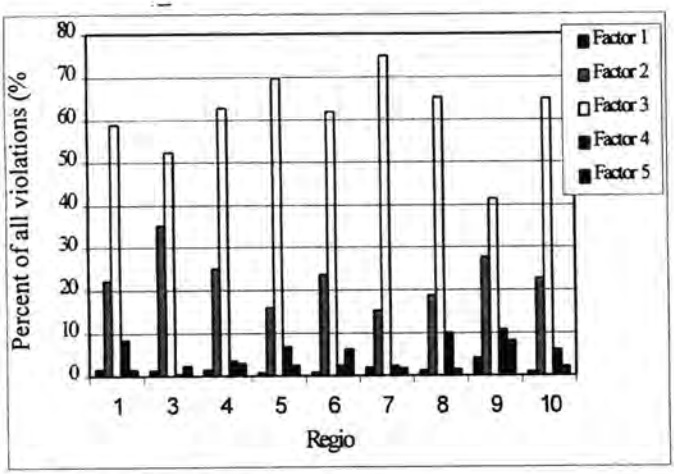
For the purposes of the analysis however, it is assumed that the characteristics of a sample from a given population are representative of that population for a given enforcement approach and strategy. It is also important to note that compliance rates of different parts of the safety regulations are not necessarily additive. For example, low violation rates with driver hours of service regulation and high violation rates of driver qualification regulations do not indicate the overall compliance rate of the FMCSRs.

4.0 ANALYSIS AND DISCUSSIONS

The analysis is based on historical data on violations of the safety regulations and the associated sanctions. A subset of the enforcement tracking database of the Office of Motor Carriers (OMC) of the FHWA was used. This database contains detailed information on the violations that resulted in enforcement cases between 1992 and 1996 inclusive. The number of violations for each regulation is expressed as percents of all violations. The frequency of occurrence of violations and the average sanctions applied are examined.

Figure 1 shows the percent distribution of violation of the safety regulations for which sanctions were applied. The figure shows only violations that are used to establish the overall safety status of a carrier during compliance reviews. Figure 2 shows percent violations arranged in descending order of magnitude and the corresponding average fines imposed. It is revealed that driver hours of service (part 395) is mostly violated part of the FMCSRs. This is followed by driver qualifications and licensing (part 391). Driver hours of service violations are 2 to 3 times the driver qualification and licensing violations. These two parts together account for 70 to 90 percent of all violations for which an enforcement action was initiated. Violations of vehicle related parts (396) of the regulations accounted for only about 5 percent of violations that resulted in some of enforcement.

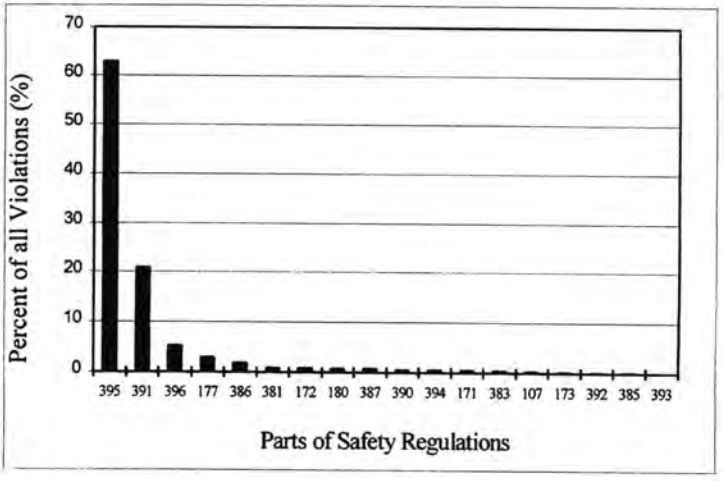
Figure 1. Violations by Factors for Overall Safety Fitness Status

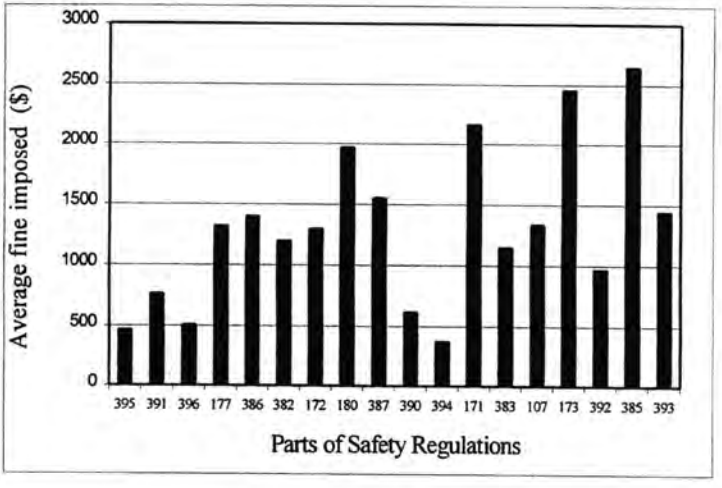


Factor	Regulation	General description
1	387, 390	General safety management
2	382, 383, 391	Driver qualification and licensing
3	392, 395	Driver hours of service (operational)
4	393, 396	Vehicle factors
5	397, 177	Hazardous material operations

The difference in violation rates between driver and vehicle related parts of the regulations can be explained by a number of factors including: (i) vehicle inspections are mainly conducted during roadside inspections whereas driver hours of service inspections are conducted as part of both roadside inspections and compliance reviews; (ii) driver hours of service records are more easily and thoroughly reviewed during a compliance review process; and (iii) some linkage has been established between driver fatigue and alertness which translates into crash potential (Federal Register, 1994). Consequently, driver related parts of the safety regulations are given more prominence in the enforcement process as indicated by the violation rates.

Figure 2. Percent violations and associated average fines

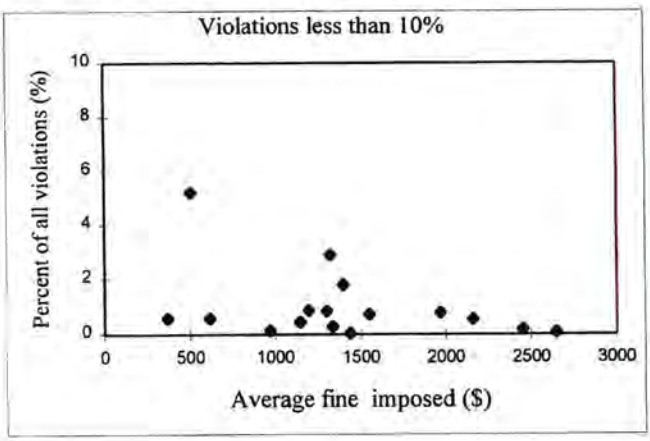




The impact of enforcement approach is reflected in the types of violations detected. Roadside inspections report mainly out-of-service violations (driver and vehicle) while compliance reviews report a wide range of violations related to driver, vehicle and safety management. The type of violation and the denominator used in calculating the percent violations is therefore important. While analysis of compliance review results may indicate that vehicle related violations are comparatively insignificant, analysis based solely on roadside inspections could indicate otherwise. However, the overall safety performance of a carrier is based on the results of compliance reviews. Compliance reviews take into consideration results of roadside inspections conducted on a carrier's vehicles and drivers.

As illustrated in Figure 2, parts of the safety regulations most often violated attract low fines, on average. For example, commercial driver license (part 383) accounts for about 1 percent of all violations, yet the fines imposed are about 3 times those imposed for driver hours-of-service violations. Figure 3 further explores the relationship between the percentage violations and the average fines imposed. The results indicate that generally, parts of the regulations attracting relatively low fines tend to be more frequently violated or more easily detected or both. The figure suggests that compliance can be improved by increasing fines.

Figure 3. Relation between violation and fines



It is however acknowledged that departmental pressure to limit citations and place emphasis on ability to pay and continue doing business in the fine assessment process are considerations that result in penalties that are too low to discourage violations.

5.0 CONCEPTS TO IMPROVE COMPLIANCE LEVELS

The concepts for improving compliance outlined in this section are based on the following premises.

- The regulatory agency has control over the internal factors particularly the enforcement approach, strategy and intensity. These can be improved to enhance compliance.

- Regulatory agencies do not have data on all of motor carriers with the result that those with no safety performance data are not included in the database and therefore not captured when programmed algorithms are used to select carriers for compliance reviews and vehicles for roadside inspections.

- Certain parts of the regulations attract more attention than others during the course of an investigation. This is dependent on a number of factors including: departmental policy, the enforcement officer, the type of carrier, safety history of carrier. The perceived or established linkage between certain parts of the regulations and road crashes greatly influences the outcome of the investigation.

- Some sanctions imposed are limited by considerations other than the severity of the offence and the potential effect on safety measured by road crashes, e.g., statutory limits on fines. However, violation rates generally improve with increasing sanction levels.

Factors affecting non-compliance that can be controlled to improve compliance levels include: sampling process and sample size inspected; safety information collection, storage and exchange; understanding the reasons for violations; identifying and defining effective sanctions. These are discussed in some detail in the following sections.

5.1 Sampling Process

Since it is impractical to inspect every vehicle or investigate every carrier in the population, the sampling process and sample size used for enforcement purposes are critical in assessing the level of non-compliance. Representative samples are required to ensure that violation rates so obtained are indicative of the overall level of compliance with safety regulations. Carrier selection methods target only carriers considered to be high risk operators. These are mostly carriers on which safety data is available and are noted to have high crash records. Those known to have historically satisfactory safety performance records are generally not included in the list. Between these extremes, is a "gray area" of operators consisting of carriers on whom there is no safety performance data or those are considered to have marginal safety performance records. This group of carriers could continue to operate in less safe conditions while enforcement efforts are directed at the potentially high risk carriers. Fekpe (1997) suggested consideration of a mix of random and programmed selection process as a step towards enhancing effectiveness in the selection process.

Improved safety information exchange through the application of advanced information technology is expected to improve the sampling process. Accessibility to, and timely delivery of real time safety data provides the opportunity for effective screening. It also provides an incentive for safe operations because carriers with good safety performance records experience efficiency in their operations by virtue of the enforcement personnel ability to easily identify and target less safe operators. An example is the on-going Commercial Vehicle Information Systems Network (CVISN) project in the U.S. Basically, CVISN is a way of existing systems to electronically exchange safety information. With CVISN, it will be potentially possible to determine from available data sources whether a vehicle has valid credentials and whether the driver has valid license. The data will help determine if there are any outstanding out-of-service violations against the driver and/or vehicle. The information exchange system enables the safety record of the carrier, vehicle and driver to be examined but that information only serves as a predictor of the likelihood of a safety violation.

5.2 Enforcement Strategies

Another potential approach to improve the level of compliance is to develop enforcement strategies based on a better understanding of the factors influencing infractions. A diagnosis of the possible reasons for violations or non-compliance should provide a better understanding of the mechanism of

interactions among the factors. This will help identify enforcement strategies that address the problem directly. For example, a National Transportation Safety Board (NTSB, 1995) study suggested that driver hours-of-service violations could be linked to methods of compensation for drivers. Driver qualification violations may be a reflection of lack or inadequacy of training and education programs or the carrier's knowledge of the stipulations in the regulations.

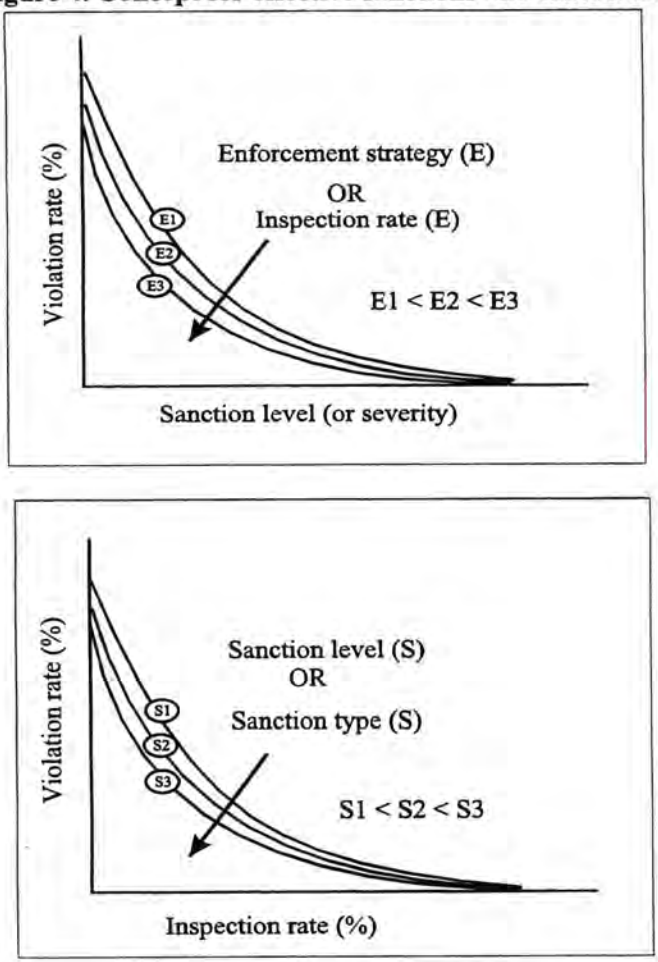
5.3 Effective sanctions

A diagnostic approach is also required to define sanctions that would be effective in improving compliance. Identifying effective sanctions will involve examination of existing sanctions and their relationships with compliance (or violation) rates from historical data. Parameters to be considered in determining the relative effectiveness of sanctions include: carriers' perception of risks and costs associated with operating in compliance versus in violation. Sanctions to be explored may include: fines, penalties, registration withdrawal, costs associated with out-of-service orders and compliance orders and industry downtime.

Figure 4 expands on the violation rate - average fine relationship shown in Figure 3 to develop a concept for defining effective and/or acceptable levels of sanctions or enforcement efforts. The relationship is similar to earlier findings (Fekpe et al., 1994) that for a given sanction level, the maximum violation rate is a decay exponential function of the enforcement intensity. A model was developed that estimates the maximum violation rate as a function of the enforcement intensity for truck size and weight regulations. In terms of safety regulations however, the two independent variables, enforcement (strategy and intensity) and sanction (type and severity) can be interchanged as illustrated in Figure 4. For a given enforcement strategy or inspection rate, for example, the violation rate - sanction level (fines) relationship will have an upper limit represented by curve E1. A different enforcement strategy or intensity that impacts truckers more than the previous one would result in lower violations for the same sanction levels as represented by curve E2. Theoretically, an effective enforcement strategy could be defined as one above which no change in the position of the curve occurs. Similarly, enforcement intensity can be substituted for the sanction level on the horizontal axis and the effects of different enforcement intensities or strategies on violation rates examined. The concept assumes that the data used is derived from representative samples of the vehicle and carrier populations. Using this concept, an acceptable level of violation can

also be defined in terms of maximum enforcement resources available (indicated by maximum possible inspection rate) and minimum sanction levels as laid down by statutory limits and/or other considerations.

Figure 4. Concept for effective sanctions and enforcement



6.0 CONCLUDING REMARKS

Compliance with the motor carrier safety regulations can only be assessed by surrogate measures such as violation rates. Factors that influence compliance rates are numerous and interact in a dynamic and complicated fashion. Certain parts of the safety regulations are clearly the focus of enforcement efforts because of the established casual relationships with road crashes. Concepts to improve compliance include improved sampling process, identification and definition of effective enforcement strategies and sanctions that encourage compliance.

7.0 REFERENCES

[1] Federal Register, "Safety Fitness Procedure: Safety Rating". U.S. DOT FHWA Docket No. MC-94-22. Vol. 59 No. 177, September 14, 1994.

[2] Fekpe, E.S.K (1997) Truck Safety Regulations and Enforcement. Proc. International Truck Safety Symposium. Knoxville, TN. Oct. 1997. pp. 317-325.

[3] Fekpe E.S.K. and Clayton A. (1994) Quantitative Assessment of Effect of Enforcement Intensity on Violations of Vehicle Weight and Dimension Regulations. Transportation Planning and Technology Journal Vol. 18 No. 2 pp 143-153.

[4] Moses L.N. and Savage I (1994) The Effect of Firm Characteristics on Truck Accidents. Accident Analysis and Prevention. 26(4) 173-179.

[5] National Transportation Safety Board, "Factors that Affect Fatigue in Heavy Truck Accidents". Vol 1: Analysis. Safety Study NTSB/SS-95-01. NTSB, Washington D.C. 1995.

TRANSPORTATION CHALLENGES FOR THE NEW TORONTO:
Mushrooms, Misinformation, Missed Connections and More...

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BACKGROUND

January 1, 1998 heralded what has been touted as a badly-needed "new age" in Toronto.. As a result of Ontario provincial initiatives, a referendum was called for March 3, 1997 The result was an overwhelming "NO" vote, with a generally large, for municipal voting, turnout. Despite this "grass-roots" protest, the Conservative-led Ontario Provincial government ignored the protest vote by those who would be directly involved, and proceeded to pass Bill 103, The City of Toronto Act, in April 1997. The new City of Toronto officially came into being on January 1, 1998, amalgamating seven governments into one, the constituent six local municipalities plus the overall Metropolitan government. The driving force for the Tories was "improved efficiency" (and there is perceived to be unnecessary duplication among the constituent municipalities). Unfortunately for all concerned, the Tories coupled the "Megacity" issue with downloading to the City, the costs of the social net (**including transit** and expected to rise) in exchange for uploading to the Province education costs (expected to fall). The changes in government finances are not addressed further in this paper.

Toronto had had a bi-level form of government since 1954 with the Municipality of Metropolitan Toronto being the umbrella government and the Cities of Toronto, Scarborough, North York, York and Etobicoke, along with "Canada's only Borough" - East York. This local governance structure had been in place from 1954.

Regarding transportation, some of the constituent passenger operations had been subsidized to various degrees, some had not, and various issues had been raised but not resolved over the years. Add to the New Toronto, several surrounding municipalities which have very close economic ties with Toronto, some as bedroom communities, and this even broader agglomeration, the Greater Toronto Area (GTA) would, from a transportation perspective, perhaps be a better overall cohesive unit. The GTA covers an area of about nine times that of Toronto, and has a population of 4.628 million. Toronto's population of 2.385 million in 1996 represents just half of the GTA's population, many of whom commute to or do business in Toronto. Of concern, however , are growth rates. From 1991 to 1996 the greatest component growth of the six Toronto constituencies was the City of Scarborough at 6.6%. Toronto had an overall population growth rate of 4.8%. Of the 24 component locations within the GTA, four had growth rates between 20% and 27%, a further six between 15% and 20%, six more between 10% and 15%, five between 5% and 10%, and only three between 0% and 5%. None experienced declines. Of the 16 constituents experiencing double-digit population growth rates, 11 have populations in excess of 50,000. These growth rates are not expected to abate. This WILL cause further transportation problems for the new Toronto.

INTRODUCTION

The title of the paper looks at some pre-existing problems including "Mushroom treatments" - so often cavalierly displayed in transportation, Misinformation - the propensity to not just to not provide correct information, but instead, to provide wrong information, Missed Connections - resulting from a lack of transit integration which "all" agree would be a good thing, but about which "no-one" can bring it about, and More. On the Plus Side, the Toronto Transit Commission (TTC) and GO Transit are often seen as excellent service providers, but on the Minus Side there are widely held beliefs that the systems are sub-optimal as a result of lack of transit integration. This paper then, sees in the new Toronto an opportunity to correct many

inadequacies in transportation, particularly with the growing environmental concerns surrounding the proliferation of the private automobile, and other current issues. Let us start with the "More".

TRANSIT INTEGRATION

Perhaps the problem with the largest benefit potential is Transit Integration. In Toronto many benefits are foreseen from continued integration of transit services throughout the GTA. Fare integration is one component of this. Over the last decade GO Transit has developed a Fare Integration Program. One such is the combined GO Transit / TTC "Twin Pass". Individually, both systems offer a monthly pass but the Twin Pass (available only from GO Transit) is sold at a discount (about 15%) off the regular price of the separate passes. Both Oakville Transit and Pickering Transit have offered connector fares (50 cents a ride or even free to/from the GO station with a valid GO ticket). This encourages approaching the GO station by municipal transit, instead of by auto which would necessitate larger parking lots, currently free to riders and as a consequence insufficient space at many GO station parking lots throughout the day.

Besides fare integration, the rider has perhaps a greater need for connection integration. Until recently, it was quite possible to alight from a GO train at Rouge Hill in the early evening only to see the TTC connecting bus either leave before the rider could get to the bus stop, or a bus to arrive "Sorry...Out of service" When pursued about this problem some transit operators have said that they are en route to the "barn". Why pass up revenue passengers *en route* to the barn? Other jurisdictions don't. Buses at that time are quite infrequent (20 minute headway) and we all know that riders value their time more highly when waiting outside in bad weather than they do when either riding or sitting on a dry, warm vehicle. Small wonder some riders have been sufficiently frustrated to believe that TTC really means "take the car". I am happy to say that since January 1 connections are generally better, and drivers usually wait, at least for the first few train riders to come through the (totally inadequate) tunnel. The megacity has the potential for doing not a little arm-twisting to get the operators to co-ordinate services for riders. As the Government of

Ontario has withdrawn all funding for GO Transit is reasonable to expect a change of name, probably reflecting Greater Toronto (or GT) instead of GO as Toronto will be responsible for 49% of the GO system running costs.

There are some potential physical connections which could improve connectivity in the new city. One will be spoken of in discussing Lester B. Pearson International airport, there are a few other potential connections between TTC and GO which merit closer examination. One of these is at Danforth GO station. This station is just one and a half very long blocks from the Bloor-Danforth subway station at Main St. TTC's streetcar 506 High Park/Carlton service passes by the GO station exit, but frequently there is no schedule connection. What would it take to time the streetcars to meet the GO train? The new Sheppard subway line will cross, but not connect with, the North Toronto GO line. **The new city should actively pursue the development of the much promised, yet ephemeral, seamless transportation service for passengers, with physical and fare integration..**

AIRPORT, LESTER B. PEARSON INTERNATIONAL -YYZ

Toronto's international airport is not located in Toronto at all, but in neighbouring Mississauga, part of the GTA. The city, by this fact, does not have direct control over "its" airport. This extends to bus and taxicab passenger services provided to the airport as well as to roadways necessary to bring both passengers and freight. Although the airport is now under a Local Airports Authority, the final say in services and adjoining infrastructure is that of Mississauga. Because of this change in municipality, TTC vehicles charge an extra fare from the outskirts of the airport into the terminals. Another problem is the licensing of taxicabs and limousines, and ultimately their availability for arriving and departing passengers. Some proposals have suggested that a rapid transit service from Union Station to YYZ would be a good thing, a la Brussels and other cities, but the greater percentage of arriving and departing passengers neither originate nor are destined for downtown. If, however, a loop were to be added to the GO rail line to Georgetown, and a link

provided between the GO Bloor Station and the TTC Dundas West Station (only a few metres apart), then air passengers could have easy access to the entire TTC network, as well as the GO network via Union Station. This would undoubtedly take some business off Pacific Western's airport buses, the taxicab and livery industries, but at least passengers would have a viable choice. Of itself, the formation of the megacity does very little to ameliorate any problems here. **The new city needs to work with Mississauga to redevelop airport access, particularly from both passengers' and "meeters-and-greeters" views.**

AIRPORT, TORONTO CITY CENTRE -YTZ

Toronto City Centre Airport, formerly known as Toronto Island Airport, is a short ferry ride across the Western Gap. That ferry ride inhibits growth of services at this airport, as does the restriction that jet aircraft may not use the airport. Over the years, the former Toronto City Council has visited and revisited the jet issue. Neighbours who live along the waterfront in its gentrified milieu since 1974 practice NIMBY-ism to thwart efforts to use even quiet small jets from using YTZ. Recently plans have been floated for a bridge from the foot of Bathurst St. to the airport, but no decision has yet been reached despite the aging of the two ferries, only one of which is in regular service, the other being a back-up. One interesting misuse of signage occurs on Eastbound Lakeshore Avenue West at Bathurst where the picture of the (small) aircraft appears to be going straight forward, but the arrow shows a right turn. Typically the aircraft is slanted in the direction which the motorist is supposed to follow. **The new city should attempt to improve services to from and using the Toronto City Centre Airport.**

TAXI-CABS AND LIVERY VEHICLES

These two industries are very alike in some ways, but very different in others. The Livery industry, commonly known as Airport Limousines, has licenses which restrict their services to trading into YYZ. The drivers are usually smartly dressed, the cars immaculate, and the price only

slightly higher that charged by taxicabs. Clearly, their services are meeting demands and very few would be critical of the livery business.

The taxicab industry, while performing many of the same functions of the liveries, provides a much less consistent service. Other researchers have identified drivers so unknowledgeable of the area that they don't even know how to get to the airport, others who have no idea where major attractions and events take place, and are driving dirty and uncomfortable cabs. Fortunately not all cabs are so disreputable, but a prospective rider does not know, *a priori*, his or her luck, - a crap-shoot.

Part of the problem falls squarely on the shoulders of the Metro Licensing Commission, which allows plate leasing and resale. With an aftermarket re-sale value of $90,000 a plate-owner likely wants to obtain at least a 10% return per year , thus necessitating an annual cost of some $9,000 per year or $750 per month - just to use the plate. A waiting list of some 20 YEARS duration presently exists, with many taxi-drivers waiting their turn to buy the plate. Once paid for, the return on the plate is considered to be the "pension" of the retired driver. If the new city removed the value from the plate, either by flooding the market with plates, or requiring as in New York, that a plate holder MUST drive 220 shifts per year the effect on current holders would be quite drastic *a fortiori* in the case where a plate holder were to be unable to drive owing to a medical problem. In practice, however, some plate holders hold many plates and can form and behave as a cartel. In which case requiring the owner to drive a substantial number of shifts per year would put the onus for quality squarely on the plate owner. Another problem with the taxicab industry is the frequency of physical attacks on drivers , the number of robberies and the number of passengers who do not pay on arriving at their destination. **The new city needs to bring about better taxicab service for the public and better conditions for the driver, including the driver being able to require prepayment for services. Further, the city should also consider subsidizing the installation of Plexiglas grilles in taxicabs to cut down on driver molestations.**

UNION STATION

Opened in its present manifestation in 1927, Union Station is owned by the Toronto Terminals Railway Company, (TTR) which itself is jointly owned by the Canadian Pacific and Canadian National Railways. Through its portals pass 100,000 persons per day, largely patronizing the GO Train system. As such it is a central node in Toronto's passenger rail system. Contiguous to Union Station are stations of both the TTC subway (built in 1954) and now desperately in need of platform widening, and a sub-surface loop of the Harbourfront streetcar line completed in 1991 At present many GO buses are served also on the adjacent Front Street. A (covered) walkway from Union Station is the SkyDome which handles 55,000 for a sporting or other event, The SkyDome is the home for the Toronto Blue Jays professional baseball team. Under construction even closer to Union Station are facilities for the Toronto Raptors professional basketball team and the Toronto Maple Leafs professional hockey team. The latter two will require access *through* Union Station to connect with the TTC Subway. Toronto, however, owns the land upon which Union Station stands, and to complicate matters the TTR is reluctant to update rent negotiations with Toronto. Paying an annual rent of under a million dollars for one square block of real estate in prime downtown Toronto, TTR has a good deal indeed, even though its own activity helps bring a high value to that real estate. The new Toronto will need to resolve the Union Station issue in the future, especially as forecasts predict a doubling of downtown traffic for GO in the next 30 years. GO's platform facilities are inadequate now. **The new city needs to preserve Union Station's transportation function, and assist in providing such improvements as are necessary to serve the anticipated ridership in the next 10-20 years.**

SUSTAINABLE TRANSPORTATION

Current trends in transportation are as unsustainable in Toronto as elsewhere in Canada. Greenhouse gases pose ever increasing threats to the health of Torontonians. Unfortunately, much

of the sustainability issue is beyond the scope of the nw city. From 1986 to 1991 public transit's share of traffic fell from 17% to 14% in the GTA. Trucking use of diesel fuel is up 32% while rail's share has declined by 10%. Urban light duty vehicles represent 60% of transport emissions. One cause of excessive pollution which is under the control of the new city is the enormously overused, and hence under-respected stop sign. This causes excessive fuel use and automobile wear and tear. The previous city fathers allowed a proliferation of stop signs far above that needed to maintain an orderly flow of traffic in order to allow NIMBY-ism by local residents. There are even through streets with a stop sign mid-block. Additionally, stop signs are frequently honoured in the breech by the proverbial "rolling stop" or "taxi stop". Whether these are "unsafe" or not is a moot point. A MUCH more sensible approach is to replace most stop signs with "Yield" signs as are widely used in other parts of the world where fuel is more expensive. A yield sign, together with a law with "teeth" and "reasonable" enforcement would do wonders for reduced fuel use and reduced brake dust. **The new city could have an active policy of using stop signs only where absolutely necessary and of using yield signs in other places.**, this would increase motorists reverence for stop signs. If done properly, no additional risk to pedestrians would occur, and would in all likelihood be reduced.

Furthermore the city in its highly questionable wisdom has subordinated pedestrian and bicycle needs to the auto. Case in point, (not only in Toronto, by the way) providing traffic lights at the intersection with added pedestrian wait/walk signs *which do not change unless the button is pressed!!!* At some intersections, either because the buttons are inoperative or from bizarre programming, a pedestrian can have to wait several MINUTES to be able to cross a street. This results in the unsafe practice of jay-walking. Typically if the city wants to cut jay-walking, the police would be requested to increase enforcement, rather than to seek and remove its cause. The city needs to do a fast re-think of such bad policies. It would create a furor if, instead, auto drivers had to take an active role if to cause traffic lights to change in their favour, they had to get out and press a button. Present day thinking is much akin to the old use of the red-flag man in England

who had to walk in front of a car with a red flag to warn pedestrians. Clearly ludicrous. At many intersections in the city, traffic is held awaiting non-existent cross traffic. Clearly the SCOOT program is not master of its task. In other parts of the world, traffic lights change with greater frequency when there is no traffic in the other direction. Sometimes in Toronto, with NO cross traffic either the magnets in the road do not work, or the timing is excessive and through drivers are thus encouraged to make a right turn, followed by a U-turn and another right turn. Hardly a practice to be encouraged. **The new city should ENCOURAGE pedestrians and cyclists by proper traffic signal programming, even at the expense of a slightly slowed traffic flow wave.**

Another option which is falling into favour elsewhere is the roundabout, or traffic circle. Vermont and other States have increased their use of roundabouts on major roads as is done in England and on the European Continent. So far Toronto has tentatively experimented with roundabouts at only a very few intersections, none of them being on a main road, and none using multiple lanes. New developments in the United States are seeing two lanes around the circle, and a third lane catering to traffic moving between adjacent slips. **The new city should start building roundabouts on some main roads, this would slow traffic down and likely reduce both the number and severity of collisions.**

MUSHROOM TREATMENTS

The mushroom treatment is, of course, keeping one in the dark and periodically throwing cold water and fertilizer on the recipient. Communicating information to transit users and drivers is a major task , and efforts are sincerely appreciated by captive riders. Although the TTC regularly tells riders on a given line of delays on that line, less regularly does it warn riders on other lines many who may be expected to transfer to the problematic line. Telling Bloor-Danforth riders, particularly those coming in from the West of delays at Bloor-Yonge (the busiest stop on the system) would enable some riders to detour via an alternate route of their choice. TTC has a habit of not telling all riders when there are delays, ostensibly because the delay is expected to clear

shortly. A brief announcement would not be considered intrusive and would be appreciated by affected individuals. TTC probably would prefer to down-play any system malfunctions.

In London, England, Underground and bus riders even in outlying areas have displays at stops stating how long until the next buses WILL come (a real-time system INCLUDING non-scheduled delays). TTC has toyed with displaying SCHEDULED surface departures as some stations, but these attempts are really quite feeble.

MISINFORMATION

On one very cold Thursday, November 27th, 1997, at Rouge Hill GO Station, GO could not make up its mind as to which track the morning rush-hour trains would be using. It must be said that the trains operate on the CN Kingston Subdivision at this point. A freight train had broken down earlier on the Westbound track. Pasengers were then told, as frequently happens when the Westbound track is used for freight shunting purposes in the area, to please go to Platform 2 , on the South side of the station for the 07:33 which was running (so they told riders) 12 minutes late, for which access is provided by a tunnel just wide enough for two riders abreast. At 07:35 I received a cell-phone call stating that GO trains on the Kingston Sub. Were ½ hour late (not 12 minutes). AT 07:43 the station loudspeaker told us that as the offending freight train had moved, our train was to come on its regular platform, No. 1 on the North side. By this time the ridership for both the 07:33 and the 07:46 had congregated on Platform 2 - some estimated 200 or more people and using GO's forecast our 07:33 was due momentarily. Now at two abreast we could not all expect to get through the tunnel and on to the platform before the train came. Ergo about 100 ran across the snow and ice covered tracks and around the barriers at the ends of the platforms (chain link fencing separates the East- and Westbound tracks). Just as the last ones were crossing at about 07:48 the 07:19 express from Pickering passed at an estimated 100 km/h on the SOUTH track. After it had gone, we were told the 07:33 was coming NOW on the SOUTH track. Back

across the tracks, around the ends of the platform barriers (*no trespassing* signs notwithstanding). The last few were crossing as the train headlights shone down the track. In such circumstances as these Although only one example, Misinformation has the potential to cause death. Where crowds are concerned, staff should not "guess" where trains will come.

MISSED CONNECTIONS

Where service is every minute or two, missed connections are generally not too serious. Each transit operator, however, should make efforts to provide "Customer Service". From time to time TTC needs to "Short Turn" its vehicles without prior warning , usually as a result of a perhaps unexpected delay. Often the local Inspector will Short Turn the *second* of two adjacent cars without holding the first car to allow riders to move ahead. This has the result of making riders cool their heels (and other parts) sometimes waiting ten or more minutes for the next (already full) car to appear. Inspectors are in touch with Control by radio and should give more priority to service to their ridership, than to getting Operator X back to schedule.

A LOOK TO THE FUTURE.

The new city Toronto council with 57 participating elected representatives, will likely have some difficulty reaching consensus. The big fear is that this will result in a minimalist approach. In the case of transportation, around which most of Toronto revolves, the new city has both the opportunity and the mandate to clear the decks of some long-standing problems and to use its mandate to give Toronto an advantage heading into the new millenium. **The new city could do worse than to listen to the world transportation professionals who will be in Toronto in 1999 for the 53rd bi-ennial Union Internationale de Transports Publiques (U.I.T.P.) Congress. Its members are operators, suppliers, and analysts from all over the world.** The Government of Ontario, GO and TTC will be trying hard to impress the delegates. I presume the delegates won't be subjected to Mushrooms, Misinformation and Missed Connections in their visits to the carriers..

But it would be a shame if some of the non-public transportation problems were neither resolved nor in the process of resolution.

BIBLIOGRAPHY

1. Report of the Transportation and Climate Change Collaborative, A Strategy for Sustainable Transportation in Ontario: Toronto, 1995
2. National Round Table on the Environment and the Economy, State of the Debate on the Environment and the Economy, The Road to Sustainable Transportation in Canada, Ottawa, 1997
3. Ministry of Transportation, Ontario, Towards a Greater Toronto Area Transportation Plan: The Challenges, Toronto, 1995

Urban Goods Movement Revisited

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1.0 Introduction

It can be argued that in the field of transportation, our understanding of goods movement in the urban environment is comparatively weak. A recent special issue of Scientific American dealt specifically with transportation yet only one article was directly related to freight or goods transportation (Giles, 1997). This fact may support the contention that the majority of urban transportation research efforts are directed at furthering our understanding of the processes and patterns of people movement.

Environmental concerns and related policies such as the Clean Air Act in the United States have honed this focus further, as have concerns over the growing congestion in many major cities. However, this "autocentric" research has indirectly highlighted both the importance of understanding the role of goods movement and how limited this understanding has been. For example, urban transportation researchers typically admit that it is important to address issues concerning the impact of "trucks" on urban air quality, but seldom are able to follow through with it.

The primary goal of this paper is to address this lack of understanding by revisiting the topic of urban goods movement. The use of the term "revisit" is based on two arguments: 1) research interest in this area is comparatively low at this point in time, although that wasn't always the case and 2) there has been tremendous change in freight transportation (both urban and regional) over the last ten years and an urgent need to revisit the topic exists.

The next section of this paper provides context by exploring the meaning of urban goods movement (UGM). A conceptual framework in which to place UGM research is forwarded as part of this context. Section 3 contains a review of traditional UGM issues and a critical examination of

related research. A discussion of the impetus behind the call for a renewed focus on UGM is presented in section 4. In the final section, an updated agenda for research in this area will be forwarded and concluding comments presented.

2.0 Urban Goods Movement Explored

The definition of urban goods movement may be verbally expressed as any movement of material goods (freight) rather than people. This rather simple definition, however, does not reflect the immense complexity associated with characterizing these movements. Figure 1 visually represents two broad classes of movement and the inherent variability associated with these classes.

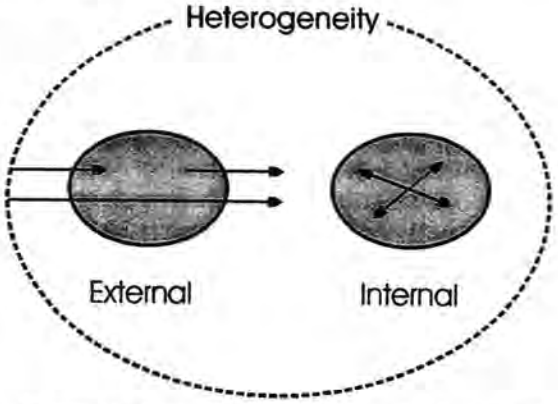


Figure 1: Characterizing Urban Goods Movement

External movements are those in which goods either enter, leave, or pass through the city while internal movements take place within the city boundaries. The inherent heterogeneity is apparent when consideration is given to the range of goods, modal choices, vehicle types, and motivations for movement. Examples of this range include 1) small parcels to heavy machinery, 2) bike courier to air, 3) pickups to B-trains and 4) city garbage collection to international commerce. It can be argued that passenger or people movement is also complex, however, it does not compare to the complexity involved in goods movement (Ortuzar and Willumsen, 1994).

Conceptual Framework

The "Urban Goods Framework" presented in Figure 2 represents an attempt to place this complexity in a broader context from which to establish a basis for research. The physical movement or transportation of goods is at the core of this framework and it is affected by the interrelationships between the "actors" on the one hand, and the "elements" which make up the physical aspects of the transportation system on the other.

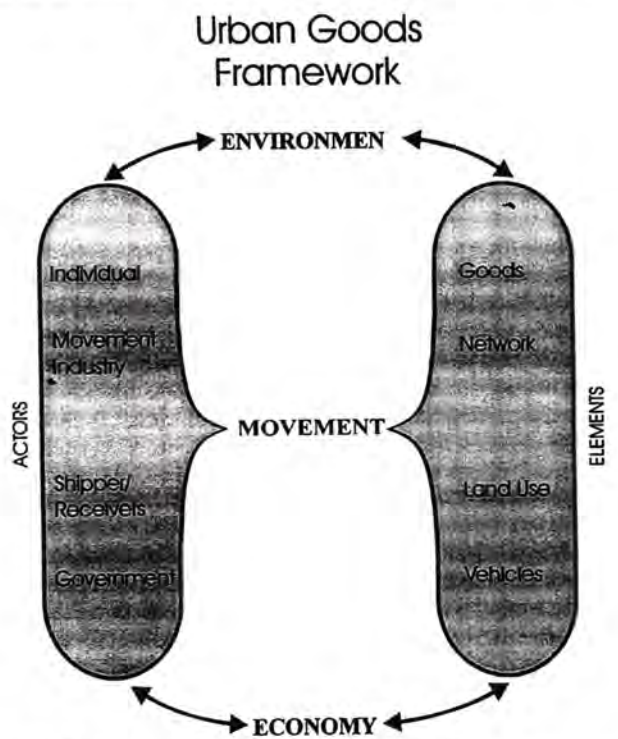


Figure 2: A Framework for Examining Urban Goods Movement

The "actors" represent groups and individuals whose decision making directly influences the character of goods movement. These decisions range from drivers' decisions on which route to follow to government

decisions on vehicle safety and infrastructure investment. The elements represent the physical realm, including the nature of the goods themselves, the vehicle stock, and the relationship between the transportation system (network) and land use.

Both the "actors" and the "elements" influence, and are influenced by, the environment and the economy, which represent the overall sphere in which goods movement takes place. For example, depressed economic conditions may influence decisions by actors on production and shipments and affect decisions to purchase new vehicle stock which has implications for local air quality (the environment). Similarly, a booming economy may result in rapid urban growth which leads to poor land use planning and increased congestion which increases shipment rates and affects the competitiveness of the local urban economy on a national and international scale.

This framework is not meant to suggest that research into UGM must necessarily involve all these components. Nor does it represent an attempt at providing a single theoretical basis for exploring UGM. Clearly, theories dealing with traffic flow, business decision making, and locational choice all find a place within this framework (Wardrop, 1952; Bourne,1982; Giuliano, 1989) The intent is to give pause for consideration and perhaps challenge researchers to broaden the scope of their interests. It also serves to highlight that research into urban goods movement requires an interdisciplinary perspective.

3.0 Traditional Issues and Research

Most major urban centres have undertaken sporadic studies of goods movement, with a primary emphasis on trucking activity (City of Edmonton, 1996; GVRD, 1993; Transport Canada, 1979). In the U.S., a handbook on urban freight has been published as a tool for planners, assisting with their compliance of ISTEA and other legislation (DOT, 1995). A review of these studies gives a sense of the issues and current state of knowledge associated with UGM.

The issues can be categorized into those related to infrastructure requirements and those related to the negative impacts of freight related movements. Typically, studies examine the movements themselves and the types of land use that generate such trips. For example, estimation of

zonal truck trips may be based on a simple linear relationship between the square footage of a particular land use type and the number of truck trips that size of facility generates per week (DOT, 1995). Other infrastructure concerns include the provision of adequate loading/unloading facilities both on and off street, street geometry and construction needed to accommodate heavy vehicles, and forecasting future demand levels (ASCE, 1989).

The negative impacts associated with freight movements are another traditional area of concern. Most major cities have established truck routes and hazardous goods routes which are designed to facilitate ease of travel between major goods movement areas of the city and ease of travel through the city (external movements) (Chatterjee et al., 1989). The primary goal is to keep these movements separate from major residential areas. In addition to minimizing the impacts of noise, vibration, and air pollution, safety is a key motivation behind this goal.

The "Characteristics of Urban Freight Systems" (DOT, 1995) publication exemplifies the state of knowledge concerning urban goods movement. General information on the percentage of freight vehicles on urban roads at various points in time throughout the day and crude estimates of the number of freight trips associated with various land use types is available. However, by their own admission, they rely in certain cases on studies conducted in the 1970's and suggest that there are few generalizable results available (DOT, 1995). This latter admission is true of much transportation research, yet it does give cause for concern.

The City of Edmonton study provides similar aggregate estimates of trucking activity. Truck trips make up 11% of daily vehicle trips and on average, trucks make 8.4 trips per day. The estimated costs of daily truck trips in the city is 6.6 million dollars while the cost of congestion is estimated at 22 million dollars per year (City of Edmonton, 1996). This study, like many others, is focussed on dealing with the practicalities related to UGM. The emphasis is on the movements, not the underlying motivations. But what of the broader research community?

On the whole, the engineering perspective is most prominent in the research surveyed. The work tends to parallel the issues just reviewed, with an emphasis on the movements and their impacts rather than broader concerns and underlying relationships. Examining texts that deal with transportation modeling and forecasting reveals that freight transportation

models do not receive the same level of attention given to passenger related models such as the ubiquitous 4-stage model (Ortuzar and Willumsen, 1994). Typically, freight models are adaptations of passenger models, with often crude adjustments; one truck equals 4 cars. There are a number of reasons for this apparent lack of attention which includes the overall greater complexity of freight transportation, and a trend for freight related research focusing on logistics.

In general, there is common view that there has been a severe shortage of research into urban freight transportation (ASCE, 1989; DOT, 1995, Anderson et al, 1996). The reasons for this shortage are varied. First, congestion issues require emphasis on cars since they make up the bulk of traffic flow. Depending on the time of day, trucks only make up from 7 to 18% of traffic (DOT, 1995). Subsequently, the priority is to understand automobile movements. Second, the elements of freight movement and the actors involved are much more complex, which makes it a difficult subject to research. Third, there is a lack of reliable data available for researchers to tap into. Government agencies have attempted to provide data at the intercity or regional scale, but intracity data is much harder to obtain. The data that is available is often viewed as unreliable given that the transportation firms which are surveyed, are skeptical about the eventual end use of the data. Finally, the phrase "important yet mundane matters" encapsulates the political view toward urban freight issues (O'Sullivan, p.1662, 1992). Firms that operate in the city are reluctant to speak up about their concerns, fearing further government intervention in their work. Local citizens are not concerned about inefficiencies in the local transport network and the eventual indirect price they pay. Politically, issues related to urban freight transportation do not carry much weight, unless safety is an issue.

The question that presents itself is can these apparent barriers to research into UGM be overcome? Is there a means of changing the traditional perspective of the various groups involved? There are a number of critical issues which may provide the power to get over these various hurdles.

4.0 The Impetus for the "Revisit"

The content of Table 1 provides an overview of the major changes that have impacted the Canadian trucking industry. It also provides one of the main reasons behind the call for a renewed focus on UGM; the massive

changes in the nature of goods movement. Trucking is taken here as an example of changes which have affected all freight related modes.

Table 1: The Changing Face of Trucking in Canada

	Trucking Industry	Infrastructure	Markets
Policy	Deregulation VWD Safety *Privatization* *Environment*	Finance NHS Corridor development	NAFTA Subsidies
Technology	MDC EDI	ITS • *Avion* • *407* • *Electronic Border* Intermodal	Logistics • *JIT* • *QR* • *EDI*

Individually, each of these elements is worthy of attention and no doubt, has been the subject of intense research activity. However, it would be safe to say that for many of these changes, their impacts are not fully evolved, nor understood, and this is especially true at the urban scale. Much work has been directed at the furthering our understanding of impacts of deregulation and privatization (e.g. Woudsma and Kanaroglou, 1995; Bowland, 1993) as well as the state of infrastructure in Canada (e.g. Leore,1996; Blanchard, 1996) and new approaches to its provision (Smyrlis, 1997a). The urban scale or intracity impact is often not the primary focus, and the relationships between these changes is similarly unexplored. For example, has NAFTA, combined with deregulation in Canadian trucking driven the development of the AVION system and what are the implications for global competitiveness in Kitchener-Waterloo, and local planning decisions concerning big box retailers? This clearly hypothetical example highlights the fact that there are many interesting avenues of research to be explored.

The content of this table also points to the remaining arguments which support the proposed "revisit". First, there is a recognized state of

urgency with respect to the quality and provision of transportation infrastructure, particularly roads. Recent estimates suggest that 38% of Canada's national highway system is below standards, and the bill for repair is estimated at 14 billion dollars (House of Commons, 1997). Most major Canadian cities are also grappling with fiscal restraint and a seemingly insatiable appetite for roads and their maintenance. In Vancouver, it is estimated that the a percentage point increase in truck travel times due to congestion translates into a 6 million dollar increase in annual costs (GVRD, 1993). Solutions like the private highway 407 in Toronto are not necessarily welcome by the freight moving community (Smyrlis, 1997a). High tolls for trucks and "value engineering" design do not necessarily mean this is a welcome alternative. This example raises the point that perhaps a more effective decision could have been made if more extensive research into UGM were undertaken. If policy makers and funding agencies are asked to make difficult decisions that impact goods movement, then would it not make sense to provide them with the best information on which to base that decision? Not only how many trucks use the road today, but how many will use it 20 years from now and what are the implications if that road is not maintained?

A second motivating factor for "revisiting" UGM concerns environmental issues. Urban air quality has been of particular focus in large metropolitan centres like Toronto, Vancouver, and Montreal. While automobiles are the major source of pollutants, diesel trucks contribute disproportionate amounts of particle pollutants (pm-10). However, the overall role of goods movement remains a poorly understood aspect of the air quality issue and many questions remain (Ontario Round Table on Environment and Economy,1995). Third, and no less prominent, is the motivation provided by the evolving nature of goods movement in general. Technological changes like the use of satellites for mobile data communication and smart highways have a major impact on goods movement. There are also changes in the way businesses function; just-in-time production methods and quick response retailing are forcing transportation firms to respond or be left behind. This response has meant a change in the nature of shipments and an obvious increase in the importance of timeliness.

Lastly, the changing nature of the Canadian economy has implications for UGM which need to be explored. What happens when your city moves from a manufacturing to a knowledge based economy? What happens when people do most of their shopping through the internet or through

mail order? Evidence in the growth of couriers and the strategic linkages they have developed suggests a new era in urban goods movement may be upon us. A need to understand the implications of these changes is enhanced by consideration of the other three motivating factors just reviewed. Rather than intractable complexity, these arguments present a real challenge to researchers.

Furthermore, a number of the changes described may be of assistance to researchers, particularly in dealing with the previously identified barriers. For example, the increasing use of satellite tracking, EDI, and AVI technologies may provide a valuable and relatively inexpensive source of data. Also, funding opportunities for UGM research may be increasing with policy developments like ISTEA in the U.S. and the National Highway Renewal Strategy in Canada. Interest in the development of North American trade corridors is also prompting research activities. Lastly, there have been significant strides in the development of tools for the measurement and analysis of goods movement related issues (TRB, 1994). Examples include the widespread adoption of routing and scheduling algorithms and Geographic Information Systems which provide a robust and versatile framework on which to base transportation research.

5.0 Concluding Comments

The argument which provides the rationale behind this paper is as follows: there are serious gaps in our understanding of goods movement in the urban environment. The content of this paper has been designed to support this position through a review of traditional issues and perceived or real barriers to research and understanding. In addition to this negative perspective, arguments supporting a renewed focus on UGM research have been forwarded and a conceptual framework in which to place this focus presented. Lastly, an outline of factors which may improve the potential for research has been suggested.

It remains to be seen if this potential will be realized. In no way should it be thought that there is a total lack of UGM research. However, the position in this paper is that there is a need for much more. Some possible directions include the following:

- development of new approaches for the modeling of commercial goods movement distinct from passenger based models

- further investigation into the role of goods movement with respect to environmental issues

- increasing our understanding of the impacts of changing urban economies on goods movement

- exploration and modeling of the relationship between land use and transportation in the context of goods movement

This is not an exhaustive list but one which gives a sense of the potential. Perhaps in some small way, this paper will provide the stimulus for future endeavours.

References

Anderson, W.P., Kanaroglou, P.S. and E.J. Miller (1996) "Urban Form, Energy and the Environment: A Review of Issues, Evidence and Policy", *Urban Studies*, 33(1), 7-35

ASCE, Committee on Urban Goods Movement (1989), "Issues and Problems of Moving Goods in Urban Areas", *Journal Of Transportation Engineering*, 115(1), 4-19

Blanchard, G (1996) "Highways and Logistics and Production Performance", Transport Canada, *Special Infrastructure Project* No. TP 12791E, Ottawa

Bourne, L.S. (1982) *Internal Structure of the City, Readings on Urban Form, Growth and Policy*, New York, Oxford University Press

Bowland, J.M. (1993) "Competing in the North American Marketplace: Emerging trends in Truck and Rail Transportation" in *Proceedings of the 28th Annual Canadian Transportation Research Forum*, University of Saskatchewan Printing, p. 363-375

Chatterjee, A, Fisher, P.J. and R.A.Stanley , eds. (1989) *Goods Transportation in Urban Areas*, Proceedings of the Fifth Conference, American Society of Civil Engineers, New York,

City of Edmonton, (1996) *Truck Route Study*, City of Edmonton Transportation Department, Edmonton Alberta

DOT, U.S. Department of Transportation (1995) *Characteristics of Urban Freight Systems*, Office of Environment and Planning, Federal Highway Administration, report DOT-T-96-22, Washington D.C.

Giles, (1997) Faster Ships for the Future, in *Scientific American*, 277 (4), 126-132

Giuliano, G. (1989) "Research Policy and Review 27. New Directions for Understanding Transportation and Land Use " *Environment and Planning A*, 21, p. 145-159

GVRD, Greater Vancouver Regional District (1993*), Trucking in Greater Vancouver: Demand Forecast and Policy Implications*, GVRD and the Province of British Columbia, Vancouver

House of Commons (1997), *A National Highway Renewal Strategy: Report of the Standing Committee on Transport*, Issue No. 5, Minutes of the Proceeding of the Standing Committee on Transport, Second Session of the Thirty-Fifth Parliament, 1997

Leore, B. (1996), "An Economic Model of Inter-Urban Traffic on the Canadian Highway Network",
Transport Canada, *Special Infrastructure Project*, no. 128000E, Ottawa

List, G.F. and M.A. Turnquist (1994) "Estimating Truck Travel Patterns in Urban Areas", *Transportation Research Record*, No. 1430, 1-9

O'Sullivan, P. (1992) a review of " Urban Goods Movement: A Guide to Policy and Planning, by K.W. Ogden,", *Environment and Planning A*, 24(11), 1662-1663

Ontario Round Table on Environment and Economy (1995) *A Strategy for Sustainable Transportation in Ontario: Report of the Transportation and Climate Change Collaborative*, Toronto, Ontario

Ortuzar, J., and L.G. Willumsen (1994) *Modelling Transport*, John Wiley, Toronto

Smyrlis, L. (1997a) "Highway To Nowhere?", *Canadian Transportation and Logistics*, 100 (2), 28

Smyrlis, L. (1997b) "Technological Leap of Faith", *Canadian Transportation and Logistics*, 100 (6), 14-34

Transport Canada (1979), *Urban Goods Movement Research: A Framework and Results Vol. 1*, Urban Goods Movement Report Series, Transport Canada, TP-1834, Ottawa

TRB, Transportation Research Board (1994) *Multimodal Priority Setting and Application of Geographic Information Systems*, Transportation Research Record No. 1429, Transportation Research Record, Washington, National Academy Press

TRB, Transportation Research Board. (1992) *Transportation Planning, Programming, Land Use, and Applications of Geographic Information Systems*, Transportation Research Record no. 1364, Washington, National Academy Press

TRB, Transportation Research Board.(1991) *Transportation, Urban Form, and the Environment*, TRB Special Report 231, Proceedings of a Conference, Beckman Centre, Irvine California, TRB National Research Council, Washington D.C.,

Wardrop, J.G. (1952), Some Theoretical Aspects of Road Traffic Research, *Proceedings of the Institution of Civil Engineers*, Part 2, 1(36), 325-62

Woudsma, C.G. and Kanaroglou, P.S. (1995) " Motor Carrier Policy Evolution and Shipment Revenues in Ontario: 1983-1991, *The Journal of Transport Geography*, 3 (2), 117–126

Canada's Commitment on Greenhouse Gas Emissions under the Kyoto Protocol and the Potential for Reductions in Transport

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Introduction

In December 1997, the parties to the UN Framework Convention on Climate Change agreed in Kyoto to a Protocol that would limit annual greenhouse gas (GHG) emissions among Annex I countries[1] to 5.2% below 1990 levels within the period 2008-2012. Differentiated limits were specified by country, that for Canada being 6% below 1990 level. This would imply substantial reductions in Canadian emissions compared to current forecasts; and as the transport sector is a major contributor of emissions, it might be necessary for substantial reductions to be made in transport emissions.

The paper is intended to summarise what is known to date about the transport components of national greenhouse gas emissions, their likely future trends, and the potential for their reduction. The consideration remains preliminary, and all of the analysis only approximate. The forecasting of trends is necessarily uncertain, and in addition there are some serious inadequacies of existing transport activity data (namely, indicators of private road vehicle use) that limit our understanding of transport needs, the extent to which alternative modes are able to meet them, their relative fuel efficiencies, and potential gains from modal shifts. Furthermore, the analysis of potential mitigation measures is at present no more than rough guesswork in many instances, awaiting more precise specification of practical measures and their schedules, and further investigation of the likely responses of all sector participants. Additional precision will be sought during the national strategy development; and the cost-effectiveness of the options will be estimated.

Transport fuel consumption trends

Table Ai (in the annex) presents fuel use by mode of transport from 1979 to 1996. Total fuel used in the sector increased from 51.3 to 55.1 billion litres in the period, an increase of 7%. That the increase was so

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* *The author is solely responsible for the analysis and interpretations.*

small in a period of rapidly-increasing traffic was largely due to unprecedented improvements in car and light truck fuel efficiencies (car fleet average consumption is estimated to have fallen from 17.8 l/100 km in 1978 to 10.7 l/100km in 1996). Total gasoline use actually fell over the period, by about 1.7 billion litres, or 4.6%, to 34 billion litres. This was offset by rapid growth in road diesel use, which more than doubled to 11.3 billion litres, and in aviation fuel use, which rose 22% to 5.3 billion litres. Meanwhile, rail and marine use declined, by 15% and 27% respectively.

Emissions forecasts

The Natural Resources Canada estimates of national greenhouse gas emissions for 1990 and 1995, and projections for 2000, 2010 and 2020 are shown in Table Aii.[2] Each "end-use" sector is shown separately, then the emissions from power generation and fossil fuel production, and non-energy emissions. The lower half of the table shows NRCan's estimates of emissions by each transport fuel (which will be broken down further into emissions by mode, below).

For the national strategy development, the key conclusions are that:

- total national emissions grew by 10% from 1990 to 1995, and on baseline assumptions would be 19% above 1990 levels in 2010;
- the Kyoto target of 6% below 1990 levels in 2010 would require emissions to fall from approx. 670 million tonnes to 530 million tonnes, ie. by 140 million tonnes, or 21%.

For the transport sector strategy, the key conclusions from table Aii and the underlying analysis are as follows:

- the transport sector is currently responsible for about 27% of total emissions;
- transport fuel efficiency (litres per vehicle-km, per passenger-km, and per tonne-km) is improving in all modes, but is expected to continue to be out-weighed by traffic growth, so that fuel use increases in all modes;
- transport sector growth overall is slightly greater than the all-sector average, so that the transport proportion increases marginally, to 28% in 2010;
- if the sector was to contribute proportionally to the Kyoto goal, transport emissions would need to fall from the baseline forecast for 2010 of 188 million tonnes to 140 million tonnes (6% below

the 1990 level), i.e. by 38 million tonnes;

Road vehicle technology assumptions

In view of the interest in the potential for technological solutions to the transport sectoral emissions, and the recent flurry of announcements of road vehicle prototypes and near-production vehicles, it is important to emphasise that these baseline forecasts have incorporated all industry plans, and sectoral experts' judgements of the most likely pace of technical development. Road vehicle technology is being developed by the motor vehicle manufacturers in cooperation with the US government through the Partnership for a New Generation of Vehicles (PNGV), aimed at producing a car achieving 80 miles per US gallon (2.94 litres/100km, compared to today's new vehicle average of approx. 8.0) by 2005. Development is focused particularly on: diesel or gasoline hybrid electric powertrains, direct-injection diesel engines, fuel cell engines, and turbine-electric engines. A realistic appraisal of the pace of development, and of the motor vehicle industry's production cycles, suggest it is likely that PNGV technologies will account for about 5% of new vehicle sales in 2010, rising to possibly 30% by 2020. These proportions are included in the baseline forecast, and none of the announcements to date causes them to be revised.

Fuel consumption, fuel efficiency and GHG emissions by transport mode and activity type

Table 1 shows the summary of fuel consumed and GHG emissions for all transport activities in 1995 (the most recent year available). Transport network-wide fuel consumption amounted to 54 billion litres; of which private cars and light trucks (ie pickups and passenger vans) were responsible for 30 billion, trucks for 14 billion, aviation for 5 billion, and the remaining 5 billion shared among (in order of amount consumed) marine freight, rail freight, transit, school buses, intercity buses and intercity passenger trains.

Total sectoral GHG emissions amounted to 149 million tonnes. The table presents an alternative and expanded distribution from that shown for 1995 by fuel type in table Aii. Of the total, 65% was from passenger transport and 35% from freight. Private passenger vehicles were responsible for 55%, trucks for 26%, aircraft for 9%, ships for 4%, freight trains for 4%, and buses and passenger trains for the remaining less than 2%.

Table 1: Fuel Use and Greenhouse Gas Emissions, 1995

	Billion litres	Megatonnes GHG	Estimated activity	GHG per pass-km (grammes)
Passenger			*billion pass-km*	
Intercity				
Intercity car/light trucks	9.004	24.48	194.9	126
Intercity bus	0.091	0.25	6.1	41
Intercity train	0.056	0.15	1.5	105
Plane (domestic carriers)	1.868	4.77	23.8	201
Ferry	0.230	0.66	0.9	705
sub-total intercity	11.248	30.31	227.2	133
Urban				
Urban car/light trucks	21.009	57.12	264.8	216
Transit	0.420	1.15	12.5	92
School bus	0.159	0.43	12.9	33
sub-total urban	21.588	58.70	290.2	202
Total passenger	32.836	89.01	517.3	172
	Billion litres	**Megatonnes GHG**	**Estimated activity**	**GHG per pass-km (grammes)**
Freight			*billion tonne-km*	
Diesel trucks - for-hire	4.995	13.72	120.0	114
Diesel trucks - not for-hire	4.692	12.89		
Gas trucks - not for-hire	5.042	13.71		
Rail	2.084	5.72	282.4	20
Marine (domestic use by carriers)	0.341	0.98	43.0	23
Marine (fishing, Coast Guard, etc)	0.851	2.45		
Total freight	17.154	49.47		
International				
Aviation	3.161	8.07		
Marine	1.190	3.41		
Total international	4.351	11.477		
Total	**54.341**	**149.9**		

Source: Transport Canada, Economic Analysis.

The upper half of table 1 refers to domestic passenger travel, and shows for each mode the total passenger-kilometres travelled, and then compares fuel efficiency in passenger-kilometres per litre, and

greenhouse gas emissions per passenger-kilometre. Important conclusions are:

- public modes combined are about 25-30% more fuel efficient than private cars/light trucks;
- aviation is much less fuel-efficient than cars/light trucks for interurban trips;
- intercity trains, system-wide and with current load factors, are only about 20% more efficient than cars/light trucks;
- intercity buses are more than 3 times as efficient as cars/light trucks;
- urban transit, with current load factors, is about twice as efficient as urban car/light trucks;
- the more fuel-efficient public modes, transit, intercity bus and intercity train, together provide less than 3% of total passenger-kilometres.

The lower half of the table refers to freight, and indicates the relative fuel-efficiencies of for-hire trucking, rail and marine, in tonne-kilometres per litre of fuel used, and then GHG emissions per tonne-km. It can be seen that rail is nearly 6 times as fuel-efficient as for-hire trucks, given current characteristics of traffic in the two modes (larger proportions of smaller shipments and shorter distances raise the truck average – comparisons of equivalent commodities and distances would show much smaller differences). Domestic marine freight appears to be slightly less fuel-efficient than rail per tonne-kilometre, but the estimate is only approximate.

Illustrative Effects of Potential Mitigation Measures

Using the above baseline composition of traffic, fuel use and emissions, and their forecasts, the likely effects of potential mitigation measures can be examined. A long and growing list of potential measures has been proposed. Most have not yet been subject to rigorous assessment, and extensive research might be necessary. The dimensions of possible effects of a wide range of suggested measures can be illustrated, however, by consideration of:

- increases in gasoline price;

- improvements in car/light truck fuel efficiency;
- passenger modal shifts away from cars; and
- freight modal shifts from truck to rail.

In addition, preliminary analyses have been reported for a number of specific measures, and a few that are frequently advocated can be quoted to illustrate their potential contributions to the national goal. These are:

- periodic motor vehicle inspection;
- congestion charges on limited access highways;
- increased parking charges;
- truck idling restrictions;
- tax exemption for transit passes.

Increases in gasoline price. A number of suggested measures would impose higher costs of operating private vehicles, to suppress their use and encourage modal shifts. This would include the conceptually-based proposals to internalise the external social costs of transport; or to charge for specific components of social costs in urban areas, notably congestion or environmental damage; or to convert fixed or periodic costs of vehicle operation to costs variable with use. It would also encompass proposals to raise prices of vehicle use to provide funds for public transport or other environmental programs. These proposals could apply to all modes and fuels, affecting both passenger and freight transport. However, the commonest practical version is for increased gasoline taxes, which can be used to illustrate the implications of increases in transport prices to users more generally.

Fuel tax increases can be expected to produce a reduction in fuel consumption. However, the size of the change is very uncertain. Responses of fuel consumption to price changes have been studied extensively, and have been found in credible studies to vary considerably. Price elasticities of demand for gasoline have been found to vary from about -0.2 to about -1.0 – i.e. the proportional reduction in demand might be as little as only one fifth of the proportional change in price, or at the other extreme might be as great as the proportional change in price.[3] If we contemplated for example a tax increase of 10¢/litre, this would change current gasoline prices of about 58¢ by 17%, and the expected reduction in gasoline consumption would be between 3.4% and 17%.

The nature of the behavioural response by gasoline users – the manner in which they reduce fuel use - also remains obscure, despite the extensive studies. However, there is strong evidence that the response increases over time, being perhaps as low as -0.2 immediately following the price increase, but rising over time, perhaps to as high as -1.0 after 10 years. This suggests that the initial response involves some minor reductions or combinations of trips, while in the longer-term greater adjustments are made to patterns of travel, including locations of residence, work and other activities, and, most importantly, vehicles are replaced by others that are more fuel-efficient. There is extensive evidence that vehicle-kilometres have over the longer term been less affected by price increases than have fuel purchases, or, in other words, that fuel efficiency (fuel consumption per vehicle-kilometre) has risen in response to fuel price increases.[4] This appears also to be confirmed by the greater average fuel efficiency of cars and light trucks sold in Canada than in the US, or in European countries than in Canada.

For purposes of illustration, the somewhat conservative estimate of the long-term price elasticity of –0.4 will be used. Table 2 shows the outcomes of alternative increases in gasoline taxes, introduced from 2000, and assuming long-term adaptation grows smoothly to 2010.

Table 2: Reductions in GHG from gasoline tax increases, assuming long-run gasoline price elasticity of –0.4

Tax increase	2000	2010	2020
	megatonnes CO_2-equivalent		
10¢	0.7	8.2	8.4
20¢	1.4	16.4	16.7
30¢	2.0	24.6	25.1
40¢	2.7	32.8	33.4
50¢	3.4	41.0	41.8

On these assumptions, the reduction in emissions in 2010 from a 10¢/litre increase in tax (ie a doubling of the current tax) would amount to about 8 million tonnes; while from a 50¢/litre increase (close to a doubling of the price) would amount to about 40 million tonnes.

Improvements in car/light truck fuel efficiency.

The next main group of proposals are those that would improve average

fuel efficiency of vehicles, through voluntary or mandatory fuel consumption standards, "feebates",[5] tax incentives, early scrappage subsidies, or vehicle maintenance improvements; and it could also represent fuel composition changes with equivalent effects on GHG emissions per vkm. Again, as most of the practical proposals are for cars and light trucks, they will be used to illustrate the potential.

Table 3 shows the effects of improvements in car/light truck fleet fuel efficiency of between 10% and 50%, phased in between 2000 and 2020. The reductions by 2010 from a 10% fleet average improvement would amount to only about 2 megatonnes; while if 50% were somehow feasible the reduction would be 22 megatonnes.

Table 3: Reductions in GHG from car/light truck fleet fuel efficiency (L/100km) improvements

Improvement	2000	2010	2020
	megatonnes CO_2-equivalent		
10%	0	2.2	9.8
20%	0	7.1	19.5
30%	0	12.0	29.3
40%	0	16.8	39.1
50%	0	21.7	48.8

Potential gains from modal shifts in traffic

The implications of inter-modal transfers of traffic are illustrated in Tables 4 and 5. For the passenger modes, the cases consider the doubling of each of the more fuel-efficient modes through diversion of traffic from passenger cars/light trucks. Table 4 first shows the annual number of passenger-km concerned for each of the public modes, then details of the fuel that would be saved from car use, the fuel needed for the public transport, and the net savings. If all the three public modes were doubled, the savings would amount to about 2.3% of total passenger-use fuel. The final column then converts these savings into annual reductions of Greenhouse Gas Emissions, showing that the total savings would amount to about 1.5 million tonnes.

For truck and rail freight, Table 4 illustrates the implications of a shift of 1% and 10% of total for-hire truck traffic to rail, given current

average emission rates. A shift of 1% would potentially save 41 million litres of fuel, which is about 0.6% of the combined total fuel used by for-hire truck and rail, and about 0.2% of the total fuel used for freight by all modes. It would result in a reduction in GHG emissions of 113,000 tonnes. If instead 10% of for-hire truck traffic were diverted, the saving would naturally be 10 times as great, with an annual reduction of 1.13 million tonnes of GHG. Note that these are overestimates of potential savings, as in reality any shift to rail would be of longer-distance truck traffic, for which fuel use would be lower than the average for all trucking.

Table 4: Implications of modal shifts from car to public transport (at current load factors)

	Pass-km diverted from car (billion)	Fuel saved from car use	Fuel use on alternative	Net savings	% of total passenger fuel	Megatonnes of GHG saved
		(million litres)				
Doubling of intercity train	1.5	68.04	56.40	11.64	0.035	0.032
Doubling of intercity bus	6.1	280.42	90.60	189.82	0.578	0.516
Doubling of transit	12.5	991.75	420.09	571.65	1.741	1.554

Table 5: Implications of modal shifts from truck to rail (at current system-wide average fuel efficiencies)

	Tonne-km diverted from truck (billion)	Fuel saved in trucks	Fuel use in rail	Net savings	% of all freight fuel	Megatonnes of GHG saved
		(million litres)				
1% for-hire trucking shifted	1.2	50	9	41	0.2%	0.113
10% for-hire trucking shifted	12.0	499	89	411	2.4%	1.129

Illustrations of specific mitigation measures

Table 6 shows potential effects of a few example measures.

Table 6. Estimates of effects of some specific mitigation measures

Proposal	Potential GHG reduction in 2010 (megatonnes)
Periodic motor vehicle inspection	0.5
Congestion charges on limited access highways	0.25-0.5
25-50% increase in parking charges	1-2
Truck idling restrictions	0.3-0.4
Tax exemption for transit passes	0.02-0.04

A very brief outline of the proposals is as follows:
Periodic motor vehicle inspection: Based on experience with in-use vehicle inspection programs, it is estimated that annual inspections could be expected to improve fuel consumption of about 15% of vehicles by about 5%, producing a fleet average improvement of about 0.75%. A national program would then produce savings of about 0.5 megatonnes of CO_2-equivalent emissions.

Congestion charges on limited access highways: A proposal for congestion charging through facility tolling in the Greater Toronto Area (GTA) was examined in the recent assessment of CO_2-reduction options for Ontario (NRTEE/ORTEE [6]). This considered charges of 30 ¢/veh-km on all limited-access highways in the region during congested conditions, which its analysis suggested would be sufficient to deter enough traffic from using those routes or times that their "level of service" would return to that considered acceptable by traffic engineers (level of service "E"). The estimated reductions in overall travel amounted to 8.7% of peak-period veh-km; and the CO_2 emissions reductions in 2010 for the region to about 0.1 Mt. By a rough extrapolation of those reductions to all urban areas of Canada subject to congestion, the national potential for congestion charging of this kind (i.e. only on limited-access highways) can be estimated to be of the order of 0.25-0.5 Mt in 2010.

Increased parking charges: That options assessment for Ontario also provides an analysis of the potential effects of increased parking charges – imposed by the municipal authorities presumably by regulation of operators of parking lots. Increased prices of 25-50% were considered, for parking within all urban areas of the province. The likely response of veh-km to increased parking charges – the relevant elasticity - was estimated from 7 north american studies to average –0.15. Applying this to the entire province produced an estimated reduction in car veh-km of 1.3-2.7%, and an emission reduction of about 0.35-0.7 Mt in 2010. Another rough extrapolation to the whole country would produce a potential emission reduction approaching 1-2 Mt in 2010.

Truck idling restrictions: A proposal in southern California would ban idling for more than 5 minutes when a vehicle was not "performing useful work". A preliminary assessment of the proposal was included in the Ontario assessment. Based on a crude estimate that engine running time could be reduced by 10% by the idling ban, a reduction in fuel consumption in urban areas by heavy trucks of 3% was predicted, which amounts to a reduction in 2.1% of total fuel used by heavy trucks in Ontario, and a CO_2 reduction in 2010 of 0.145 Mt. Extrapolating to national heavy truck use, emissions might be reduced by 0.3-0.4 Mt.

Tax exemption for transit passes: This proposal has been adopted in some parts of the US, and is advocated strongly by environmental interest groups in Canada. to allow transit to receive the benefit of tax exemption currently received *de facto* by employees who use employer-provided or –subsidised parking and fail to declare it as a taxable benefit. An assessment undertaken for an advocacy project and distributed widely[7] analyses the potential effects. Its conclusions suggest that introducing the policy in 1998 could produce emission reductions that would grow over time, and amount by 2010 to about 0.04 Mt (i.e. 40,000 tonnes). There are a number of respects in which the analysis can be disputed as over-optimistic, particularly in the likely availability of public transit as an option for commuting, the likely shift from car to transit induced by availability of tax-free passes, and the average lengths of commuting trips. A reasonable range of effects is from about 0.02-0.04 Mt by 2010.

Discussion and Conclusions

The Kyoto Protocol would oblige Canada to reduce GHG emissions by about 21% below the level they are forecast to reach in 2010 under "business as usual", a total of 140 megatonnes. That reduction is nearly equal to the entire amount of current transport emissions. The contribution that each sector could or should make to that total will be a key subject of the national strategy development.

The paper has examined the potential for reductions in transport emissions within the time envisaged by the Protocol, from some changes in major features of the transport system – car/light truck operating costs, represented by gasoline prices; car/light truck fleet average fuel efficiency; modal distributions of passenger and freight traffic; and some specific proposals of mitigation measures. It seems clear that large reductions in transport emissions would require a large number of effective measures, or major system interventions to deter traffic, improve fuel efficiencies or induce modal shifts.

Whether practical measures can be designed that are cost-effective relative to those in other sectors is an analytical task to be undertaken within the strategy development. It is instructive to note that examinations of the effects that might be induced by broad-based economic instruments – carbon taxes or tradeable emissions permits – which are argued by economists to be the most efficient means of reducing emissions, suggest the Protocol might be met by carbon taxes of $100-150 per tonne of carbon.[8] Translated into gasoline prices, these would amount to 6.4-9.6 ¢/litre. Such price increases would (from Table 2 above) induce reductions in emissions of no more than about 8 megatonnes. Adding the effects on other transport fuels, the sectoral reduction might be of the order of 10-12 megatonnes. The transport sector would clearly contribute much less than proportionately to the national goal in that scenario.

Table Ai: Fuel use by mode (million litres)

Year	Rail diesel	Marine fuel	Aviation fuel	Road diesel	Road gasoline	All
1979	2,409	3,396	4,334	5,504	35,707	51,350
1980	2,436	3,702	4,371	5,918	36,076	52,503
1981	2,360	3,612	4,186	6,066	34,495	50,718
1982	2,123	2,745	3,781	5,779	31,876	46,304
1983	2,009	2,202	3,631	6,245	30,586	44,674
1984	2,242	2,114	3,895	7,340	31,170	46,760
1985	2,210	1,842	3,973	7,906	31,119	47,050
1986	1,950	1,856	4,075	8,180	31,038	47,098
1987	1,972	2,143	4,350	8,617	31,604	48,687
1988	2,205	2,455	4,641	8,891	32,390	50,583
1989	2,361	2,646	4,717	8,992	32,823	51,539
1990	2,313	2,660	4,399	8,564	32,059	49,996
1991	2,143	2,761	3,861	8,172	31,135	48,072
1992	2,240	2,709	4,122	8,215	31,875	49,161
1993	2,232	2,396	4,031	8,791	32,746	50,196
1994	2,310	2,574	4,351	9,847	33,777	52,858
1995	2,092	2,502	4,704	10,843	33,664	53,805
1996	2,046	2,489	5,272	11,251	34,052	55,110

Source: Transport Canada, Economic Analysis.

Table Aii: Greenhouse Gas Emissions (million tonnes CO_2-equivalent)

End-Use Sector	**1990**	**1995**	**2000**	**2010**	**2020**
Residential	44.1	47.1	43.6	38.4	38.3
Commercial	26.2	28.7	30.6	33.0	36.0
Industrial	90.1	98.0	106.0	117.3	129.6
Transport	149.2	163.5	169.7	188.0	211.7
Sub-total	*309.6*	*337.3*	*349.9*	*376.7*	*415.6*
Electricity Generation	95.1	103.1	88.1	110.1	146.6
Fossil Fuel Production	83.4	101.6	98.6	96.2	99.9
Total Energy-Related	*488.1*	*542.0*	*536.6*	*583.0*	*662.1*
Total Non-Energy-Related	75.9	76.6	73.2	85.7	105.6
Grand Total	**564.0**	**618.6**	**609.8**	**668.7**	**767.7**

Within Transport:

	1990	**1995**	**2000**	**2010**	**2020**
Road gasoline	90.2	95.4	98.0	108.2	121.5
Road diesel	21.2	28.3	30.3	34.0	39.1
Road propane	1.5	2.0	2.1	2.3	2.6
Road CNG	0.1	0.4	0.4	0.5	0.5
Rail diesel	6.2	5.7	6.4	7.1	8.0
Aviation Turbo (domestic)	9.9	10.2	11.3	12.7	14.1
Aviation Gasoline	0.4	0.3	0.4	0.4	0.5
Marine fuel (domestic)	5.4	5.3	5.5	6.0	6.7
Sub-total	*134.9*	*147.6*	*154.3*	*171.1*	*193.1*
Transport demand in other sectors	14.3	15.9	15.4	16.9	18.6
Total	**149.2**	**163.5**	**169.7**	**188.0**	**211.7**

Source: Natural Resources Canada

NOTES

[1] "Annex I" to the Convention includes 39 countries, the most developed plus those of the former USSR.

[2] *Canada's Energy Outlook 1996-2020*, Natural Resources Canada, Energy Forecasting Division, Apr. 1997.

3. See Eltony, MN: "Transport gasoline demand in Canada", *Journal of Transport Economics and Policy*, 27(2), 193-208 (1993); Dargay, JM: "Demand elasticities - a comment", *Journal of Transport Economics and Policy*, 27(1), 87-90 (1993); and Johannson, O and Schipper, L: "Measuring the long-run.fuel demand of cars", ", *Journal of Transport Economics and Policy*, 31, (Sept., 1997).

[4] Greene, DL: "CAFE of price: an analysis of the effects of fuel economy regulation and gasoline price on new car MPG, 1978-89", Energy Journal, v. 11, 37-57 (1990).

[5] "Feebate" is shorthand for "fee/rebate", referring here to a schedule of fees required from purchasers of vehicles with higher fuel consumption and rebates paid to those buying vehicles with lower consumption.

6. Apogee Research International Ltd and The Osborne Group: "A Policy Instruments Working Paper on Reducing CO_2 Emissions from the Transportation Sector in Ontario", prepared for Environment Canada, National Round Table on the Environment and the Economy, Ontario Ministry of Environment and Energy, and Ontario Round Table on Environment and Economy, Nov. 1995.

7. Litman, T: "Employer Provided Transit Passes: a Tax-Exempt Benefit" , report prepared for The Transit Advocacy Project of Transport 2000 Canada, January 1997.

[8] Standard and Poor's DRI: "Impacts on Canadian Competitiveness of International Climate Change Mitigation", prepared for Environment Canada and other Depts., September 1997.

Applications of Artificial Neural Networks To Transportation Systems and Planning

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Introduction

This paper will appraise the use of artificial neural networks (ANN)s in transportation systems and planning. ANNs are one of the latest innovations to the tool kit for any analyst wishing to engage in data forecasting and pattern recognition for very complicated systems. This paper will provide: (1) a discussion concerning the connection between ANNs and transportation; (2) a general overview of ANNs; (3) some detailed analysis of their inner-workings; (4) a review of some applications for ANNs in transportation; and (5) some conclusions.

The Economics of Transportation Systems

Efficient provision of transportation services is a fundamental component to production and social interaction. An accelerated pace of technological advances this century has increased the mobility of both passengers and freight which is all to the good. Of course, transportation economics, as a discipline, furnishes the economist with a dual appreciation for the elements of time and space as necessary ingredients to the production and consumption processes of economic agents. Transportation is not so much a constraint to economic activity as it is really a factor of production that, of course, is subject to all theory that is applicable to factor demand, supply and pricing. As well, transportation may be looked upon as a source of utility as witnessed by the rapid growth in tourism in the latter half of this century. However, this paper will focus exclusively on the role of transportation as a factor of production.

It is time and space that are the true constraints to this process of

transportation. Time highlights the opportunity cost of current activities foregone in order to place people and goods in transit over a particular time period. In this case, there is a netherworld that exists between the times of pick-up and drop-off; as well as risk to what is actually being transported. In an efficient marketplace, fares and freight rates will account for these concerns. Modern modes of transportation also occur over well-defined paces. There are such things as air flight paths, shipping lanes, canals, rail tracks, road networks, and pipelines. In other words, climate, topography, and man-made infrastructure define the paths of transportation. With well-defined paths of transportation come a series of side-effects. Congestion, peak-loads and deterioration of infrastructure are negative side-effects while, on the positive side, paths of transportation may be seen as a precursor to regional economic development and population expansion.

There can be no doubt that transportation paths, when seen in the context of large networks, are a source of interesting and yet complicated decision problems. Efficient provision of transportation services by any one firm obviously requires some feeling for, what an economist would call, optimal usage of a given infrastructure. If a firm can understand: (1) the behavior, to a large degree, of all other users of a common transportation network; and (2) the lay-out and viability of the network itself; the firm may then be able to calculate a strategy for the optimal usage of that network. Certainly, it is fairly easy to postulate so large a number of users and such a vast network as to make this calculation impossible. Fortunately, the advent of high-speed computers coupled with sophisticated iterative techniques is allowing many of the complicated problems to be solved. One type of tool used in this regard is known as an artificial neural network (ANN).

ANN models: a general overview

ANNs are non-linear adaptive models which, like non-parametric models, make no assumptions about the distribution of the data with which it is being fed. As a result ANNs are capable of mapping any kind of relationship between inputs and outputs. Technically, ANNs are exploratory and data-oriented models which include a learning mechanism through which the model is "trained" to learn the underlying data generation process.

The training process is a sophisticated application of trial-and-error. This is a particularly powerful tool when applied to very complex data sets for which the structure of the model is not known. And once an ANN is properly trained, a variety of possibilities become apparent. For example, the model may be used to forecast or classify the future values of the output(s), or the quality of the model itself may be tested against more traditional econometric models using in- or out-of-sample testing.

It is not just the ability of an ANN to deal with a large and complicated data set that gives it its power. Another source of power is its ability to consider the "non-linearity" that exists in the world. That last vehicle that gridlocks the expressway is an example of a non-linear system--- effect was not proportional to cause. In this way, the environment is unstable since equally-sized causes may have different-sized effects. A firm's simple decision process--- obtaining the optimal value for an objective function subject to constraints--- would be rendered invalid when the very system giving rise to these equations is inherently unstable. But, in fact, there is order to this instability--- a non-linear, dynamic order--- and an ANN may be used to *discover* this order. Consider again the expressway: if it was gridlocked yesterday it may be gridlocked today or possibly even empty (that is, "the place is so crowded, nobody goes there anymore"). Certainly, the decisions of these users may lead to these extremes or any result in-between. In its simplest sense, the instability may be clustered in some way while the number of users from day-to-day appear to follow a random walk.

Of course, like all econometric modeling, ANNs are still very much dependent on the quality of the data to be inputted. But a problem peculiar to ANNs is that a pattern may be recognized which, under further investigation, may be soundly dismissed. A pattern calculated for our expressway showing congestion during the early mornings and late afternoons would be obvious and expected; but consider a traffic data set that contained the effects of the major, late-day snowstorms of the period that happened, coincidentally, to all occur on a Tuesday. The ANN would bias toward a prediction of higher congestion on Tuesdays as opposed to any other day. Fortunately, there are techniques available to the researcher to overcome this sort of problem. Note also that long-term forecasting will

exponentially increase the size of any errors inherent in the pattern predicted by the ANN. Therefore, even though the ANN appears to be a wonderful "black-box", there is still a role for an experienced analyst.

ANN models: detailed analysis

ANNs have currently attracted much research in various fields. This is due to the potential of ANNs in finding a solution for complex problems, and to its freedom from the assumptions usually made in order to ease the solution process by the traditional mathematical models. ANN models tend to mimic the way the brain processes information. Although ANN models are still far removed from the way the human brain performs, by mimicking the basic features of the biological neural networks, they have succeeded in doing certain jobs very well.

In general, ANN models can be viewed as a non-linear input-output model with certain special features: Mass parallelism, nonlinear response of neural units to input, and processing by multiple layers of neural units. The ANN models can also be viewed as vector mappers: they accept a set of inputs (an input vector) and produce a corresponding set of outputs (an output vector) according to some mapping relationship encoded in their structure **[Wasserman, 1994]**. Figure 1 shows a very general form of the ANN models.

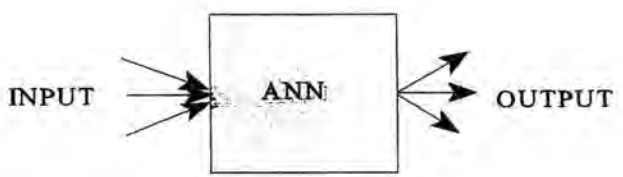


Figure 1. A general view of a neural network as an input-output model or a vector mapper.

ANN is rooted in physics and has been developed in other fields such as mathematics, computer science, cognitive science and engineering. The most popular applications of ANN include pattern classification, pattern completion, function approximation, optimization, prediction, and automatic control. ANN models have recently been applied in economics and finance where forecasting results with the traditional models have not been very encouraging. Financial markets have been the subject of most ANN research in economics and finance due to apparently random behaviour of financial variables and also to the abundance of data required by the ANN. In most cases, ANNs have outperformed the traditional time series models in forecasting the financial variables such as stock prices, exchange rates, etc., or classifying applications such as bond ratings **[Ahmadi (1993)]**.

The interesting features of ANN models and their success in a variety of applications suggest that they may serve as a useful addition to the tool-kit of economics and econometrics.

Single and Multi-layer ANN Models

Before going through the ANN models, it may be useful to explain some of the important and commonly used jargon which have different meanings or interpretations in econometrics. Some jargon may find an equivalent terminology in econometrics, as to be presented here, but some may not and we will use them as they are.

Input = independent (explanatory) variable
Output = dependent (explained) variable
Actual output = the output generated by the ANN model; predicted dependent variable
Desired (target) output = observed values of dependent variables
Error = difference between the actual output and the desired output
Layer = vector
Neuron unit = a component of the hidden or output layer where inputs are processed.

Weights = parameters to be estimated
Learning (Training) = iteration and weights adjustment process through which the error is minimized, or a better fit to the data is produced; estimation of the parameters
Activation (transfer) function = a function (usually nonlinear) which receives the initial outcomes of the hidden or output units and generates a final output for those units.
Generalization = ability of a network to generate the closest output pattern for input patterns that were not included in the training set; forecasting.
Number of patterns = number of observations
Bias unit = a unit with the value of one; intercept in a regression model

The basic structure of an ANN model can be explained through Figure 2.

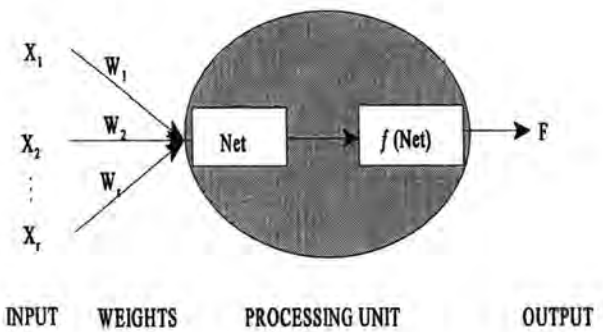


Figure 2: The basic structure of the ANN model

The inputs, (X :X_1, X_2, ...,Xr), are applied to the network. Each input is then multiplied by a random weight (wi), and summed. The result, Net, is as follows:

$$(1) \qquad \text{Net} = \sum_i W_i X_i$$

The "Net" is then applied to an *activation (transfer) function*, F = f(Net), that generates the output value for the unit. The activation function can be of any form. If it is *linear*, it only transfers the "Net" value to the output unit, that is, f(Net) = Net. This is similar to the familiar linear regression model in econometrics: $Y = \Sigma i\ W_i\ X_i$, where $Y \equiv$ Net. The activation function can be a "*threshold function*" which generates the value of 0 or 1. For instance, it can take the following form:

$$f(\text{Net}) = 1, \text{ if Net}>0$$
$$f(\text{Net}) = 0, \text{ if Net}<0.$$

The above network with its threshold activation function is similar to *limited dependent variable models*, where the dependent variable has a binary form. F(Net), however, in most applications takes the form of the "*sigmoid function*" which is a continuous and nonlinear function and generates the values between 0 and 1. It has the following form:

$$(2) \qquad f(\text{Net}) = 1/[1 + e^{-\alpha \text{ Net}}],$$

where the value of α determines the steepness of the function. If α becomes very large, the function approaches a *threshold (step) function* producing either 0 or 1 as the output; and if it becomes very small, the function approaches a smoother function.The sigmoid function is similar to a *logit model* where the dependent variable has a logistic functional form. One of the reasons for the popularity of the sigmoid function is that calculating its first derivative, which is needed for weight adjustment and will be discussed later in this paper, is relatively simple. Figure 3 shows the sigmoid function with two extreme values for α.

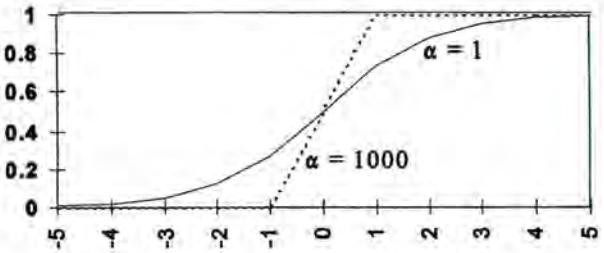


Figure 3. The sigmoid (logistic) function with two different values for α.

The output generated by the network, F, is called the *actual output*. This actual output is compared with the output data, i.e. *the target (desired) output*, and then the *error*, i.e. the difference between the actual output and the desired output, is calculated. The objective is to minimize the error. This can be done by applying a *learning rule* through which the network adjusts the weights (w) in the direction in which the error is minimized.

In general, the learning rule has the following form:

$$W_{ij}(t+1) = W_{ij}(t) + \Delta W_{ij}(t) \qquad (3)$$

where the W_{ij} is the connection weight from input i to output j, and ΔW_{ij} is a function of input value (Xi), output value and the target output. For example, in the"*delta learning rule*", ΔWij is specified as follows:

$$\Delta Wij = \eta\, Xi\, (Tj - Fj), \qquad (4)$$

where η is a parameter (called *learning rate*), and Tj and Fj are the target and actual outputs of output unit j, respectively.

Despite its simple form, this basic ANN model, which is also called *Perceptron*, is very powerful in learning the patterns. However, it cannot learn all types of the patterns.[1] The next generation of ANN models are

those which have another intermediate layer, called a *hidden layer*. These models, as will be discussed below, are able to learn all kinds of patterns.[1] In this case, the inputs are processed in the hidden units and the outcomes of the hidden units are applied to the output units where the final results of the actual output will be produced. The process in the hidden units are exactly the same as that in the output units explained through Figure 2. That is, in each hidden unit, the incoming data is processed as follows:

$$Netj = \Sigma i\ \gamma ji\ X_i,$$

and

$$Gj = G\ (Netj),$$

where γji is the connection weight from input i to the hidden unit j, G is the activation function,
and Gj is the output of the hidden unit j. Figure 4 shows an ANN with two hidden layer units and one output layer unit.

In the case where the number of hidden units is more than one, say q, the above formula can be written in the following matrix form:

$$Net = \Gamma X,$$

where Γ is a qxr hidden layer weight matrix and X is rx1 input vector. Or,

$$\begin{vmatrix} Net_1 \\ . \\ Net_q \end{vmatrix} = \begin{vmatrix} \gamma_{11} & \gamma_{12} & \cdots & \gamma_{1r} \\ . & . & \cdots & . \\ \gamma_{q1} & \gamma_{q2} & \cdots & \gamma_{qr} \end{vmatrix} \begin{vmatrix} x_1 \\ . \\ x_r \end{vmatrix}$$

and

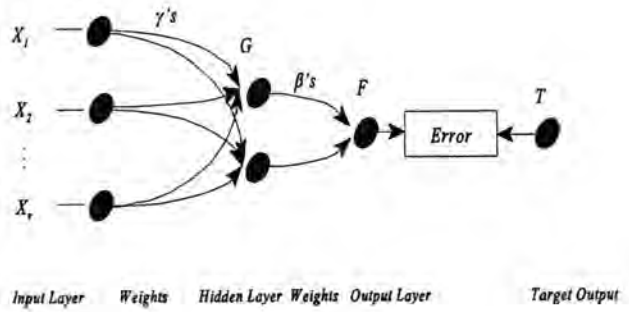


Figure 4: A Multilayer ANN with r input units, two hidden units, and one output unit.

$$G = G(\Gamma X),$$

where G is a qx1 vector, or

$$\begin{vmatrix} G_0 \\ . \\ G_. \end{vmatrix} = \begin{vmatrix} G(Net_0) \\ . \\ G(Net_.) \end{vmatrix}$$

The output of the hidden units, G, is then applied to the output layer where the following calculation is performed.

$$Net = \Sigma i\ \beta i\ Gi,$$

and

$$F = F(Net).$$

Again, if there is more than one output unit, say v, the output can be presented in the following matrix form:

$$Net = B\,G,$$

or,

$$\begin{vmatrix} Net_0 \\ . \\ Net_{\cdot} \end{vmatrix} = \begin{vmatrix} \beta_{00} & . & . & \beta_{0} \\ . & . & . & . \\ \beta_{\cdot 0} & . & . & \beta_{\cdot\cdot} \end{vmatrix} \begin{vmatrix} G_0 \\ . \\ G_{\cdot} \end{vmatrix}$$

and

$$F = F[B\,G\,(\Gamma X)], \qquad (5)$$

or

$$\begin{vmatrix} F_0 \\ . \\ F_{\cdot} \end{vmatrix} = \begin{vmatrix} F(Net_0) \\ . \\ F(Net_{\cdot}) \end{vmatrix}$$

where B is a vxq matrix and F is a vx1 vector. In this stage, the ANN compares the value of actual output (F) with the value of the target (desired) output (T), and calculates the error. The error is then minimized by iteration and adjusting the weights (γs and βs) through the specified learning rule.

There are a variety of ANN models. They can be categorized into different groups such as *static* (feed-forward networks) and *dynamic*

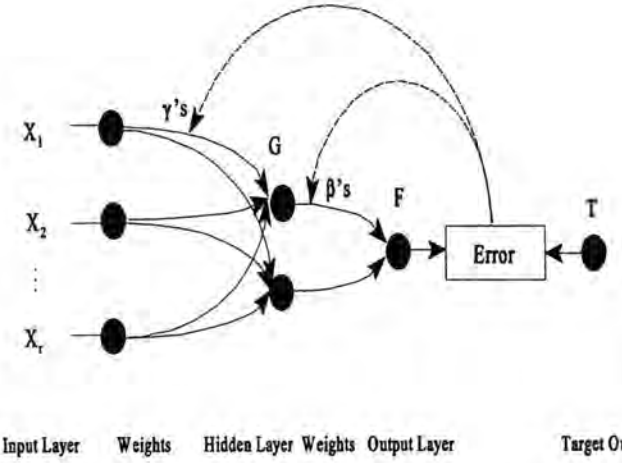


Figure 5. A single hidden layer BPN model with r input units, two hidden units, and one output.

(networks with feedback), *hetero associative* (where an output vector which is different from input vector may be generated) and *auto associative* (where the output vector and input vector may be the same). ANN models can also be categorized based on their learning algorithm. The learning can be either *supervised* or *unsupervised*. In a supervised learning ANN, an input vector and output vector pair is defined and the networks tend to learn the relationship between them through a specified learning rule. In an unsupervised ANN, however, the networks are trained by only the input vector.

The Back-Propagation Neural Network (BPN) Model

The back-propagation neural network (BPN) model is by far most commonly applied ANN model which has been used in different disciplines including economics and finance. It has an easily understood paradigm and

generates reasonable results in various applications. Some of the economic and finance applications of the BPN can be found in **Ahmadi (1993)**, **E. Maasoumi, Khotanzad, and Abaye (1994)**, and **Swanson and White (1997)**. As a multilayer feed forward ANN, the BPN was introduced by **Rumelhart, Hinton and Williams (1986)** and became a key development in the history of ANN. The BPN model is a universal approximator; that is, it is able to approximate any continuous function with arbitrary accuracy, provided that the sufficient number of the hidden layer units is provided **[White (1990)]**.

The BPN model is feed-forward, i.e. there is no feedback from output or hidden layers to input layers, and hetero associative with supervised learning, i.e. an output vector different from the input vector is presented in this model. A typical BPN model consists of three layers: an input layer, a hidden layer (one or more), and an output layer. Figure 5 shows a BPN model with an input layer X which consists of r units, (X: X_1, X_2,..., X_r); a hidden layer G which consists of two processing units, (G: G_1, G_2); and an output layer F which consists of one processing unit (F). All the three input, hidden and output layers are fully connected to each other with two sets of weights (γs and βs). The directions of the connection lines from the input layer to the hidden layer and from the hidden layer to the output layer indicate that the BPN is a feed forward network.

The BPN maps the inputs to the outputs and learns the relationship between them through iteration. The process of learning in the BPN model is as follows:

1. Inputs are applied to the network and the initial random weights are generated. No processing is done in the input units.
2. Each hidden layer unit receives the inputs, multiplies them by their correspondent weights and adds them all together. That is, the hidden layer unit j calculates

$$(6) \qquad Net_j = \Sigma_i \gamma_{ji} X_i, \quad i = 1, ..., r, \quad j = 1, 2.$$

where X_i is the input of the unit i and γ_{ji} is a weight connecting the input unit i to the hidden unit j. The output of the hidden layer unit j, G_j, is a

transformation of the net, as follows:

$$(7) \qquad Gj = G(Netj),$$

where G is a transformation or activation function. G can have any functional form , linear or nonlinear, but the most popular one as mentioned above is the nonlinear *sigmoid* or *logistic function*. In this case,

$$(8) \qquad Gj = 1 / [1+e^{-\alpha Netj}],$$

where the value of α determines the steepness of the function.

3. The output units receive the outputs of the hidden layer units (Gs) as their input. The function of the output layer units is exactly the same as that of the hidden layer units. That is, each output unit calculates the *Net*, the sum of product of the inputs and weights, as follows:

$$(9) \qquad Net_h = \Sigma i\ \beta i\ Gi,$$

where "Net_h" is the net value for the output unit h, βi is weight coming from the hidden unit i and Gi is the output of the hidden unit i, which is input for the output unit h. The output unit then applies a transformation function, F, to the Net_h. Therefore, the output of the output layer unit h, *actual output*, is defined as:

$$(10) \qquad F_h = F(Net_h).$$

4. The network compares the actual outputs (Fs) and the desired (target) outputs (Ts), and calculates the error. The objective is to minimize the error. Two commonly used measures of errors which are to be minimized are Total Sum of Squared Errors (TSSE) and Root Mean Squared Error (RMSE). TSSE and RMSE for unit h of the output layer are defined as follows:
where N is the number of patterns (observations).

5. After calculating the error, the network returns the error to the network and adjusts the connection weights (γs andβs), hence *back-*

$$(11) \qquad TSSE_{\theta} = \sum_{x \in \Theta}^{\phi} (T_{\theta x} - F_{\theta x})^{\theta},$$

$$RMSE = \sqrt{\left(\sum_{x \in \Theta}^{\phi} (T_{\theta x} - F_{\theta x})^{\theta}\right)/N}$$

propagation. The weight adjustment, which is called *learning (training)*, is done by a specific learning rule. The network iterates the process until it reaches a certain specified error.

Learning rule

The BPN learning algorithm uses gradient descent; that is, it changes the weights in a direction that minimizes the error. A learning rule which is commonly used in the BPN model is the "*generalized delta rule*". In this learning rule, the weight is updated for each unit in the output layer as follows:

$$(12) \qquad \beta_{hj}(t+1) = \beta_{hj}(t) + \eta \nabla_{hj},$$

where $\beta_{hj}(t)$ is the weight connecting unit j of the hidden layer to unit h of the output layer at time t, η is the learning rate (typically less than 1), and ∇_{hj} is the gradient vector associated with the weight from unit j in the hidden layer to unit h in the output layer. The gradient vector is the set of derivatives for all weights with respect to the output error. BPN calculates the gradient vector on a layer-by-layer basis using the chain rule for partial derivatives. For weights in the output layer, components of this vector may be evaluated as follows [**Wasserman (1994)**]:

$$\nabla_{hj} = \partial E / \partial \beta_{hj}$$
$$= (\partial E / \partial Fh)(\partial Fh / \partial \beta_{hj}),$$

where E is a function of the error. If E is defined as the Root Mean Squared Error (RMSE), the first component of ∇_{hj} becomes:

$$\partial E/\partial Fh = \partial [n^{-1}\Sigma i (Thi - Fhi)^2]^{1/2}/\partial Fh = \delta h,$$

and by the definition of the Net_h and F as in (9) and (10), the second component of the ∇_{jh} can be written as follows:

$$\partial Fh/\partial \beta_{hj} = G (Netj).$$

Therefore,

$$(13) \qquad \nabla_{hj} = \delta hG (Netj)$$

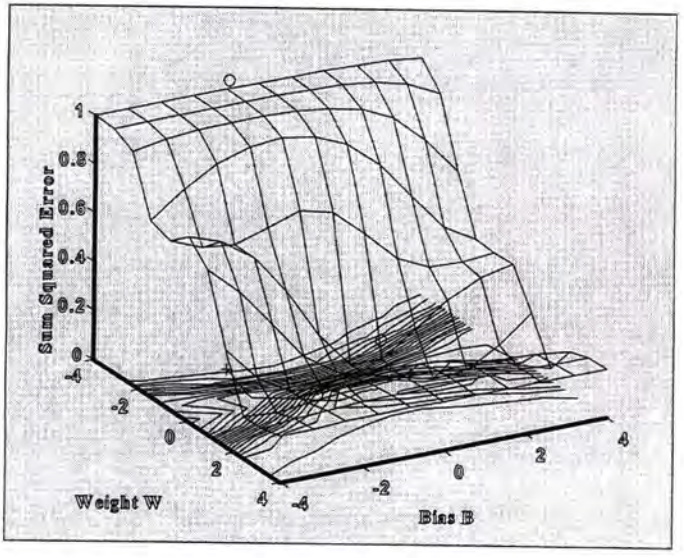
Figure 6 shows the error surface graph in which the sum squared error is minimized through the
change in weights. The initial and the final position of the error is shown by the two balls at the top and
the bottom of the surface, respectively.

The weight update rule for each neuron in the hidden layer is as follows:

$$(14) \qquad \gamma ji\ (t+1) = \gamma ji\ (t) + \eta\ \nabla ji,$$

where γ_{ji} (t) is the value of the weight connecting the unit i in the input layer to the unit j in the hidden layer, η is the learning rate and ∇ji is the gradient vector which is calculated as follows:

$$\nabla_{\gamma x} = \partial E/\partial \gamma_{\gamma x}$$
$$= \Sigma_{\beta} (\partial E/\partial F_{\beta})(\partial F_{\beta}/\partial G_{\beta})(\partial G_{\beta}/\partial Net_{\beta})(\partial Net_{\beta}/\partial \gamma_{\gamma x})$$



Fiure 6. The error surface graph. The ball at the top shows the initial position of the error and the ball at the bottom shows the final position of the error.

where

$$(i) \quad \partial F_j / \partial G_j = \beta_{pq}$$
$$(ii) \quad \partial G_j / \partial Net_j = g'(Net_j)$$
$$(iii) \quad \partial Net_j / \partial \gamma_{ji} = X_i$$

Substituting (i), (ii), and (iii) into ∇ji, it can be written in the following form:

$$(15) \qquad \nabla ji = g'(Netj)\ Xi\ \Sigma h\ \delta h \beta hj.$$

It is common for each unit in the hidden and the output layers to have a "*bias*" input. It has a value of (+1) and its weight is adjusted like other weights. Bias term can be viewed as a constant term in the regression model.

BPN, in certain problems, may generate oscillation of the weights rather than smooth convergence to a solution. This can be alleviated by adding a "*momentum*" term to the weight update rule. Momentum makes the current weight change as a function of previous weight change in addition to the current error and encourages weight changes to continue in the same direction. That is,

$$(16) \qquad wji\ (t+1) = wji\ (t) + [\Delta wji\ (t) + \alpha\ \Delta wji\ (t-1)],$$

where $\Delta wji\ (t) = -\ \eta\ \nabla ji$.

Applications of ANNs to transportation

i. Short term traffic forecasting

Consider how ANNs have been used in transportation research. **Nam, Yi and Prybutok (1997)** tested their ANN against traditional regression and exponential smoothing techniques for the prediction of airline passenger volume. Using a 12-year, monthly data set their ANN was found to have superior predictive performance. Roadway sensors have been a source for huge amounts of data that may be applied to ANNs for the purpose of forecasting traffic volume, speed and occupancy. It should be noted that inter-urban roadway data is a relatively rich source in that inputs (i.e. vehicles numbers and their attributes) are of a large variety and outputs, such as volume and speed changes, occur quite frequently. In other words, with the great distances that can be traveled during, say, one-half hour on a given roadway there is a great range to the density of the information that may be used by the ANN in order to lay out a forecast for the next half-hour. Of course, the real-time computational effort will rise approximately with

the square of the number of inputs used; and the more inputs there are, the more data there needs to be in order to properly train the ANN. In this way, practicality requires in most cases that only a subset of available inputs be ultimately used. For example, **Dougherty and Cobbett (1997)** used an ANN to forecast traffic volume on the Rotterdam/The Hague/Gouda triangle in The Netherlands. Each motorway had about 17 count sites generating hundreds of input points. They would settle on 40 inputs as part of their acknowledged trade-off between accuracy and computational effort. Again, the time the analyst saves in model specification using ANN the more this is made up for in data selection and fine-tuning.

Finally, an ANN makes better use of real-time systems than does conventional time-series estimation. It is easy enough to specify a functional form for traffic flow at a point (i) that is dependent upon the flows that occurred at previous points (i-1, i-2, ..., i-h) at time intervals (t, t-1, ..., t-p). However, what such analysis ignores is the structure of the system between measurement points. Simply put, the time it takes to physically move between any two points is based upon both traffic conditions and the chosen, or constrained, speed of travel. Thus, while the time series estimation would take these time lags to be fixed, an ANN would be able to input speed data along with the count data as part of its pattern recognition process. Multi-dimensionality is one of the great strengths of ANNs.

ii. Optimization

The ANN models have been used to solve very complex constrained optimization problems. One of these applications is known as the "traveling salesman" problem. The problem is to minimize the total travel distance among cities a traveling salesman must visit. The constraints are that all cities must be visited, each city must be visited only once, and finally a salesman must return to the starting point at the end of the trip. The practical applications of this problem in transport economics may include scheduling of truck deliveries and of airline crews.

The traveling salesman problem is computationally intensive if it is solved on an exhaustive search comparing all possible routes to find the

best one. In general, a problem with a n-city tour will have n!/2n distinct circuits to consider. That is, 12 distinct tours (=120/10) for a five-city tour, but 181,440 tours (=10!/20) for a ten-city tour, and $4x10^{30}$ possible tours for a thirty-city tour. Therefore, the computation cost, in terms of amount of time required by even a very advanced computer to solve this problem grows exponentially as the number of cities increases. In this kind of problem, it is often the case that a *good* solution obtained in a quicker time would be preferred to the *best* one found in a very long time.

One may design an ANN model to find a reasonably fine solution to the traveling salesman problem. Mapping the optimization problem into an ANN model is complicated and, therefore, the details are not presented here. Interested readers can check **Freeman and Skapura (1991)** and **Hertz et al. (1990)**. Figure 7 shows different steps in solving the travelling salesman problem for 20 cities.

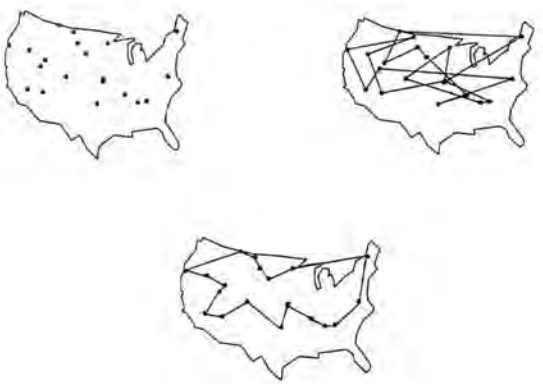


Figure 6: An ANN solution to the Traveling Salesman Problem

iii. Classification and Pattern Recognition

The ANN models are able to do classification and pattern recognition tasks very well. In the field of transportation economics, classifying the traffic patterns in a city or province can be used to develop a traffic monitoring system. The ANN models which are appropriate for this application are back-propagation networks (BPN), radial basis function networks (RBFN), probabilistic neural networks (PNN). If there is no output, a self-organization map (SOM) network, which learns the patterns of the data without supervision, can be applied. After the network has learned the pattern, it will be able to classify a new piece of information into the existing pattern with reasonable precision. The details of the BPN was discussed previously, and due to limited space, the interested reader is referred to **Wasserman(1994)**, **Hertz et al.(1991)**, and **Haykin (1994)** for a detail discussion on the RBFN, PNN and SOM networks.

Conclusions

This paper has shown that transportation systems are a rich source of applications for ANNs. The complexity of such systems give the ANN a comparative advantage that should not be overlooked. ANNs promise to become more sophisticated as their adoption becomes more widespread. Such an occurrence makes the need for high quality data to be imperative. Once such data is obtained the ANN will prove to be a fast and efficient source for some of the most interesting and complicated problems in transportation analysis today.

Endnote

1. A typical example of the failure of the above *perceptron* in learning a pattern is the X-OR problem. This basic ANN cannot learn the X-OR pattern: [(0,0), (0,1), (1,0), (1,1)], where the output is on (+1) if one or other of the two inputs is on, but not when neither or both inputs are on. The reason for the failure is that the network cannot separate input patterns into two classes. For more details see **Hertz, et al. (1990)**.

Bibliography

Ahmadi H. (1993). "Testability of the arbitrage pricing theory by neural networks." in Trippi R. and E. Truban, eds. *Neural Networks in Finance and Investing.*

Dougherty, M., and M. Cobbett. (1997). "Short-term inter-urban traffic forecasts using neural networks." *International Journal of Forecasting*, vol. 13. pp. 21-31.

Freeman, James A., and D. M. Skapura. (1992). *Neural Networks: Algorithm, Applications, And Programming Techniques*. Addison-Wesley Publishing Company Inc.

Haykin, S. (1994). *Neural Networks*. Macmillan College Publishing Company.

Hertz, J., Anderskrogh, and R. G. Plames. (1991). "Introduction To The Theory of Neural Computation." A *lecture notes volume in the Santa Fe Institute Studies In The Science Of Complexity*. Addison-Wesley Publication Co.

Kuan, C., and H. White. (1994). "Artificial Neural Networks: an econometrics perspective." *Econometric Review*, vol. 13.

Maasoumi, E., A. Khotanzad, and A.Abaye.(1996). "Artificial Neural Networks for some Macroeconomic Series: A first Report." *Econometric Reviews*, 13 (1).

Nam, K., J. Yi, and V. Prybutok. (1997). "Predicting Airline Passenger Volume." *The Journal of Business Forecasting*. spring. pp. 14-16.

Rumelhart, D. E., G. E. Hinton,, and R. J. Williams. (1986). "Learning internal representations by error propagation", In *Parallel Distributed Processing*, vol. 1, pp. 318-62.

Swanson, N. and H. White. (1997). " A Model Selection Approach to Real-Time Macroeconomic Forecasting Using Linear Models and Artificial Neural Networks." *The Review of Economics and Statistics*.

Wasserman P. D. (1994). *Advanced Methods in Neural Computing*. Van Nostrand Reinhold.

White H. (1990). " Connectionist nonparametric regression: multivector feedforward networks can learn arbitrary mappings." *Neural Networks*, 3. pp. 525-549.

Competition Policy Activities Related to the Transport Sector, 1976-1996*

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1.0 INTRODUCTION

The present decade has witnessed an unbelievable transformation of the transportation sector. A few years ago before deregulation, it seemed difficult to bring about change. Now however, companies and organizations that were familiar to nearly everyone no longer exists.

In air transportation, the national and regional roles defined for air carriers have become obsolete. Air Carriers that were once famous and legends in the business like CP Air, Nordair, Québecair, Pacific Western Airlines, and Wardair International have disappeared. The airline industry has restructured itself into two major families under Air Canada and Canadian Airlines International Ltd. Entry and exit into the industry have not only occurred domestically but also on the international front. In early 1995, an open skies aviation agreement was signed between Canada and U.S., followed by other open skies agreements with Germany, U.K. etc., new liberalized agreements with numerous countries and air agreements with some countries for the first time. Another notable event was the consolidation of a number of global air alliances. In addition, changes have also occurred in other segments of the aviation industry. Not only has there been consolidation but there have been policy changes as well. For example, airports that were once under the tight control of the Federal government have been privatized and the Air Navigation system that was owned and operated by the Federal government has also been privatized.

In rail transportation, changes have also occurred. Canadian National Railways once thought to be one of the most valuable crown jewel was sold after several attempts. And while most crystal ball gazers would have predicted that the sale of CN might fail, it turned out to be a remarkable success, which to this

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day has been thrilling its purchasers due to its performance on the Toronto Stock Exchange. The process of rationalizing the railways began due to major losses by the two railways between 1988 and 1993 and due to its severe structural problems in Eastern Canada. CN undertook internal restructuring by reorganizing its Eastern Operations, through line abandonment's and a further reduction of its work force. CP also undertook an internal reorganization. It cut its administrative budget by a quarter, announced a massive restructuring by cutting 1,450 jobs and moving its headquarters to Calgary. And after years of considering to sell its eastern network, it has finally decided to keep it.

In ocean shipping, superconferences emerged together with new services and forms of agreements. The number of conferences serving Canada decreased from 34 to 20, the number of lines serving the East coast declined from 59 to 41 and the number of lines serving the West coast has remained roughly the same between 1987 and 1996. Changes occurring at the domestic level are even more dramatic, as major reforms are being proposed in Canada's marine transportation system. Federal involvement in ports is being redefined so as to encourage ports to operate according to business incentives. Attempts are being made to commercialize the operations of the St. Lawrence Seaway, and to improve the way pilotage authorities and ferry services operate.

In trucking, the industry also witnessed several structural changes - mergers, expansions, acquisitions and rationalization of operations. The ranking of the carriers at the top changed and well known names disappeared from the scene or combined to form new entities. For example, TNT jumped to first place in 1994 from second place in 1993 and CP Express & Transport jumped to second place from fifth over the same period; CN Route went bankrupt and other companies closed down operations such as Thompson Transport, Imperial Roadways, Glengary etc.; Canadian Motorways, Ltd. purchased Direct Transportation System Ltd., the former owned by Federal Industries Ltd. which is now looking to divest itself of its transportation business, Auto Haulaway purchased McCallum Transport; and CP Trucks is now known as Interlink. This period also witnessed the entry of US carriers into the Canadian market. As a result, the operating authorities held by them

In addition, major legislative changes have also occurred or are occurring. For example the *Canada Transportation Act*, the *Canada Marine Act*, amendments to the *Railway Safety Act*, *Carriage of Passengers by Water Act*, repeal of the *Western Grain Transportation Act*, amendments to the *Air Transportation Regulations*, etc. All of the changes noted above have been useful in making businesses in the transport sector more competitive domestically and internationally more efficient. This will encourage these businesses to make profit margins acceptable for a while. However, as their competitors benchmark themselves to these restructured firms the profit margin of these firms could become squeezed again, leading to further changes. At

times, the competitive struggle may involve anti-competitive acts leading to complaints to the Competition Bureau. For these reasons, it is important to continue to maintain a dialogue between the transport community and the competition policy authorities.

The purpose of this paper is to present the activities of the Competition Bureau as they relate to the transport sector over the past two decades in order to provide an information base to help continue this dialogue. It is organized as follows: Section 2 outlines the regulated conduct defence; the competition enforcement activities which led to a successful conviction including criminal cases (Table 2) and civil cases (Table 3); and Table 4 provides a list of discontinued inquires. Section 3 describes the Bureau's regulatory interventions. Table 7 presents the number of these interventions by sector and the bodies to which these were made, respectively. Section 4 discusses the Bureau's policy development and advocacy activities related to transport. In Section 5 some emerging issues for transportation are discussed and the final section concludes with a summary and some observations.

Before proceeding with the above description, the importance of the transport sector is summarized below. In 1994, it accounted for $100-$115 billion, an amount equivalent to about 14 percent of total national output. Table 1 illustrates the relative size of various parts of the transportation sector. In 1995, the value of Canada's international trade in transportation services was $24.5 billion, approximately 10 percent of Canada's exports and about 3.5 percent of the total national output. In terms of employment, this sector employed 462,000 in 1995 or about 4 percent of the total work force employed in the industrialized sector. The magnitude of the above numbers illustrate the importance of this sector. However, its importance can be downplayed given the fact that nearly everyone needs some form of transportation everyday either in the form of schoolbus services or transportation services to work and nearly every product that one consumes or uses has been transported from one place to another.

2.0 COMPETITION ENFORCEMENT ACTIVITIES IN THE TRANSPORTATION SECTOR

In this section, the enforcement activities of the *Competition Act* related to transportation over the last two decades (i.e., 1976-1996) are reviewed. However, since transportation has traditionally been a regulated sector, the regulated conduct defence will first be reviewed, followed by criminal cases, civil cases, and merger cases with a brief mention of discontinued inquiries. Before these cases are examined, the applicable competition law to those cases will be briefly explained.

2.1 A Brief Digression - The Regulated Conduct Defence

The *Competition Act* is framework law which establishes basic rules for the conduct of businesses in Canada generally. However, the relationship between competition policy and economic regulation is governed by a doctrine known as the regulated conduct defence (RCD).[1] This doctrine provides a legal defence to individuals or corporations for conduct which would otherwise be a criminal violation of the *Competition Act* (i.e., *Act*) when that conduct is subject to valid federal or provincial regulatory authority.

Before the RCD applies four elements must be present according to the Competition Bureau's interpretation of jurisprudence: First, the relevant regulatory legislation must be validly enacted (i.e., it must be *intra vires* the responsible legislature). Second, the activity or conduct in question must not only fall within the scope of the regulatory legislation, but must also be specifically authorized by the relevant body.[2] Often the details of a regulatory regime are contained in its regulations or subordinate legislation. Third, the regulator's authority must be exercised for the defence to be applicable, mere passive acquiescence or tacit approval will not suffice to displace the application of competition law. Finally, before the defence will apply, a court must be satisfied that the activity that has raised concern will not frustrate the exercise of authority by the regulatory body.[3]

Since the RCD was developed in the context of the criminal law provisions, its applicability in the context of the non-criminal (i.e., civil) provisions of the *Act* is less clearcut. The view of the Competition Bureau is that:

> ...the courts may be willing to accept the enforcement of the non-criminal provisions (supported under the trade and commerce powers of the federal government), which prohibit certain anti-competitive conduct, a regulator might otherwise accept. In other words, judicial bodies may be more willing to accept the paramountcy doctrine once the criminal stigma is removed.[4]

It is worthwhile noting that in a recent case involving the Law Society of Upper Canada, the court accepted the regulated conduct defence in a civil case.[5] Nevertheless, it has been pointed out that the civil provisions may be concurrently applicable to particular conduct, along with relevant regulatory statutes. The issue of the applicability of the regulated conduct defence has not been completely resolved as some circles believe that its applicability should be further delineated according to whether the statute is federal or provincial, and that different tests may be applicable.

As far as the transport sector is concerned, the existence of exemptions and the application of the regulated conduct defence may limit the application of competition law in some important areas. If the criteria outlined earlier are met, to the extent that a statute specifically authorizes the key activities of transport agencies, it effectively puts them beyond the purview of the criminal law sections of the *Competition Act* due to the regulated conduct defence. This however should be interpreted with caution, for under appropriate circumstances, the Director could argue that they are not beyond the reach of the civil law provisions.

Related to the above doctrine is the concept of forbearance.[6] The issue is whether forbearance by a regulatory agency would render the regulated conduct defence invalid. It is believed that in such circumstances, the defence would no longer be applicable. The reasoning is largely based on the third reason given above when the defence is applicable, as in such a situation there is an explicit and unambiguous act by the regulator not to regulate. Principles of whether or not to forbear, for example, have been set out with regard to telecommunication in a recent decision. Experience with this new concept and jurisprudence on this matter will provide invaluable insights on how the RCD applies to such situations.[7]

We now turn to the enforcement activities of the Competition Bureau. In the case of transportation, the Bureau was involved in several successful criminal cases and merger cases, the latter under the reviewable provisions. In addition, a number of cases were discontinued involving the conspiracy provisions, the predatory pricing provisions, the resale price maintenance provisions, the misleading advertising and deceptive marketing practices provisions, the abuse of dominance provision, and the restrictive marketing practices provisions.

2.2 Criminal Cases

Over the period 1976-1996, the Bureau successfully completed twenty-one criminal cases related to the transportation sector (Table 2 and Table 5). Seven involved the conspiracy and bid rigging provisions (i.e., ss. 45/47/47(2) of the *Act* (or ss. 32/32.2 of the *Combines Investigation Act*, i.e. CIA)). One involved the monopoly section (i.e., s. 33 of the CIA) and thirteen involved false or misleading advertising or deceptive marketing practices (i.e., ss. 52(1)(a)/58(1)/57(2) of the *Act* or (ss. 36(1)(a)/37.1/37(2) of the CIA)). The above statistics do not include two ongoing cases, one involving contracts for transportation of Household Goods and the other involving Driving Schools in Sherbrooke. If the above statistics are examined by transportation subsector, eleven were in road (i.e., bus, truck and taxi), five were in air, and five were in the travel and tour subsectors. The law applicable to each case and some of the

interesting aspects of a case from each of the above sections will be briefly examined.

Conspiracy and Bid-Rigging: The key criminal provision of the *Act* is the conspiracy provision. This section (i.e., 45), makes it an indictable offence for any person to conspire, combine, agree or arrange with another person to prevent, limit or lessen competition unduly.[8] It does not prohibit any or all types of agreements outright, necessitating an assessment of the likely effect of the agreement on a case-by-case basis. The *Act* lists several defences from the conspiracy provision.[9] If the conspiracy relates only to the export of products from Canada, the conspiracy section does not apply provided that the conspiracy does not result in a reduction or limitation of the real value of a product or has restricted or is likely to restrict any person from entering into or expanding the business of exporting products from Canada or has lessened competition unduly in the supply of services facilitating the export of products from Canada. A conviction under section 45 could result in imprisonment for a term not exceeding five years or to a fine not exceeding $10 million, or both.

One such conspiracy case involved the transportation of used household goods. It arose out of an alleged conspiracy to prevent or lessen competition by five companies and two associations, and several others named as unindicted co-conspirators. On December 14, 1983, the five van lines and their tariff bureau pleaded guilty to conspiracy to lessen competition unduly in the interprovincial transportation of used household goods within Canada over a 17-year period starting in 1963. This is not surprising given the adverse impact of the conspiracy on the public and due to the fact that they controlled more than 85 per cent of the interprovincial moving industry after 1973. To remedy this situation the Court issued a Prohibition Order and imposed a punitive fine on the five companies of $250,000 to discourage such anticompetitive behaviour in the future.

There were a few noteworthy issues in this case. First, the Prohibition Order dealt with certain intra-van line activities although the charge in this case specifically related to joint van line action.[10] Second, the Canadian Household Good Carriers' Tariff Bureau Association was directed to cease operation - this has significant implications to policy makers and regulators in deciding the role of tariff bureaux. Finally, the order incorporated monitoring and educational provisions.[11]

Related to the above conspiracy provision is the bid-rigging provision (i.e., s. 47) which is illegal per se. Bid-rigging means an agreement or arrangement between one or more persons, where one or more persons agrees not to submit a bid in response to call or request for bids or tenders. Further the agreement is not made known to the parties calling for or requesting the bids or tenders at or before the time when any bid or tender is made by any person or

party to the agreement. It does not apply to agreements that are arrived at by affiliates.

An example of a bid-rigging case was one involving the supply of school bus services in the Regional Municipality of Peel in the Province of Ontario. An information containing one count under the bid-rigging provisions of the *Combines Investigation Act* was laid against: Charterways Co. Limited, Travelways School Transit Ltd., Lorne Wilson Transportation Limited, and Arthur Elen / School Bus Services.

One of the interesting issues that arose in this case was that the accused parties made an application to the Supreme Court of Ontario for the purpose of squashing the committal for trial on grounds that the authority calling and receiving the tenders should have known beforehand of the identical bids which were in fact submitted by the accused because of certain matters which they had allegedly brought to the attention of the tendering authority. This application was dismissed on grounds that there is an affirmative obligation upon those who join in such an agreement to affirmatively notify all those calling for the bid in some manner other than the production of identical bids.

Monopoly: Monopoly, section 33, under the *Combines Investigation Act* was a criminal offence. Under this provision, every person who was party or privy to or knowingly assisted in, or in the formation of, a merger or monopoly was guilty of an indictable offence and was liable to imprisonment for two years. The definition of monopoly was provided in section 2 of the above noted Act.[12]

With reference to the above provision, there was only one successful case in transportation that was brought forward over the period 1976-1996. A small sight-seeing tour operator in Vancouver alleged that Gray Line of Vancouver Inc., owned and operated by Pacific Northwest Bus Company Ltd. (i.e. PNBCL), was engaged in activities in order to establish a monopoly in the sight-seeing tour market in readiness for Expo '86. The evidence was referred to the Attorney General of Canada which led to an Order of Prohibition under subsection 30(2) against PNBCL.

The above Order contained a number of interesting terms and conditions. Some of these were: 1) The Court prohibited PNBCL from entering into any arrangements with any hotel or tourist attraction that prohibited the hotel from entering into contracts with the competitors of PNBCL; removing or interfering with the promotional and advertising material of competitors in the market; engaging in predatory pricing; and engaging in conspiracy to lessen unduly competition, or to prevent entry or expansion of a competitor; and 2) PNBCL was prohibited for a period of two years from the date of the order from acquiring the control of any competitor in the market or acquiring the sight-seeing licence authorities or substantially all the assets of any competitor.

Misleading Advertising / Sale Above Advertised Price / Failure to Supply Adequate Quantities: The misleading advertising and deceptive marketing practices provisions in sections 52 to 59 of the *Act* help to ensure an honest and effective functioning of the market. Representations which are false or misleading in a material respect are prohibited. Unsubstantiated performance and durability claims, misleading warranties and misrepresentations as to regular price fall into this category. Penalties include a fine at the discretion of the court or imprisonment for not more than five years, or both.

An example of a case involving the misleading advertising provisions was the Air Canada case. In this instance, five charges were laid on May 10, 1982 against Air Canada under paragraph 36(1)(a) of the *Combines Investigation Act* regarding misleading advertising about travel packages. The accused pleaded not guilty to four charges and guilty to one charge, nevertheless Air Canada was convicted on November 16, 1982 on all charges and fined $2,000 on each of four charges and $4,500 on one charge for a total fine of $12, 500. One of the noteworthy points in this case was that the judge ruled that though Air Canada was a Crown Corporation it was responsible under the law to the same extent and to the same effect as any other Corporation. A second matter of interest that the judge noted was though the advertisements were not false, they were misleading due to the failure to disclose a material truth.[13]

The *Act* also prohibits other deceptive marketing practices for example, double ticketing (where the higher of two prices marked on the product is charged), pyramid selling, sale above advertised price and bait and switch selling (when a product is advertised at a bargain price, but a reasonable supply of it is not available). Examples of the latter two that have arisen in the transport sector will be briefly described.

An example of a case involving sale above advertised price involved Great Lakes Airlines Limited of London, Ontario. In this case, one charge was laid on June 7, 1980 under paragraph 37.1 in the matter of airline tickets. The advertisement placed by the airline was more general in nature than what the airline had intended to offer buyers. The judge was of the opinion that though they may be an offence under section 36, he was of the opinion that the advertisement fell under section 37 as well, since the complainant was forced to pay a higher price than that advertised. The accused was convicted and fined.

In another case (involving failing to supply an advertised product in reasonable quantities), Air Canada was charged in May 1985 with failure to supply an advertised product in reasonable quantities in connection with a seat sale. The charge was dismissed in March 1986,[14] but that decision was reversed on appeal to the District Court of Ontario, which found that the trial judge had erred in several respects. Some interesting matters that the Court

pointed to was that inability to comply with the provision of subsection 37(2) is no excuse. Further, appearance of a disclaimer is not an adequate excuse for failure to provide reasonable quantities of the product. The accused was found guilty and fined.

Turning now to the civil reviewable provisions of the *Competition Act*, only one, the merger provision will be examined in greater detail.

2.3 Mergers

2.3.1 An Overview

The civil law provisions covering mergers (sections 92-107) are intended to control transactions that substantially lessen or prevent competition. The Tribunal shall not find that a merger or proposed merger prevents or lessens competition or is likely to prevent or lessen competition substantially solely on the basis of evidence of concentration or market share. In determining the matter, other factors such as whether a party to the merger is a failing business, the extent of foreign competition, barriers to entry, the extent of change and innovation in the market, etc. may be considered. These respond directly to such developments as the growth of foreign competition, the importance of innovation to Canada's future economic development and the need to facilitate the efficient restructuring of Canadian businesses. Further, an explicit exception for transactions that yield efficiency gains that will be greater than and will offset the likely anti-competitive effects of the merger is contained in the provision (see s. 96).

Since the new *Competition Act* was enacted, the Bureau has examined a number of mergers in transportation. These are shown in Table 3 for the period 1986/7-1996/7. Over this period 94 mergers were examined, i.e., approximately 8.5 per year. Mergers in transportation account for 4.5 percent of all merger transactions received by the Bureau over this period. In most of these mergers, the file was closed and the merger allowed; in a few advance ruling certificates were issued; and in some cases the merger was processed under the program of advisory opinion with the Director monitoring its effects. Only four of the mergers in transportation involved an application to the Competition Tribunal. If examined by sector, thirty-two were in air transportation, nine mergers were in rail transportation, thirty-three were in road transportation, eight were in water transportation, six were in pipeline transportation and six related to the travel or tour business. Perhaps, a much better overall picture would have been obtained if the civil merger provisions were in place before 1986, as much of the transportation industry began to anticipate regulatory change and to adjust to the possibility of deregulation. A few of the mergers will be reviewed in greater detail.

2.3.2 Mergers in Detail

The four merger cases involving Transportation that were brought before the Competition Tribunal were: a) Reservec/Pegasus; b) The Gemini Automated Distribution Systems Inc.; c) Seaspan; and d) CP/Cast. These are examined hereafter.

a) Reservec/Pegasus: On March 4, 1988, the Director filed an application with the Competition Tribunal challenging the merger of the Reservec and Pegasus computer reservation systems (i.e., CRS). The former was owned by Air Canada and the latter by Canadian Airlines International (i.e., CAIL). The merged systems would be operated by Gemini Group Automated Distribution Systems Inc. (i.e., Gemini), and owned by Air Canada and PWA Corporation - the parent of CAIL. Relief was sought in the form of dissolution of the merger or any appropriate order that the Tribunal saw appropriate.

On July 7, 1989, the Director requested the Tribunal for adjournment of the application seeking dissolution of Gemini and filed an amended application for a Consent Order.[15] This order which was later issued provides access to information to competing CRS and direct access links on a reciprocal basis to commercially significant CRS. The order also contains CRS rules which have general application to all CRS vendors and owning carriers who may be granted a direct access link under this order. The rules incorporate, in part, neutral display, non discriminatory access and fees, and provides a *per se* prohibition on tied selling between carriers and the CRS system which they own.

One of the interesting issues that arose in the case was the role that the intervenors would play. The Competition Tribunal by an Order limited their participation to presentation of argument on matters that affect them. This Order was appealed to the Federal Court of Appeal which confirmed that the Competition Tribunal has wide powers of discretion.[16] This decision was later confirmed by the Supreme Court of Canada.

b) The Gemini Automated Distribution Systems Inc.: On November 5, 1992, the Director filed an application under section 106 of the *Act* asking the Competition Tribunal to modify the Consent Order issued by the Tribunal in July 1989. The Director asked the Tribunal to provide for the early termination of a hosting contract which requires CAIL to keep its internal reservation system in Gemini at least till 1999. Due to the deterioration of the financial viability of CAIL, the Director alleged that the only alternative open which would not substantially lessen competition was a proposed transaction with AMR Corporation. Part of the transaction was the transfer of CAIL's internal reservation system to Sabre, the CRS operated by AMR Corporation's wholly owned subsidiary American Airlines, Inc.

The initial decision rendered by the Competition Tribunal in April 1993 indicated that it had no jurisdiction to grant the order sought.[17] However, it later reheard the matter addressing two issues: a) did the Gemini merger cause the likely substantial lessening of competition, and b) the appropriate remedy. In its decision, the Competition Tribunal concluded that the Gemini merger did cause the likely substantial lessening of competition and ordered the dissolution of Gemini by November 1994, in the absence of an alternative agreement by the parties. Air Canada, Covia and Gemini announced that they would appeal the Order, however it was later abandoned. The transaction between the AMR Corporation and CAIL, including the transfer of the latter's CRS, was completed in April 1994.[18]

An interesting aspect of this case was the decision by the Federal Court of Appeal on the matter of the Tribunal's jurisdiction to grant relief from an earlier order and to grant a new order. The Federal Court ruled that the Competition Tribunal had the jurisdiction to vary its earlier order in accordance with the terms of section 92. An appeal to the Supreme Court was later dismissed. This has important implications when the market situation changes or earlier orders are no longer relevant. It enables the Director to seek a new and more appropriate order.

c) Seaspan: On March 1, 1996, the Director filed an application with the Competition Tribunal with respect to two mergers. The application opposed both the October 1994 merger whereby Mr. Denis Washington, the owner of C.H. Cates & Sons Ltd., indirectly acquired a significant interest in Seaspan International Ltd. and the June 1995 merger whereby Mr. Washington purchased Norsk Pacific Steamship Company, Limited. The application alleged that the mergers prevent or lessen competition substantially in the provision of tug boat services used to berth ships in the port of Vancouver, and in the provision of wood chip and covered barging services in and around British Columbia's coastal waters. In this market, Cates had a virtual monopoly in the provision of ship berthing services in Burrard Inlet, the main portion of the Port of Vancouver for several years. As a result, the application sought interim relief to prevent the integration of the operations of Cates and Seaspan.

In September 1993, Seaspan entered this market bringing unprecedented competition. In June 1994, in response to the new competition Cates announced its intention to enter the Roberts Bank market in competition with Seaspan. The acquisition removed the only source of competition in the two markets. Given that entry into the market was difficult, that Seaspan was a dominant barging company in B.C and the acquisition of Norsk the third largest company in this market, the potential of Cates being a vigorous and effective competitor was removed.

On January 13, 1997, Acting Director of Investigation and Research under the *Competition Act* filed an application for a Consent Order. The terms of the proposed Order were agreed to by the parties. One of the interesting aspects of this Order was that the terms and conditions of the divestiture were framed with respect to the speed with which the divestiture was undertaken. Another issue was the question of whether alternative suppliers could enter the market from neighbouring areas. Regarding this aspect, regulatory barriers made entry from the US difficult, and entry from adjoining Canadian areas appeared unlikely to bring about alternative services.

d) CP/Cast: On December 20, 1996, the Acting Director of Investigation filed an application with the Competition Tribunal opposing the 1995 acquisition of Cast North America Inc. and related companies by Canadian Pacific Limited, its affiliates and subsidiaries. The two entities operate fully integrated intermodal container shipping service companies known as Cast and Canada Maritime. The application alleged substantially lessening of competition in the North Atlantic intermodal containerized shipping industry involving carriers operating between the Port of Montreal and ports in Northern Continental Europe and the United Kingdom.

On September 9, 1997, the Competition Bureau announced that it was seeking a stay of proceedings regarding its application. The application was filed in response to the planned entry of competing service in the market by a consortium consisting of Maersk Line, Sea-Land Service Inc., and P&O Nedlloyd Container Ltd. If the Bureau does not apply to the Tribunal to lift the stay by March 31, 1998, the complaint will be dismissed permanently.

This case had several interesting aspects. First, the stay of proceedings sought by the Director indicates that an application is not written in stone, if market conditions change or if the situation no longer warrants, the Director can seek a stay in proceedings. Second, an application can be made by the Director even if another federal agency approves the application. In this case, the Canadian Transportation Agency had approved the acquisition. This indicates that the regulated conduct defence may not necessarily hold in civil matters.[19] Third, the market was defined with regard to origin-destination pairs. In this case, the Port of Montreal and the Ports of Northern Europe and U.K.

In addition to the above acquisitions/mergers that were taken to the Tribunal, several other mergers were reported upon and details are found in various Annual Reports of the Director of Investigation and Research (for example, Paxport Inc. and T3LPCO Investment Inc./Transport Canada; Canada Post Corporation/ Purolator Courier Inc.; and Wisconsin Central Transportation Corporation (WCTC)/Algoma Central Corporation). The files were closed on most of these mergers.

2.4 Discontinued Inquiries

Besides the above successful criminal prosecutions and merger cases brought before the Competition Tribunal, discontinued inquiries also provide a measure of the activities undertaken by the Bureau. For the period 1976-1996, the Director discontinued 30 inquiries related to the transport sector (Tables 4 and 6). An investigation usually becomes an inquiry when the Director "believes on reasonable grounds" that a criminal offence has been or is about to be committed or grounds exist for the making of an Order by the Tribunal in a civil reviewable matter.[20] An inquiry is discontinued when the Director concludes that there is insufficient evidence to recommend to the Attorney General that charges be laid or, that an application be made to the Tribunal in a civil matter.

Of the 30 discontinued inquiries, eight involved road transportation, seven involved air transportation, five involved water transportation, one involved rail transportation, one involved multimodal transportation and eight involved the tour and travel business. The most important sections of the *Act* which were involved were false or misleading advertising (14), conspiracy (9), bid-rigging (1), price maintenance (1), predatory pricing (2), abuse of dominant position (2), and tied selling (1).

3.0 COMPETITION BUREAU'S REGULATORY INTERVENTIONS IN TRANSPORTATION

Another important activity, besides the enforcement activities examined in the previous section, is regulatory interventions by the Competition Bureau. Interventions have been instrumental in promoting competition in the Canadian economy in accordance with the objectives of the *Competition Act*, particularly in those regulated industries or activities which cannot be reached through the other provisions of the *Act*. In 1976, interventions were made possible under the then new section 27.1 of the *Combines Investigation Act* (now section 125 of the *Competition Act*). This section empowers the Director to make representations and call evidence before any federal board in respect of the maintenance of competition,[21] whenever such representations are relevant to a matter before the federal board and to the factors that it is entitled to take into consideration in determining the matter. The Director may also make representation at the request of a federal board or when he is directed to do so by the Minister of Industry.[22] An amendment made in 1986, also enables the Director to make representations at the request or with the consent of provincial regulatory boards.[23]

Since the above provision was enacted, the Bureau made 207 interventions between 1976-1996. Of these fifty-six interventions have been

made in the transportation sector or 27.05% of the total. These interventions are provided by sub-sector and regulatory agency in Table 7. This table indicates that in the air transportation sector, twenty-nine interventions were submitted to the federal regulatory board. Of these twenty-nine, twenty eight were on air passenger service and one was on air freight service; sixteen interventions were on road transportation of which twelve were in road freight, three in intercity busing and one in local taxi; eight interventions were made in the rail sector, three of these dealt with rail passenger service and five were on rail freight; two interventions were made in maritime transport; and one intervention was on transportation in general.

When these interventions are classified by the type of regulatory body to whom they were made, the statistics reveal that forty-one representations were submitted to various federal boards or bodies and fifteen to provincial boards or persons. Of the former, thirty-five were submitted to the Canadian Transportation Agency (formerly the Canadian Transport Commission and thereafter the National Transportation Agency of Canada), two to the House of Commons Standing Committee on Transport, and one to each of: the Standing Committee on Transport, the International Air Policy Committee, the Airports Task Force and the Royal Commission on National Passenger Transportation. Of the latter, five were submitted to the Manitoba Motor Transport Board; two to each of the following bodies: the Motor Carriers Commission of British Columbia, the Ontario Highway Transport Board, and the Alberta Motor Transport Board; and one to each of the following bodies or persons: the Québec Transport Board, the New Brunswick Motor Carrier Board, the Minister of Transport for Alberta, and the Ontario-Québec Rapid Train Task Force.

Generally, the issues addressed have included licence and access, rate/tariff, merger-agreement, regulation, policy, etc. However, in transportation these can be classified into two basic issues: licence or access, and regulations. Other issues that were at times addressed were merger-agreement and policy. These issues will be briefly examined hereafter.

Regarding the first, i.e., licence and access, the matter was addressed in 23 of the 56 interventions by the Competition Bureau. In submissions, on such matters, the Bureau sought to promote entry into various transportation modes. In several of these interventions there are statements by the Director to the effect that "Allowance of this application would offer consumers a competitive alternative to existing air services. This would be in keeping with the objective set out in the air policy statement of May 1984 of placing greater emphasis on the benefits of competition in the judging of public convenience and necessity."[24]

Regarding the second, i.e., regulations, the issue was addressed in fourteen interventions by the Competition Bureau. These submissions have

attempted to remove entry regulations, rate regulations and other economic regulations for example interswitching, confidential and secret rebates, etc. The basic thrust of these submission was to minimize or eliminate regulations so as to encourage the development and provision of new services and to facilitate the entry of new firms. In addition, many of these interventions argued that regulators should rely on competitive market forces as much as possible.

On other issues, submissions on policy addressed a wide variety of competition policy concerns including the implications of proposed policy changes. Here, the Director has generally advocated a free competitive regime in various subsectors of transportation and indicated the benefits arising to the public. On merger-agreement matters, representations have generally opposed the creation of monopoly or near monopoly situations or vertically integrated situations in particular markets and have stressed the potential harm to the public that could result from higher prices, a reduction of both output and its variety, etc. from a reduction of competition.

We now turn to the impact of these interventions in each of the sub-sectors in transportation. First, however it is worthwhile noting that due to the confluence of events, and fundamental changes occurring simultaneously, it is difficult to attribute changes in most industries solely to the interventions of the Director. Generally, the Director's interventions do not bring about change directly in an industry but assist in creating the conditions and atmosphere for change. Some of the changes that have occurred in each sector are described below, notwithstanding that they can be ascribed to several developments.

The most profound changes in *transportation* were witnessed in the last decade. For instance, there are several examples in air transport. In the early 1980s, the traditional distinction between national, regional, local and charter airlines was removed. There followed a period of "administrative deregulation" characterized by increasingly liberal interpretation of formerly restrictive regulations. The Director played a major role during this period by advocating deregulation of domestic airlines. He also supported applications of licences that would increase competition, in numerous instances. His efforts were usually successful as reflected in the decisions. As deregulation progressed, the late 1980s saw the rise of two large carriers (Air Canada and Canadian Airlines International) with alliances of smaller carrier families feeding into the hub and spoke networks formed partially by mergers, new authorities, amendments to add points, operating conditions, etc.

The rail subsector also underwent changes in which the Director played a role. He made submissions on interswitching and the Staggers Rail Act of 1980 which later led to establishment of a secondary interswitching zone, maximum interswitching charge, endorsement of confidential rates and secret rebates. Later he made comments on Transport Minister's paper *Freedom to*

Move. This paper led to important changes that were embodied in the *National Transportation Act, 1987*.[25] As result, railways have been able to bring about changes such as abandonment of redundant trackage, cutbacks in passenger service and rationalization of internal network.

Similarly, in trucking, structural changes have occurred including mergers, expansions, acquisitions, changes in the ranking of the top trucking companies, new entrants and changing traffic patterns between truckload and less than truckload. The NTA surveys on the trucking industry and qualitative estimates such as consolidations, changes in route structures and expansion of existing authorities designed to reduce interlining suggest an increase in overall efficiency. In this deregulatory process, the Director played a limited role before regulatory motor boards of various provinces in interprovincial applications, given his limited powers under the statute. When the opportunity arose, however, he did make comments to various bodies, using it as a general forum to advocate deregulation in trucking.

Finally, in water transport, several changes incorporated in the *Shipping Conferences Exemption Act,* 1987 reflected suggestions put forward in a 1982 submission by the Director before the Canadian Transport Commission. These included a statutory right of independent action on conference tariff rates and services, as well as limited provision for confidential service contracts between exporters/importers and carriers.[26] While it may be too early to tell, to date these statutory changes appear to have brought about only limited structural or behavioural changes.

In addition to the changes described above, decisions of regulatory bodies provide some proxy as a measure of contribution by the Director's interventions. Consequently, these decisions were examined to determine if the regulatory body accepted the arguments of the Director. Our examination revealed that of the fifty-six interventions made: thirty-six were favourable, nine were partially favourable, seven were unfavourable and four were withdrawn. This indicates that the Director's interventions were generally successful and quite effective. This observation also seems to have been emphasized by other writers who have pointed out that the Director has made important contributions and that his approach to competition advocacy has been marked with important successes.

Before concluding this section, perhaps, it is worthwhile inquiring whether there were any noteworthy or interesting lessons that one learnt from the interventions or the regulatory proceedings. As an overall observation, one can conclude that it is generally very difficult for a regulatory body to accept the Director's philosophy of competition if the climate for change has not been accepted by all. In other words, support for competition in the industry has not

been widely publicized and embraced, the regulatory body's traditional view will not change, i.e., it will initially reject competition.

Apart from this overall observation, there were a number of interesting issues that arose in the course of various proceedings. First, certain concepts evolved over time, for example the terms 'public convenience and necessity' was gradually interpreted to include 'competition' in air transportation. Second, the meaning of Provincial boards was clarified i.e., provincial boards also act as 'federal boards' in dealing with extra-provincial undertakings. Third, the Director advanced a dynamic meaning of 'maintenance'[27], a term used in section 27.1 of the *Combines Investigation Act*, which was challenged. This ultimately led to its removal from section 125 of the *Competition Act*. Finally, provincial motor boards placed a great reliance on 'demand for service' in deciding whether a licence should be granted in accordance with the interpretation of its statute.

4.0 COMPETITION BUREAU'S POLICY DEVELOPMENT ACTIVITIES RELATED TO TRANSPORTATION

In addition to enforcement of the *Competition Act* and formal submissions to federal and provincial regulatory bodies, the Competition Bureau engages in efforts to influence a variety of public policies, directly or indirectly. The policies it attempts to influence are very largely those of the federal government, but the Bureau also participates in the policy development activities of several international bodies, e.g., the OECD. These policy-related activities have had a long history in the Competition Bureau.

Policy development activities arise not only from the initiative of the Bureau, but also because its advice is frequently sought by others as they develop policy. Some policy-related actions are relatively formal while others are very informal. Some involve a substantial amount of resources, others far less. In some cases, the Bureau acts alone while in others it is part of a team within the federal government. The Bureau tries to choose those policy activities in which it has a comparative advantage, and where there is a reasonable chance of having a beneficial effect, consistent with the objectives of the *Competition Act*.

From a Bureau perspective, there are tradeoffs between devoting resources to policy development and spending those resources enforcing the *Competition Act* or intervening before regulatory bodies. While the advocacy of competition in the policy development process may consume current resources which could have been used enforcing the *Competition Act*, they may replace or reduce the need for enforcement actions or regulatory interventions in the future. They can also increase the responsibilities of the Bureau in terms of the amount

of economic activity which is subject to the *Competition Act*. The best example of this is where the Director has urged the CRTC to forbear from regulating certain activities in telecommunications.

The Bureau's policy development activities take several forms and occur in a variety of fora. Besides regulatory interventions described in section 3, these include: participation in intra-departmental policy-making (since 1994, the Bureau has been lodged in Industry Canada); participation in the federal inter-departmental policy process; providing comments to policy advisory bodies; participation in international bodies, e.g., OECD, various trade bodies; financial support for and diffusion of research (by grants to academics and others outside the Bureau, and by Bureau staff (some of which is used largely inside government, while other research is publicly disseminated)); and speeches and seminars. These are examined in further details hereafter.

Intra-departmental policy activities: The Competition Bureau is part of Industry Canada and participates in policy development with other parts of Industry Canada. While the Competition Bureau administers the *Competition Act*, Industry Canada is responsible for administering several other Acts. The latter has many more professional staff than the Bureau's, reflecting Industry Canada's wide-ranging responsibilities. As a result, the Bureau and other branches largely benefit from intra-departmental consultation. In some instances, coordination is required, e.g., where the Director is making regulatory interventions under s. 125. This is needed when the Bureau's pro-competition position could be at odds with an interventionist approach proposed by sector specialists in Industry Canada. However, the extent of the Bureau's involvement varies with the issue, the interests and the expertise of staff members.

Inter-departmental policy activities: Policy making is a collaborative process although the degree of involvement of particular departments and agencies varies across issues and over time. On a selective basis, the Bureau participates in the federal government's interdepartmental policy development process. This may include analysis, discussions and briefings regarding draft policy papers from other departments. The Bureau may also review and comment on Memoranda to Cabinet and draft bills.

The importance of inter-departmental activities stems from the different policy perspectives of different departments. It is not an uncommon belief that most federal regulatory agencies are very much concerned about the economic well being of incumbent firms. The Bureau, however, is much more concerned about the protection of competition in the market place than the protection of specific competitors. This frequently raises questions about access and barriers to entry. For example, the convergence of telecommunications and broadcasting has led to extensive rhetoric by the CRTC and officials in Industry Canada and Heritage Canada on the subject of "fair and sustainable competition." Effective

competition is frequently seen by incumbents as unfair. The tradition of regulated monopolies has not yet adapted to Schumpeter's "gales of creative destruction".

Providing comments: The Bureau also helps to shape public policy by appearing before ad hoc commissions or other bodies. For example, Bureau officers have appeared before Parliamentary Committees (i.e., the Standing Committee on Transportation and the House of Commons Standing Committee on Transportation) and Royal Commissions (e.g., Royal Commission on National Passenger Transportation). Further, the Bureau may respond to a public announcement. For example, it recently submitted comments on Amendments to the *Air Transportation Regulations* primarily concerning International Charter Air Services.

In addition, the Competition Bureau also regularly provides comments on research and reports by other government departments and agencies. On occasion and upon request, it comments on private sector research relating to competition matters where the Bureau has developed expertise.

Participation in international bodies: One of the more recent and growing policy-related activities of the Competition Bureau is its participation in international discussions involving competition matters. This has become particularly important as a result of trade liberalization. These international developments have led a number of countries to establish agreements with competitive clauses or to develop or amend their competition legislation extensively. For example, officials from the Bureau have participated on specific issues in the Canada-United States Agreement through interdepartmental work and industry consultations. Officials have also been active participants in the activities in the OECD and in other international fora. Canada's approach to antitrust has been seen as a model by other countries. As a result, many countries have been interested in the *Competition Act* and the Bureau has hosted delegations from other countries to explain how the *Competition Act* works both in theory and practice.

Research: The Bureau conducts its own research on a variety of policy matters, besides matters in which it has a permanent interest, for example, shipping conference, air transportation, trucking, etc. Much of this research is made available in Bureau publications and papers which are available to the public. Between April 1991 and fall 1996, Bureau officials have written or been co-authors of 38 competition policy-related papers dealing with such issues as the role of competition policy as a dimension of Canadian economic policy, applied aspects of competition law and policy, theoretical aspects of industrial organization, competition policy and intellectual property rights, competition policy and economic regulation, Canadian and comparative competition policy institutions, and international aspects of competition policy.[28]

It also provides financial assistance for academics conducting research on competition policy-related issues. For example in transportation, see the studies undertaken by I.A. Bryan and Y. Kotowitz, and William A. Jordan.[29] Some projects are directly related to interventions before regulatory bodies, some are related to current competition policy issues, and some are done in anticipation of future developments.

This research effort is strengthened by linkage to academic research through the annual appointment of an academic to the T. D. MacDonald Chair in Industrial Economics in the Bureau. These academics often provide ongoing advice to the Bureau in cases that require expert opinion.

Speeches and seminars: Senior personnel (particularly the Director) make speeches regularly to the business and academic community. These occasions are used not only to provide information about competition policy, but also to gain feedback. A number of these have been related to various subsectors in transportation. For example, in February 1983 the Director addressed the University of New Brunswick on economic regulation in transportation and the growing need for change, and in November 1983 he addressed the Canadian Transportation Research Forum's Annual Meeting on Motor carrier collective ratemaking in Canada. Again in May 1985, the Director addressed the Canadian Transportation Research Forum and recently (September 1994) he addressed the Board of Directors of the Canada Ports Corporation on the *Competition Act* and the Canadian Transportation sector in the 1990s.

The Bureau also sponsors/participates seminars and workshops (e.g., Canadian Transportation Symposium - Economic Regulations Can They Help Ensure Competitive Services). These not only help to diffuse the Bureau's own analysis and the research it has supported, but they also bring into the Bureau the ideas and analyses of others. Further, the Bureau regularly invites Canadian and foreign experts in the field of industrial economics and competition policy to provide seminars for staff members.

At a general level, in its policy development activities the Bureau urges federal and provincial governments to rely to the maximum extent possible on market forces supported by the application of the *Competition Act* to prohibit anti-competitive behaviour. That is not to say that there is no role for regulation in the economy, but rather that its scope and use should be narrowed to those instances where market forces and competition cannot be relied upon to discipline participants in the market place and to allocate resources efficiently. As long as there is no anti-competitive behaviour, competitors are expected to succeed or fail based on price, quality and service.

5.0 EMERGING ISSUES

Deregulation in transportation has increased the scope of activities that fall under the *Competition Act*. This increase in scope has unfortunately not been balanced by an increase in budgetary or manpower resources. As a few recent studies point out, the resources i.e., the operating budget has dropped by 21.6 percent in real terms and the person years have dropped by 36 or 14.8 percent from the mid 1970s and 1980s to 1995-96.[30] This makes it difficult to maintain let alone increase the dialogue between the Competition Bureau and the transportation community. However, the approach in this partially regulated environment now places an increasing emphasis on consultation, and comments or opinions between the Competition Bureau and other regulated agencies and compliance by other transportation industries. A number of issues that are expected to emerge in the near future will be briefly noted.

In the marine sector, there are a number of emerging issues. First, the *Shipping Conferences Exemption Act* (i.e. *SCEA*) continues to come under pressure for repeal or amendment. The National Transportation Act Review Commission noted that the exemption runs counter to the general policy of encouraging competition. The Commission was opposed to the intent of *SCEA* which is clearly in conflict with the overall competitive thrust of the *National Transportation Act, 1987*. The Commission recommended that the Minister of Transport introduce legislation to repeal the *SCEA* at such time as United States antitrust immunity for shipping conferences is withdrawn. Since the U.S. Shipping Act of 1984 is actively being considered for amendment, it is possible that SCEA will need to be revisited for possible amendments. Further, the Canadian Shippers' Council and numerous shippers' council throughout the world are calling for a repeal of exemption to liner conferences.

Second, the *Canada Marine Act* (i.e. *CMA*) is likely to have competitive implications that need monitoring. This legislation is intended to make it easier for ports to operate according to business principles, to enable the Minister of Transport to commercialize the operations of the St. Lawrence Seaway and to improve the way pilotage authorities and ferry services operate in Canada.

Turning to rail, problems associated with the movement of grain are likely to continue, similar to the problems that arose in the winter of 1996. As a result, the Minister of Transport is considering overhauling the legislation dealing with grain transportation. Consequently, the removal of maximum rates, the lack of competitive solutions and captive shippers may lead to a deregulation of grain movement.

Another issue that will likely attract attention is the restructuring of railways. Rationalization and accelerated abandonment made possible under the

provisions of the new *Canada Transportation Act* are likely to lead to more short line railways. These short lines have the potential for lower labour costs, increased productivity and enhancing competition. As a result, the competitive implications of conveying or selling these lines could raise concerns.

Related to the above are the competitive concerns posed by the U.S. railways. The recent mega-mergers between the railways in the U.S. have competitive implications for Canadian railways. Though these mergers have not yet been approved in the U.S. and though Canadian railways have reached tentative agreements with the emerging new railways, many of the implications have to be worked out and renegotiations may be involved.

In highway transportation, the intercity bus industry is still in the process of being deregulated. The Canadian Intercity Bus Task Force made an excellent attempt to bring about deregulation, unfortunately the problems have not been fully resolved. The Task Force stopped short of recommending full industry deregulation and this was unacceptable to provinces already committed to deregulation. In addition, the Task Force's recommendations to bring about charter bus and bus parcel express services have not been embraced by all provinces.

In addition to the above, alliances, mergers and acquisition between Canadian trucking carriers are taking place in order to expand service both within and between provinces and to other regions - i.e., U.S. and Mexican markets. In some cases, the companies integrate their information systems and share invoicing and inventory control. These alliances, mergers and acquisitions may have competitive implications in which the Bureau would likely participate.

Finally, in air transportation, the precarious position of Canadian Airlines International Ltd. could raise concern. The share prices of CAIL have once again risen on the Toronto Stock Exchange from its low reached in late 1996, and hopefully the crisis is over. Since CAIL is the only air carrier that provides competitive services to Air Canada, the competitive struggle between the two major airlines is likely to attract attention. If CAIL fails, resulting in the creation of a monopoly, the pressure to allow for cabotage in air bilaterals will increase to allow for competition. The competitive struggle is also likely to continue in the interantional arena over the international air policy which is expected to be reviewed. Basically, the concern is about the allocation of routes and destinations among domestic carriers in the Asian market.

In addition, amendments are being proposed to the international charter regulations together with a schedule of penalties. Since these amendments are likely to affect the extent of competition between scheduled and charter airlines,

it is likely to raise concern among charter airlines and tour operators and could draw the attention of the competition authorities.

Overall, a number of other matters have arisen from time to time that could have competitive implications. These are: cabotage in air bilateral agreements; global air alliances; foreign registry in shipping; container cargo imbalances in the Canada-U.S. movement; joint rates in intramodal competition; and finally whether the new provisions of the *CTA*, *CMA* and other transportation legislation are effective.

It is hoped that the major emerging issues that have competitive implications have been outlined. However, crystal ball gazing can at times be hazardous, and like predicting the weather, sudden changes and uncertainty are not uncommon as we have recently witnessed. Nevertheless, regardless of whether our forecasting is accurate or not, the Bureau is always interested in transportation matters with competitive implications that could arise.

6.0 SUMMARY AND CONCLUSIONS

The purpose of this paper is to outline the activities of the Competition Bureau in the Transport sector to continue a constructive dialogue between the Bureau and the transportation community.

This paper examines the three major activities of the Bureau in transportation over the past two decades (1976-1996). The three activities that the Bureau have been engaged in to a substantial extent are: Competition Enforcement; Regulatory Interventions; and Policy Development.

As far as competition enforcement, most of the twenty-one successful criminal cases were in the area of false or misleading advertising or deceptive marketing practices, followed by matters involving conspiracy or bid-rigging. One case involved a violation of the monopoly provisions. By subsector, eleven were in road transportation, five were in air transportation and five were in the travel and tour business. Regarding the civil provisions, the Bureau processed eighty acquisitions/mergers in transportation over the period 1986-1996. Of these, four were brought before the Competition Tribunal. Thirty additional inquiries involving criminal provisions of the *Act* were discontinued and the most important sections of the *Act* which were involved were false or misleading advertising and conspiracy.

In the area of regulatory interventions fifty-six interventions were made over the period 1976-1996. Forty-one of these were made to various federal boards and fifteen to provincial bodies. Most of these interventions were in air transportation, followed by road transportation and rail transportation. The issues addressed in interventions in various sub-sectors of transportation have

ranged from licence and access, rate/tariff, merger-agreement, regulation, policy, etc. These interventions have had a positive effect and have assisted in creating conditions and atmosphere favourable for change.

Less visible and although potentially as important as the above two activities, the Competition Bureau has also been involved in policy development activities. These include: intra-departmental policy activities; inter-departmental policy activities; commentaries; participation in international bodies, research and speeches and seminars. It is expected that activities in this area are likely to increase.

In conclusion, the transportation environment and the transportation industry have changed rapidly over the last decade. Deregulation has increased the scope of the activities of the Bureau. As a result, numerous issues that have competitive implications are expected to emerge and dominate the transportation scene. Some of these have been outlined such as: *SCEA* and *CMA* in water transportation; rail transportation of grain, ongoing restructuring of the railways and short lines, and the impact of U.S. rail mergers on Canadian railways in rail transportation; intercity busing, restructuring in trucking and competition from the US, and safety legislation in highway transportation; and the financial viability of CAIL, amendments to air regulations, cabotage and alliances in air transportation. It is hoped that the Competition Bureau can play an increasing role in assisting the transportation community including other federal agencies in constructing a more competitive transportation environment leading to greater efficiency and to the benefit of consumers and the industry. Greater co-operation and compliance with the competition laws can enable the Bureau serve the transportation community better and propel this sector into the new millennium. Together, not only can we make it a more productive, efficient and innovative sector but also a leading sector in the global economy.

ENDNOTES

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[1] For general background, see W.T. Stanbury, "How Wide the Ocean: The Regulated Conduct Defence in Canada," ***Antitrust Bulletin***, Fall 1984, pp. 577-604 and W.T. Stanbury, "Provincial Regulation and Federal Competition Policy: The Jabour Case," ***Windsor Yearbook Of Access to Justice***, Vol. 3, 1983, pp. 291-347.

[2] Some commentators argue that a general authorization will suffice. See, e.g., Lawson A.W. Hunter *et al*, ***All We Are Saying, Is Give Competition A Chance -- The Role of Competition Policy in Industries In Transition from Regulation to Competition*** (Paper presented at a Roundtable on the Competition Act, Ten Years On: A Stock Taking, University of Toronto Faculty of Law, December 8, 1995).

[3] This point was established in ***R. v. Canadian Breweries***, a competition law case. ***R. v. Canadian Breweries Ltd.***, (1960) O.R. 601, 126 C.C.C. 133, 33 C.R. 1, 34 C.P.R. 179. For example, in the *Charterways* case, school bus operators were charged with bid-rigging tenders to a Board of Education for school transportation services. At both trial and appeal, the application of the RCD was rejected on the basis that the bid-rigging offence prevented the provincial authority from exercising the power given to it to protect the public interest. ***R. v. Charterways Transport Ltd.*** (1981), 32 O.R. (2d) 791.

[4] Submission of the Director of Investigation and Research to the Canadian Radio-television and Telecommunications Commission re: Telecom Public Notice CRTC 92-78, ***Review of Regulatory Framework***, April 13, 1993, pp. 7-8, and Don Mercer, ***The Regulated Conduct Defence and the Telecommunications Industry*** (Ottawa: Competition Bureau, September 1995).

[5] Mercer, ***op cit.*** In this case, the applicants alleged that the Law Society's scheme which did not permit members from buying insurance competitively on the open market was contrary to the abuse of dominant position and tied selling provisions of the ***Competition Act***. The Court found that the ***Ontario Law Society Act*** contained specific authority to operate an insurance scheme and therefore the regulated conduct defence applied. The Director decided to not proceed with the inquiry even though it involved the civil provisions.

[6] Forbearance is an action whereby the regulator explicitly withdraws from regulation of a specific activity based on a determination on his part that such action serves best the purposes of relevant legislation. Forbearance starts with legislative authority to forbear, a determination by the regulator that the private actions of market participants serve the purposes of relevant legislation as well if not better than regulation. By forbearing the regulator refrains from certain forms of market intervention, he does not however abdicate or transfer responsibilities. Forbearance is reversible (i.e., if the regulator resolves that the assessment of market performance was wrong, or that changes in the marketplace no longer warrant a reliance on competitive processes, the status quo ante can be restored). Forbearance does not relieve the regulator from the duty of monitoring whether the forborne activities are carried out in a manner consistent with the relevant legislation. Further, forbearance may be conditional or unconditional, in whole or in part, it may apply to some sellers in a market or to all of them.

[7] For a further discussion see Stanbury, W.T., "Competition Policy and the Regulation of Telecommunications in Canada", in Stanbury, W.T. (ed.), ***Perspectives on the New Economics and Regulation of Telecommunications***, Montreal: Institute for Research on Public Policy, 1996, pp. 103-160.

[8] "Undueness" has been described by the Supreme Court of Canada as a serious or significant effect on competition as determined by a two stage examination. As a preliminary step, the relevant product and geographic markets in which the parties operate are defined. The first stage is to determine if the parties to the agreement have market power, which is the ability to unilaterally affect industry pricing. Market share alone, although a significant factor, is not sufficient to demonstrate market power; other factors, such as ease of entry, are also of importance. The Supreme Court has noted that possession of even a moderate amount of market power may support a finding of undueness. The second stage requires the court to look at the parties' behaviour to determine whether some behaviour likely to injure competition has occurred, or is likely to occur. It is a combination of market power and behaviour that makes a lessening of competition undue; particularly injurious behaviour may trigger liability even if market power is not considerable. About one half the acquittals in Canadian conspiracy cases are due to the Crown's failure to prove, beyond a reasonable doubt, that the effect of the agreement was to lessen competition unduly.

[9] These include cooperative arrangements relating to research and development, the exchange of statistics, product standards and other matters when it is unlikely to lessen competition in respect of prices, the quantity and quality of production, markets or customers, or distribution channels.

[10] Van line agents were given greater independence with respect to price and product competition formerly controlled through the van-line agreement. See ***Annual Report, Director of Investigation and Research, Combines Investigation Act***, 1984, p. 24.

[11] Monitoring related to access to various premises on 24 hours notice when the Director is not satisfied with any requested information in the order; and education related to in-house voluntary compliance programs and provisions for the Director or his representatives to address van line officers and directors annually for six years.

[12] The definition contained three aspects that often led to controversy: substantial or complete control; class or species of business; and detriment to the public. The latter aspect often proved the most troublesome. A situation however was not deemed to be a monopoly within the definition that resulted solely from enjoyment of any right or interest under the ***Patent Act*** or other Act of the Parliament of Canada.

[13] The advertisements failed to indicate that the holiday package deal could not be obtained during all months at the advertised price of $82 and that there was a $19 surcharge per day per room.

[14] An interesting point made by Judge Porter in *R. v. Air Canada* was his rejection of Air Canada's argument that the Court did not have jurisdiction to hear charges on the basis that the airline industry is a highly regulated industry. He noted that the *Combines Investigation Act* provides a direct forum for complaints that are by and large outside the rules and regulations addressed by the *National Transportation Act* and the *Aeronautics Act* and, therefore the *Combines Investigation Act* is not in conflict with these Acts.

[15] Before this event, AC and PWA Corporation announced a second merger between Gemini and a U.S. based CRS called Pars. The Director sought an amended application seeking dissolution to it and the parties to this merger later abandoned it.

[16] These include permitting full participation, right to discovery, calling of evidence and cross-examination.

[17] The Competition Tribunal indicated that had it the jurisdiction, it would have granted the relief requested. The Director and PWA Corporation appealed with respect to the Competition Tribunal's decision regarding jurisdiction, and Air Canada, Covia and Gemini cross-appealed with respect to the Competition Tribunal's decision regarding the Tribunal's conclusion.

[18] Gemini was reconstituted to form two separate companies: Advantis Canada and Galileo, the former owned by IBM Canada Ltd. and the latter by Air Canada.

[19] It should be noted that section 4 of the *Canada Transportation Act* specifically indicates that nothing in or done under the authority of the aforementioned Act affects the operation of the *Competition Act*.

[20] An inquiry can begin in two other ways: following a formal request by six citizens, or upon the direction of the Minister. See s.10 of the *Competition Act*.

[21] It is also worthwhile noting that the word 'maintenance' was deleted in the 1986 amendments.

[22] The legislation formerly referred to the Minister of Consumer and Corporate Affairs.

[40] Monteiro, Joseph, "Regulatory Interventions by the Bureau of Competition Policy," in Khemani, R. S. & W.T. Stanbury (eds.), ***Canadian Competition Law And Policy At The Centenary***, Halifax: Institute for Research on Public Policy, 1991, *451-461*.

[24] Intervention of the Director of Investigation and Research, In the Matter of an Application by Austin Airways Ltd. for Authority to Operate a Scheduled Air Service for the Points Kapuskasing, Timmins and Toronto, Ontario, Docket No. 6963.

[25] These were confidential contracts between railways and shippers, abolition of collective rate making by the railways, competitive access options by increasing interswitching limits and a streamlined rail abandonment procedure.

[26] These developments are discussed in detail in R. D. Anderson and S. D. Khosla, "New Canadian Legislation to Govern Shipping Conferences: Provision for Competition Within the Cartel System," ***Canadian Competition Policy Record***, Vol. 9, No. 1, March 1988, pp. 49-67.

[27] It was held to be more than retaining the present competitive *status quo*, i.e., increasing competition.

[28] For a list of these documents, see ***Annotated Listing of Economic and Policy Analysis and Research***, Competition Bureau, Industry Canada. Ottawa, 1996. This list can be made available upon request.

[29] Bryan, I.A., and Kotowitz, Y., ***Shipping Conferences in Canada***, Research Monograph No. 2, Research Branch, Bureau of Competition Policy, Consumer and Corporate Affairs Canada, 1978 and Jordan, William A., ***Performance of Regulated Canadian Airlines in Domestic and Transborder Operations***, Research Monograph No. 12, Research Branch, Bureau of Competition Policy, Consumer and Corporate Affairs Canada, 1982.

[30] See Stanbury, W. T., "Expanding Responsibilities and Declining Resources: The Strategic Responses of the Competition Bureau, 1986-1996," ***Review of Industrial Organization, (forthcoming)***.

TABLE 1 Expenditures on Transport (1994)

Item	($ b)
1. Private Passenger Travel (Motor vehicle purchase, repairs fuels and others)	48.4
2. Revenues of commercial passenger carriers (Air, intercity bus, intercity rail, urban transit, school bus, ferry and taxi)	13.4
3. Revenues for commercial freight carriers (For-hire truck, rail and marine)	19.9
4. Business spending on in-house transport (Private trucking, private marine and business car use)	12.5-19.5
5. Government spending, net of direct fees (Road construction and maintenance, subsidies*, other operations, and administration, less direct fees)	4.3-14.4
Total	98.5-115.6

Source: ***Transportation in Canada 1996***, Annual Report, Transport Canada, TP 13012E, p. 10.

TABLE 3 - Merger Cases in the Transportation Sector (1986-1996)

Section	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97
Mergers Commenced	40	146	191	219	193	195	204	192	193	228	
Transp. Mergers	6	7	7	9	12	6	12	7	12	3	13
Transp. Mergers as a % of Total	15	4.8	3.7	4.1	6.2	3.1	5.9	3.6	6.2	1.3	
App. to Comp Tribunal	0	1	0	1	0	0	0	1	1	0	0

Source: ***Annual Reports and the Merger Register of the Competition Bureau***

Table 7 - Interventions in Transportation by Sub-Sector and Agency (1976-1996)

Transportation	1976-1986	1986-1996	Total	Federal	Provincial
Passenger Air Transport	26	2	28	28	0
Air Freight Transport	1	0	1	1	0
Road freight Transport	9	3	12	1	11
Intercity bus	1	2	3	1	2
Local taxi	1	0	1	0	1
Railroad - passenger	0	3	3	2	1
Railroad - freight	5	0	5	5	0
Maritime transport	2	0	2	2	0
Transportation General	0	1	1	1	0
TOTAL	45	11	56	41	15

TABLE 2 - Convictions in Cases in the Transportation Sector (1976-1996)

Year	Name of Case	Section	Sector	Source*
		False/Mislead. Representation & Deceptive Mark. Practices		
1976	1. Voyageur Colonial Limited - Bus Fare	36(1)(a)/52(1)(a)	Bus Transportation	1979, p. 106.
1977	1. Atcan Travel Service Ltd (Ottawa, Ontario) Tour	36(1)(a)/52(1)(a)	Tour Service	1979, p. 103.
1977	2. Voyageur Colonial Limited	37.1/58	Bus Transportation	1979, p. 103.
1980	1. Skylark Holidays Limited. (Stephenville, NB)	36(1)(a)/52(1)(a)	Travel Tours	1986, p. 109.
1980	2. Henley Holidays Limited (St. Catharines, Ontario)	36(1)(a)/52(1)(a)	Air Transportation	1981, p. 92.
1980	3. Air Canada. (Edmonton, Alberta)	36(1)(a)/52(1)(a)	Air Transportation	1981, p. 92.
1981	1. The T. Eaton Company Limited and Eaton Travel Limited (Toronto, Ontario)	36(1)(a)/52(1)(a)	Vacations	1981, p. 102.
1981	2. Great Lakes Airlines Limited. (London, Ontario)	37.1/58	Air Transportation	1982, p. 101.
1982	1. Music Mann Tours Limited. (London, Ontario)	36(1)(a)/52(1)(a)	Bus Tour	1984, p. 114.
1982	2. Air Canada. (Toronto, Ontario)	36(1)(a)/52(1)(a)	Travel Packages	1983, p. 107.
1984	1. Travelways Tours Limited (formerly Trailways of Canada Limited. (Markham, Ontario)	36(1)(a)/52(1)(a)	Bus Tour	1985, p. 106.
1985	1. Air Canada.	37(2)/57(2)	Air Transportation	
1987	1. Value Vacations Limited (Toronto, Ontario)	36(1)(a)/52(1)(a)	Vacation cruises	1987, p. 127.
		Conspiracy		
1976	1. 'For-hire' Trucking -Western Canada	32(1)(c)/45(1)(c)	Trucking	1980, p. 55.
1977	1. Tax Cab Services - Chatham, New Brunswick	32(1)(c)/45(1)(c)	Taxi Transportation	1979, p. 63.
1978	1. Suppliers of School Bus Services. (Ontario)	32.2/47	School Bus Transportation	1983, pp. 47-48.
1979	1. Household Goods Removal Services	32(1)(c)/45(1)(c)	Trucking	1980, pp. 55-56.
1982	1. School Buses 32.2	32.2/47	School Bus Transportation	1988, p. 52 & 1989, p. 61.
1985	1. Wholesale Travel Agencies – Western Canada	32/45	Air Transportation	1985, p. 54.
1993	1. Wainwright Transportation	32.2/47	Bus Transportation	1994, p. 29.
		Monopoly		
1982	1. Gray Line Bus	33	Bus Transportation	1986, p. 57.

* Source: Compiled from *Annual Report, Director of Investigation and Research, Competition Act.* Note that the numbers before the slash in column three refer to sections in the *Combines Investigation Act* and numbers after the slash refer to sections of the *Competition Act*.

TABLE 4-Cases Discontinued or Acquitted in the Transportation Sector (1976-1996)

Year	Name of Case	Section	Sector	Source*
		False/Misl./Dec. Mark. Practices		
1976	1. Voyageur Colonial Limited - Bus Fare	37.1/58(1)	Bus Transportation	1979, p. 106.
1977	1. Robert Benjamin Naft (Town and Countrye Travel)	37(1)(b)/57(1)(b)	Travel Bonus Packages	1978, p. 80.
1978	1. British Airways Board (Toronto, Ontario)	36(1)(a)/52(1)(a)	Travel Arrangements	1980, p. 102.
1978	2. Strand Holidays (Canada) Limited (Ottawa, Ontario)	36(1)(a)/52(1)(a)	Cruise	1980, p. 103.
1978	3. Charter Class Airfares - National	37.2/59	Air Transport.	1978, p.. 63
1979	1. Wardair Canada (1975) Ltd. and International Vacations Ltd., carrying on business as Intervac (Malton, Ontario) Air Transportation	36(1)(a)/52(1)(a)	Air Transportation	1981, p. 97.
1979	2. Taxi Royal Radio S.O.S. (Enr'g) (Granby, Québec) Taxi service	36(1)(a)/52(1)(a)	Road Transportation	1980, p. 99.
1979	3. Wardair Canada (1975) Ltd. and International Vacations Ltd., carrying on business as Intervac (Toronto, Ontario) Air Transportation	37.2/59	Air Transportation	1980, p. 109.
1983	1. Snowbird Travel Ltd. (Nampa, Alberta)	36(1)(a)/52(1)(a)	Travel Tours	1985, p. 102.
1985	1. Eagle Air Tours Inc. [Jetlink] (Vancouver, British Columbia)	36(1)(a)/52(1)(a)	Air Transportation	1986, p. 118.
1987	1. Carousel Travel 1982 Inc. and others	36(1)(a)/52(1)(a)	Vacation Package	1987, p. 132.
1987	2. 314347 Ontario Limited - Talk Travel Tours and Larry Kleinmetz (Toronto, Ontario)	36(1)(a)/52(1)(a)	Vacation Package	1987, p. 127.
1994	1. Air Canada	36(1)(a)/52(1)(a)	Air Transportation	1994, p. 37.
1996	1. Travel promotion	36(1)(a)/52(1)(a)	Travel Vouchers	1996, p. 44.
		RPM		
1980	1. Trucking Rates -- Maritimes	38/61	Road Transportation	1984, p. 68.
		Conspiracy		
1979	1. Mass Ground Transportation, British Columbia	32/45 and 33	Road Transportation	1979, p. 69.
1980	1. Transportation of Valuables -- Québec	32/45 and 33	Road Transportation	1982, p. 56.
1980	2. Rate Discrimination - Port of Valleyfield	32/45	Water Transport	1980, p. 62.
1984	1. Container Shipping Services - Port of Montreal	32/45, 34(1)(c)/ 50(1)(c)and 33	Water Transport	1984, pp. 92-93
1986	1. Taxis - Vancouver	32.2/47(2)	Road Transportation	1986, p. 36.
1987	1. Airport Services	32/45	Air Transportation	1987, pp. 59-60.
1991	1. Clarke Transport Canada Inc. and others	32/45	Freight forwarding	1991, p. 37
1995	1. Travel Agent	32/45 and 38/61	Travel Agents	1995, p. 62.
1995	2. Tour Operators	32/45	Tour Operators	1995, p. 61.
1996	2. Ottawa Taxicabs	32/45, 33 & 38/61	Road Transport.	1996, pp. 17/47.
		Monopoly or Abuse of Dom.		
1988	1. Air Transportation products and air carrier leasing - Atlantic region	33 and 34/50	Air Transportation	1988, p. 56.
1989	1. Meat Shipping - Eastern Canada	79	Water Transport	1989, p. 20.
		Predatory Pr.		
1980	1. Multi-Modal Transportation Rates	34(1)(b), (c) and 31.4/77	Multimodal	1981, p. 55.
1987	2. Transportation Services	49/77	Rail Transp.	1987 p. 68..
1988	1. Container Shipping - North Atlantic	34/50	Water Transport	1988, p. 56.

* Source: Compiled from *Annual Report, Director of Investigation and Research, Competition Act.*

TABLE 5 - Convictions in Cases (non- Merger) in the Transportation Sector (76-96)

Section	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
Mis. Adv.																		
36.1/ 52(1)(a)(b)	1	1			3	1	2		1			1						
37.1/58		1				1												
37(2)/57(2)										1								
Conspiracy																		
32/45	1	1		1						1								
32.2/47(2)			1				1											1
Monopoly																		
33/79							1											

Note: The first number in column one refers to the provision under the *Combines Investigation Act* and the number after / refers to the provision under the *Competition Act.*

TABLE 6 - Cases (other than Merger) Discontinued or Acquitted in the Transportation Sector (1976-1996)

Section	76	77	78	79	80	83	84	85	86	87	88	89	91	94	95	96
Mis.Adv.																
36.1/52(1)(a)(b)			2	2		1		1		2				1		1
37(1)(b)/57(1)(b)		1														
37(2)/57(2)			1													
37.1/58(1)	1															
37.2/59				1												
38/61					1											
Conspiracy																
32/45				1**	2**		1*			1			1		2#*	1#
32.2/47(2)									1							
Monopoly																
33 or 79											1**	1				
Pred. Pr.																
34/50					1*						1					
49/77										1						

Note: The first number in column one refers to the provision under the *Combines Investigation Act* and the number after / refers to the provision under the *Competition Act.*
**Also section 33. **One case also involved section 33. *Also sections 34 and 33. #One case also involved section 38. #Case also involved sections 33 and 38. **Also section 34. *Also section 31.4.

"A Thumbnail sketch of writings on Canadian Transport History: 'Its Past and its Future?'"

By Michael Butt
&
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University of Manitoba Transport Institute
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Since Confederation and in fact up until the 1960s, Canadians have exhibited a peculiar fascination, a romance with transportation.[1] All throughout our history transportation's importance has grown as we sought to overcome the barriers of geography. The significant contributions that transportation networks subsequently made to Canada's development— the seaway system, road, rail and air systems— and its role in building both agricultural; and industrial bases, by now seems somewhat obvious. For Canadians 'geographic distance' is central to understanding our own past. As a consequence transportation has stood at the very century of the construction

[1] Probably the most famous of these popular historical works which celebrate the technological construction of a national identity is Pierre Berton's, *The National Dream: The Great railway, 1871-1881* (Toronto: McClelland and Stewart, 1970); and his, *The Last Spike: The Great Railway, 1881-1885* (Toronto: McClelland and Stewart, 1971).

of 'nation'.[2]

If for a particular period in our history transportation was central to our historical understanding of Canada's past, much has changed since these earlier times. Our fascination and romance with transportation seems to have long since passed. If anything transportation today in this country is in a state of crisis. A new national marine policy scheduled for implementation in 1996-97 was delayed reading in the House of Commons and the deadline has since expired. In the past year at least two major second tier air-carriers declared bankruptcy and have been either significantly restructured or abandoned. Our national highway system is in a poor state. For instance, in Manitoba while the provincial government currently collects $150 million annually in fuel taxes and ear marks a similar amount to put back into roads, the federal government pulls more than that out of the system in fuel taxes and returns roughly just four percent; the remainder is reallocated. The problems in Manitoba's transportation infrastructure are, unfortunately, representative of national trends. It is ironic that such an important part of Canada's past and potential future has been allowed to develop to such a sorry state.

To understand the current challenges facing Canadian transportation it is important to explore what has already been written about the subject. The following paper offers a thumbnail sketch in this direction highlighting some of the major accomplishments in the writing of Canadian transport history. It then turns to identify a number of gaps in the field and explores some of the reasons why transport history in general, suffered such a serious decline in popularity since the 1960s.

The paper suggests that the writing of Canadian

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[2]On the meaning of 'nation' and its construction see E.J. Hobsbawm, *Nations and Nationalism since 1780: Programme, Myth, Reality* (Cambridge: Cambridge University Press, 1990).

transport history has gone through several phases— and is mode dependent. In its earliest period it was linked to the construction of a national identity. It then became a focus for significant regional study and helped highlight some of the structural inequalities in this country. It was during this phase that Canadians' fascination with the subject also receded. Currently however, there are a number of developments within industry and outside it, which promise to bring new life to our thinking about transportation issues. These changes might have the potential to reinvigorate this field in the near future.

Transportation once enjoyed a favorable place in Canadian historiography. Indeed, by the 1950s, transport history had emerged as one of the richest bodies of writing in Canada.[3] It consisted of biographies, company studies, commission reports, and was often at the centre of historians' discussions of Canada's "national identity". Transport history seemed to satisfy both liberal and conservative interpretations of our place and destiny in North America and in the context of the North Atlantic Triangle. Some viewed transportation as an outward and practical extension of the basic tenets of American liberalism, "the belief that technology could liberate mankind from the frustrating bonds of nature and human frailty."[4] For these persons transportation had evolved to meet the needs of individuals and communities within the nation and complimented a perceived evolution in our political institutions. For conservatives transportation served as the link to Empire because our markets for overseas trade originated with Great

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[3]The standard introduction to transportation history in Canada is G.P. de T. Glazebrook, *History of Transportation in Canada* (Toronto: Ryerson, 1938).

[4]See A.A. Den Otter, *The Philosophy of Railways: The Transcontinental Railway Idea in British North America* (Toronto: University of Toronto Press, 1997) pp.10-11.

Britain.[5]

When the major focus of the writings of Canada's leading 20th century historians were not directly concerned with transportation, transportation's indirect influence in shaping the destinies of the industries and the events these authors explored remained central to the stories they told.[6] For instance, Donald Creighton's classic 1937 study *The Commercial Empire of the St. Lawrence: 1760-1850*, explored the role of the great waterway and its inhabitants in shaping business life in the 18th and 19th century mercantile economy. Like a Greek tragedy—a play in three acts, it was the river and the collapse of the British North American transportation network that killed much of the region's entrepreneurial spirit. More specifically Creighton argued that political encumbering and the severing of the waterway system ultimately stifled the natural course of the region's development and thus ended a chapter in its history.[7]

In addition to Creighton, one could turn to a number of other early Canadian historians, and find similar dialogues between transportation and economic activity. To a significant

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[5] See, F.H. Underhill, *In Search of Canadian Liberalism* (Toronto: MacMillan, 1960). Also see A.R.M. Lower, *This Most Famous Stream* (Toronto: Longman's, 1966). For the conservative view, see W.L. Morton, *The Canadian Identity* (Toronto: University of Toronto Press, 1961). On technology and Canadian political ideology see, Arthur Kroker, *Technology and The Canadian Mind: Innis/McLuhan/Grant* (Montreal: New World Perspectives, 1984).

[6] An important contribution to the writing of Canadian history is, Carl Berger, *The Writing of Canadian History: Aspects of English-Canadian Historical Writing Since 1900* (Toronto: University of Toronto Press, 1986).

[7] Donald Creighton, *The Commercial Empire of the St. Lawrence, 1760-1850* (Toronto: Ryerson Press, 1937). This view was also advanced in his *Dominion of the North: A History of Canada* (Toronto: MacMillan, 1944); and in his "The Decline and Fall of The St. Lawrence," CHA *Report*, 1969.

extent this early interest in transport-related history was the result of the influence of University of Toronto professor, Harold Innis. In the early 1920s Innis began studying the contributions British and American scholars made to understanding the patterns of national economic development. He began to apply their insights in his own studies, first in rail, then in the fur trade and cod fisheries.[8] In Canada, he presided over what is now considered the dominant economic school in the 1920s and 1930s. Influenced by the writings of Frederick Jackson Turner, the economic historian G.S. Callender (who was one of the first to explore the role of staple exports in undeveloped regions), as well as the Scottish geographer Marion Newbigin, Innis made new inquires in the development of young countries.

From Turner, Innis began to question what the 'closing' of the frontier had meant for Canada's resource-based export economy. From W.A. Mackintosh, an early Queen's University economist, who had studied at Harvard and was familiar with American scholarship, he learned innumerable lessons. In a 1922 paper Mackintosh had written "In the settlement of new countries ... one problem takes precedence over all others — the problem of discovering a staple product with a ready market. The world makes a path to the door of those regions fortunate enough to possess such a product, and all commodities of other countries are obtainable in exchange. ...So well do young communities understand this fact, that it is almost possible to write the history of the settlement of North

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[8] For Innis' major writings see his, *A History of the Canadian Pacific Railway* (London: P.S. King and Sons, 1923); *The Fur Trade in Canada: An Introduction to Canadian Economic History* (New Haven: Yale University Press, 1930); *The Cod Fisheries: The History of an International Economy* New Haven: Yale University Press, 1946); *Settlement and the Mining Frontier* (Toronto: Macmillan, 1936).

America in terms of the search for new vendible products...."[9] Mackintosh and Innis emphasized the determining force international markets had in the development of new economies. For Innis, in particular, overseas markets more than the closing of the Canadian frontier, the 'acquisitiveness' of Central Canada, and transportation links combined to make possible the extraction of staple exports."[10] His doctoral dissertation which subsequently became his first full-length work, a study of the Canadian Pacific Railway, had already reached many of these conclusions. In the decades since, both he and his students tested his theory's applicability in their studies of timer, the fisheries, and mineral resources. For decades, Innis' staple thesis explained Canadian economic history. It was through the staple thesis also that transportation emerged as a field of inquiry in its own right.[11]

While transportation was implicated in the very construction of 'national identity,' it also became important to the writing of regional histories. In Western Canada, historians and economists such as W.L. Morton and V.C. Fowke began, by the late 1950s identifying the origins of regional inequalities in the staple-based economy; in doing so they criticized the existing picture of national identity. They concluded that regional inequalities were shaped by a 'bias' in the political and economic organization of the country; existing transportation networks, tariffs, freight rates, had at key points in our past

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[9]W.A. Mackintosh, "Economic Factors in Canadian History," *CHR*, iv (March 1923), pp., 12-25.

[10]For transportation's contribution to staple production and economic development see Harold A. Innis, "Transportation As a Factor In Canadian Economic History," in his, *Problems of Staple Production In Canada* (Toronto: The Ryerson Press, 1933). pp., 1-17.

[11]The study of Transportation at Universities in Canada also owes a great debt to early agricultural economists.

favoured Central Canada. To Morton, moreover, this 'bias' was directly responsible for protest movements that emerged in the 1920s.[12] For Fowke the fate of Western Canada— one of perpetual dependence, was sealed by 1930 with the loss of preferential tariffs and favourable rates.[13]

By the 1960s, transportation had also become a key to understanding the regional inequalities that emerged in the Maritimes. The decline of shipbuilding in Nova Scotia in the late-19th century and the collapse of the Inter-Colonial Railway in the 1920s, were the result of economic policies that favoured Central Canada.[14] Again the result was regional protest. In sum, transportation issues had contributed to the fragmentation of our *collective identity*, as much as it had originally contributed to the building of one.

While transportation has figured prominently in both the national and regional histories, it was still largely bound by Canada's dominant liberal and conservative traditions. On occasion, however, scholars stepped outside of these boundaries.

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[12]W.L. Morton, *The Progressive Party of Canada* (Toronto: University of Toronto Press, 1950); also see his "The Bias of Prairie Politics," *CHR*, (1955).

[13]See V.C. Fowke, *National Policy and the Wheat Economy* (Toronto: University of Toronto Press, 1957).

[14]See George Rawlyk, "Nova Scotia's Regional Protest 1867-1967," *Queen's Quarterly*, (1968); C.M. Wallace, "The Nationalization of the Maritimes," in J.M. Bumsted., ed., *Documenting Problems in Canadian History* (Georgetown: Irwin-Dorsey, 1969); J. Murray Beck, "The Maritimes: A Region or Three Provinces," *Transactions of the Royal Society of Canada*, 1977; David Alexander, "New Notions of Happiness: Nationalism, Regionalism and Atlantic Canada," *Journal of Canadian Studies*, (1980); Ernest Forbes, "The Origins of the Maritime Rights Movement," *Acadiensis*, (1975) and his, *The Maritime Rights Movement 1919-27* (Montreal: McGill-Queen's University Press, 1979); A.G. Bailey, "Railways and The Confederation Issue in New Brunswick," *CHR*, (1940); T.W. Acheson, "The National Policy and the Industrialization of the Maritimes 1880-1910," *Acadiensis*, 1972.

For instance, H.Clare Pentland, a distinguished Marxist scholar, had begun by the late 1950s to examine the process of capitalist development in Canada. Specifically, he was interested in the structure of the early labour market: he examined workers lives. In his doctoral dissertation he explored the contributions Irish canal workers made to the early development of the St. Lawrence system . He studied migration patterns of these immigrants, their wages and working conditions in canal building and the relationship between labour and capital in a series of economic settings. To Pentland, canal workers represented Canada's first industrialized proletariat. They were also among the earliest immigrants to challenge the new industrial discipline.

Pentland's dissertation was a turning point in Canadian history because of its labour focus, but it also signaled the need for a reconsideration of transport history through its exploration of the lives of canal workers. For many years his thesis earned an underground following in Canada, but it remained unpublished until 1981. The questions he asked and the way he thought about workers' lives breathed new life into an old profession. Exploring workers' lives in any field in Canadian history remained uncommon in the 1950s and 1960s and transport was no exception. Until the mid 1970s there were few, if any, studies in Canada that asked similar sorts of questions. Almost none explored the life of the early transport worker.[15] The full influence of Pentland's work, however, would not be felt until the 1980s.

The writings on Canadian transport history have a

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[15] A notable exception was Rosemary Ellen Speirs, "Technological Change and the Railway Unions, 1945-1972," Ph.D. thesis, University of Toronto, 1974. A few years early Stanley B. Ryerson, a member of the Canadian Communist Party, had written about railroad workers in, *Unequal Union: Confederation and the Roots of Conflict in the Canadas, 1815-1873* (Toronto: Progress Books, 1968).

series of nuances particular to each of the modes. For instance, some of the early rail studies dealt with workers in the building and operation of the railroads but for the most part, their lives had remained peripheral to the 'main story', the financiers, rail magnates and politicians responsible for overseeing their completion. It was not until 1974 that Canadians had their first dissertation on these workers. Probably one of the earliest actual accounts of a railway worker's life, however, arrived much later with the Canadian Committee on Labour History's (CCLH's) publication of an autobiography of R.E. 'Lefty' Morgan. This study was in keeping with the direction that social history as a field was taking. It addressed the question of 'human agency' in terms of its subject matter by recovering a lost voice. Needless to say, it offered an approach that reveals many of the strengths as well as some of the limitations in the current generation of labour scholarship in Canada. Still, on balance, it fills an important gap.

In the 1980s sailors and waterfront workers commanded some significant attention in Canadian historiography. Along with a plethora of articles, two major studies were published in this area that dealt with the life of these transport workers — one at the beginning and a second towards the end of the decade.[16] Maritime history, in general, through organizations like St. Johns' Maritime History Research Group and the Institute of Social and Economic Research, under the early direction of historian David Alexander and more recently Rosemary Omar, flourished during this period. In addition, its journals like *Acadiensis*, contributed many of the greatest advances that have been made in the 1980s in transport and economic history.

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[16] See for instance, Judith Fingard, *Jack in Port: Sailortowns of Eastern Canada* (Toronto: University of Toronto Press, 1982); also see Eric W. Sager, *Seafaring Labour: The Merchant Marine of Atlantic Canada, 1820-1914* (Kingston and Montreal: McGill-Queen's University Press, 1989).

Historians specializing in Maritime transportation in the broadest sense have studied women in the industry and have looked at their contributions to family income and the relations between market and household economies. It has become evident in the 1990s that the same progressive and stimulating work already done in Maritime studies cannot be claimed by the other modes. We need to continue or in a number of instances begin to study the cultures, the family lives and the nature of the work performed by many of these transportation workers. We need to examine their industries and their influence upon the community. Both their economic contributions these workers made, their demands, as well as their voices in the innumerous communities need to be reclaimed and brought into the Canadian picture.

While the broader transportation field has left an indelible mark in our national historiography, study of the highway transportation industry in particular, went entirely undeveloped in Canada, outside of industry journals and trade magazines. Basic questions about the industry— the composition of its workforce, the evolution of its employer associations and government bodies, for instance, have not been explored. Nor have the kinds of policy questions that one might expect— been addressed. In each area of its history, highway transportation has received none of the interest given other modes, water, rail or air transportation. For instance, its provincial trucking associations were established in the 1920s and 1930s, but to date only British Columbia, Manitoba, and Ontario have provincial histories. These are commemorative in their approach, and while they serve as a good starting point, they offer little insight into the nature of the industry. Similarly, the parent organization formed in the late 1930s, the Canadian Trucking Association (CTA), has also missed its historian. In terms of policy, the most important change this century in federal and in many instances provincial policy formation took place in the late 1980s with the passage of the National

Transportation Act (1987). This act is similar to the Motor-Carrier Act which in the United States passed in 1980. Deregulation in Canada in both its intra-provincial and extra-provincial form, which within industry immediately became the focus of considerable debate— elsewhere seemed to have gone virtually unnoticed.

There are similar deficiencies at the regional and local level. There are no company histories, union studies, or studies of the type of work that drivers, dockworkers, or that terminal employees performed. In general, the labour process is not understood, nor has the arrival of new technologies and their implications for the industry been adequately assessed. It is almost unthinkable that in the late-20th century Canadians understand less about how 70 percent of their non-bulk commodities and goods get shipped from their point of production to final destination— then they did much earlier in the century.

Despite some of the new inroads made in the field— it seems clear that the failure to study highway transportation must be linked to the broader, more general demise of transport history in Canada since the mid 1960s. In part, transport's decline seems to have coincided with the emergence of a number of new approaches to the writing of history. On the one hand the decades-old staples approach in Canadian economic history seemed less relevant with the rise of manufacturing and the coincident growth of a number of other major forces that re-shaped the economy. As a theory, it was also slowly being overturned (although not entirely). Some claimed it had lacked the theoretical foundation which many of its supporters had celebrated. In the 1960s a few of its critics tried to provide it with a new theoretical basis. The impetus had come from the empirical work of M.C. Urquhart, K.A.H. Buckley, O.J. Firestone and P. Hartland. The importance of understanding Canada's economic growth in terms of its "steady diversification around primary resource industries" was what

some scholars like G.W. Bertram, for instance still considered most important.

As Mel Watkins points out it was possible to "...recast the staple thesis in terms of a Keynesian mulitplier-accelerator model." Still other work on the staple thesis included Richard Cave's 'vent-for-surplus' model which 'placed the staple thesis in the context of a traditional neo-classical growth theory.' The staple approach ultimately receded after 1967 with the publication of E.J. Chambers and D.F. Gordon's 'Primary Products and Economic Growth," which signaled a new economic history in Canada.[17] With the declining importance of the staple thesis a similar severing occurred in the traditional ties to transport writing. This was one outcome of the changes within the economic history discipline. Not only had the national histories become a 'thing of the past' by the late 1960s, but the recasting and receding staple approach was also killing the desire to pursue transport history.

Another change taking place in the 1960s was the decline of what in retrospect could be considered 'traditional' transport history (i.e. biographies, company studies, studies of the structure of the industry and government policy). This trend commenced just as for-hire carriers were beginning to be recognized for their importance nationally in the economic life of the country. The growth of the for-hire carrier industry coincided with social history's rising popularity within the discipline. As the new analytical approach and as the new questions it posed began to displace the traditional approaches to writing history in the 1970s one of its first casualties seemed to have been an institutional overview of the highway transport mode. In essence, in forcing a generation of historians to 're-

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[17] For this discussion, I have benefitted substantially from M.H. Watkins and H.M. Grant's "Introduction," in their collection of essays, *Canadian Economic History: Classic and Contemporary Approaches* (Ottawa: Carleton University Press, 1993), pp., xi-xiii.

think' what mattered in telling the story of Canada and its peoples, an institutional study of the highway transport mode in particular, fell by the wayside.

If it was to be expected that in their efforts made to overturn traditional history, social historians avoided institutional transport studies in the 1960s and 1970s, it is perhaps more difficult to understand just why among 'traditional' practitioners there appeared little interest in studying the motor-carrier industry? After all, collectively they still remained the dominant force through the 1970s. One possible explanation, for the absence of a sustained highway transport literature, is that the 'trucker' and the company owner both lacked the grandeur, the splendor, and political intrigue of the railway magnate, the great ship owner, or of the successful airline entrepreneur. As a result there was little desire to develop a historiography similar to the one that had emerged in the study of rail. Truckers who built companies from small beginnings made poor substitutes for the late-19th and early-20th Century nation builders with their overseas connections to banks, high finance and major political figures. Furthermore, highway transport failed to cut into the Canadian landscape and reshape regions to the extent that rail did. Although this argument is valid, it has also become increasingly less so since the 1950s. By the early 1960s, 'trucking' in Canada was already big business, and transportation in general, played an increasingly significant economic role. Perhaps, it can be asserted, that a diminishing role for rail and an increased role for highway transport might in fact have offered a new and fresh interpretation of Canadian history that was more in step with the realities of the second half of the 20th Century?

The most likely answer to why so little has been done on highway transport would appear to be that by the time the mode was firmly embedded in the national landscape, our imagination, our romance for transportation in general, had all but collapsed. Transportation had increasingly become removed

from our collective identity as Canadians. As we moved into the suburbs by the 1950s, we no longer felt that the possibilities for economic growth, nor that our 'promised' future was necessarily linked or even remotely associated with our transportation system. In fact, by this point we already believed that we had a mature transportation network fully developed. If anything our transportation industry was tending towards a state of excess or over-development. The last great transportation feat Canadians had accomplished, and particularly the last one directly associated with the 'land,' was the completion of the Trans-Canada Highway. Even it however, had none of the awe, or fascination, of other modes in their geographic and spatial relationship to communities. With the completion of the Trans-Canada Pipeline, the Trans-Canada Highway, the St. Lawrence Seaway— our attention turned elsewhere, and in abandoning our romance with 'our' land, staples, and development, we abandoned our romance with transportation and looked elsewhere to redefine ourselves.

In the writing of Canadian transportation history, we have gone from exploring its role in the construction of a national identity and in the building of a nation— to its identification and links with regional identities and similarly its regional inequalities. Most recent, since the 1960s, there has been a considerable unevenness in the development of the field as a whole. In the future, however, as we turn to re-examine our transportation industry in Canada and its history both past and present— what once seemed overdeveloped, and fully mature, will again appear undeveloped. This seems particularly true since NAFTA (good or bad) and with the rise of a series of new continental corridors, superhighways, hubs and gateways inventing and reinventing themselves. In sum, the timely abandonment of a great national mythology, a technologically-driven boosterist ideology, should in no way deter us from

studying transportation and its role in the economy.[18]

[18]The authors would like to thank Dr. Barry E. Prentice for his insightful comments. An early sketch of this paper was presented by Michael Butt at the Great Plains History Conference in October 1997.

"Canadian Civil Aviation History: Nationalism, Modified Competition, and the rise of a 20th Century 'Competitive Age Ideology'"

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Introduction

A new 'language of consumerism' entered transport debates in the House of Commons in the early 1980s. Providing consumers with 'choices' became a focal point of Canadian policy response to global competitive pressures. To an extent, the appeal to 'consumer interests' was tacit recognition that Canadian transportation policy was following policy initiatives in other countries, particularly the United States. However, the policies of the 1980s also had their roots in an earlier process of liberalization — designed to strike a balance between traditional social goals of transportation policy and the new realities of a rapidly changing industry and world — which, once initiated, could not be stopped.

By the early 1990s, liberalization had come to mean wholesale deregulation (or re-regulation) of the industry, with a substantially reduced role for government. Federal regulatory bodies were completely revamped, new agencies were established while others ceased to function. In the process, safety— which had always been important— became *the* primary focus of government involvement in industry. In other areas, 'consumer interests' became the dominant concern and set the parameters of future debate. Indeed, transport issues are now rarely debated in terms of the role of private versus public operation of services.

Few studies of Canadian transport policy have explored the historical antecedents of the consumerist ideology of the 1980s. This paper, therefore, examines the evolution of Canadian civil aviation policy, from the 1920s through the early 1980s, in an attempt to account for how we arrived at this 'new' period in policy. In particular, it focuses on the role of key politicians who set the agenda and who outlined the major policy shifts in House of Commons debates. While politicians' speeches are only one source on the

policy-formation process they best illustrate the major themes in the evolution of policy.[1]

In addition to the House of Commons debates, the paper is influenced by a paper presented at a Conference on Canadian Transport Policy held at York University in May of 1972.[2] It described the evolution of transport thinking in Canada, particularly as it applied to the railway mode, in terms of a perennial conflict between "the ideals of efficiency (or competitive efficiency) and the use of transport (especially railways) as a policy tool." Rather sensibly the author concluded that, in the case of rail (which was, of course, the cornerstone of transport policy), "neither approach has been fully successful..."[3] Furthermore, the author contended, a 'Railway Age Ideology' (RAI) had come to dominate transport thinking up until the 1960s. This line of reasoning would seem applicable to the evolution of other modes of transport in Canada, including civil aviation.

The Origins and Rise of Canadian Civil Aviation Policy, 1919-39

The development of Canadian civil aviation owed a great deal to wartime technological advances and training.[4] By the end of the war civil aviation was considered an essential element in policy initiatives to advance the interests of Canadian nationalists. Following the Imperial Conference in 1919 the Canadian government passed the Air Board Act, which made Cabinet responsible for overseeing safety regulations on the advice of the newly-established Canadian Air Board (1920). In 1923 these responsibilities were transferred to the Department of National Defense (DND).

In 1936, the Department of Transport was established, under which

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[1] On actors and processes, see Garth Stevenson, *The Politics of Canada's Airlines: from Diefenbaker to Mulroney*, Toronto, University of Toronto Press, 1987, pp., 202-206.

[2] See Howard J. Darling, "Transport Policy in Canada: The Struggle of Ideologies versus Realities," in K.W. Studnicki-Gizbert, *Issues in Canadian Transport Policy*, Toronto: Macmillan of Canada, 1974, pp., 3-46.

[3] K.W. Studnick-Gizbert, *Issues in Canadian Transport Policy*, pp.,vii-ix.

[4] Philip Smith, *It Seems Like Only Yesterday: Air Canada The First 50 Years*, Toronto: McClelland and Stewart, 1986, p.12.

Air Services Division became responsible for administrative tasks and the Board of Transport Commissioners became responsible for regulatory aspects. What is particularly unique about these developments, one author has concluded, was that they had developed so smoothly and continuously — "in advance of the development of airline services."[5]

In this period airline services consisted of a substantial number of independent outfitters — small bush-pilots and local one, two or three-plane operations. In fact, this pattern of development was the same in many cities, towns, and municipalities across the country.[6] Max Ward, an industry pioneer, later recalled, "that the most exciting people around were the bush pilots, who were always in the news with stories of their exploits."[7] They were such the stuff of legend, that one chronicler of this early period concluded: "[the] history of the airline business, particularly in North America, is really the story of the men who — with their enthusiasm, their energy and their sometimes romantic notions — built and operated the airlines."[8]

In comparison to European countries, Canada was a relatively late entrant to the world of state-owned and operated airlines. Although provincial air service operations began to emerge (first in Ontario in 1924), for the most part they remained on the fringe of the industry.[9] By the time of the Great Depression, however, there was a growing need for some control and regulation over the industry. In the case of the airlines, bush pilots and small frontier air carriers were constantly complaining that the government "did nothing to

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[5] David Corbett, *Politics and The Airlines*, Toronto, University of Toronto Press, 1965, p.33.

[6] See for example, Frank H. Ellis, *In Canadian skies: 50 Year of Adventure and Progress*, Toronto: The Ryerson Press, 1959; P.H. Godsell, *Pilots of the Purple Twilight: The Story of Canada's Early Bush Pilots*, Toronto: The Ryerson Press, 1959.

[7] Max Ward, *The Max Ward Story: A Bush Pilot in the Bureaucratic Jungle*, Toronto: McClelland and Stewart, 1991, p.12.

[8] Wayne Skene, *Turbulence: How Deregulation Destroyed Canada's Airlines*, Toronto: Douglas and Mcintyre, 1994, pp.,4,9.

[9] Smith, *It Seems Like Only Yesterday*, p.13.

prevent cut throat competition among them."[10] The lack of policy, it was argued, had contributed to a number of deaths and untold accidents because pilots ran services and filled planes with cargo beyond capacity in an effort to survive. At the same time it was recognized that there was a need to push ahead with an airport infrastructure program, specifically to establish aerodromes across the country at 100 mile intervals.

A key figure in the effort to increase government regulation of aviation in the 1920s was John Armistead Wilson, a Scots-born engineer turned civil servant who had helped frame the countries first air regulations. As Controller of Civil Aviation Wilson promoted men in the CPR and CNR who he thought could well serve the fledgling airline industry in a joint venture.[11]

In the mid 1930s, Canadian transport policy was substantially under the control of two individuals — W.L.M. King and C.D. Howe. King's philosophy of government was one that gave it an over-riding responsibility to something called the "community" which was greater then the sum of its parts. Applied to industrial relations, his philosophy was influential in the creation of a tripartite board responsible for balancing industrial disputes in favour of the public good. From King's own experience, the philosophy was equally applicable to other industries including transportation.[12] In government and in industry there was a key role for the manager and the expert.

Immediately following the October 1935 election, King moved to establish a new Department of Transport portfolio combining those of Railways and Marine. It was not at all surprising that he selected Clarence Decatur Howe, an Engineer and successful businessmen, to create the new department. Howe was a rationalist who, as his biographers suggest, was willing to allow a major role for government influence in the economy, a view he shared with King.[13] He was also a tested policy veteran, having helped create three major pieces

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[10] Corbett, *Politics and The Airlines*, p.36.

[11] Smith, *It Seems Like Only Yesterday*, p.11; on Wilson's role see esp. pp.,11-20.

[12] W.L.M. King's training and his philosophy on government is the subject of considerable enquiry in Paul Craven, *'An Impartial Umpire': Industrial Relations and the Canadian State 1900-1911*, Toronto: University of Toronto Press, 1980.

[13] Robert Bothwell and William Kilbourn, *C.D. Howe: a biography*, Toronto: McClelland and Stewart, 1979, p.66.

of legislation — the National Harbours Board, the CBC and the establishment of the modern structure of the CNR, pulling it out of its bankrupt status, a position it had succumbed to in 1932. In each instance Howe made a case for the principle of the independent crown corporation, which he described "...as a publically owned enterprise, but not directly part of the civil service. It was to be managed as efficiently, absolutely and aggressively as if he himself were the private entrepreneur at the head of it, and no nonsense about politicians meddling with the management."[14]

Howe was joined by the Minister of National Defence and the Postmaster General in a cabinet subcommittee to develop air policy. The government's first decision was to transfer civil aviation from Defence to the new Department of Transport. Then in the summer of 1936 the Department turned its attention to the establishment of a national airline, Trans-Canada Airlines (TCA). The passage of the TCA Act in 1937 established a publically-owned national scheduled charter service and a policy of "cross-subsidization."

By the late 1930s Canadian civil aviation and transport policy in general, and been firmly established. A new department had been created, centralized and brought under the control of a single and powerful cabinet minister in Ottawa. Learning from the lessons of the railways, the government wanted to chart a new course in airline policy. Centralization, fostering a trans-national identity and a high degree of public control became the foundation of Canada's national civil aviation policy. The government's underlying philosophy, influenced by King and Howe, was a passionate concern with community interests and an over-riding faith in the experts and managers responsible for implementing policy.

Formation of a Postwar Civil Aviation Policy

Postwar civil aviation policy for both domestic and international services was worked out by King and cabinet during 1943 and 1944. As a result of the effects of the Depression and the subsequent conversion of industries to wartime production (including the removal of men for overseas service), it was decided to amalgamate ten air carrier service operations, including Richardson's, into the Canadian Pacific Airlines Limited (CPAL) under CPR control. This action and earlier battles over the TCA prompted demands for a clearly defined government policy which King made on 2 April 1943. This policy statement, which served as the cornerstone of government

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[14] Ibid., *C.D. Howe*, p.97.

policy up until 1957, made two main points. On international service, King stated that "the government sees no good reason for changing its policy that Trans-Canada Air Lines is the sole Canadian agency which may operate international air services." On domestic service, he stated that "competition between air services over the same route will not be permitted whether between a publically owned service and a privately owned service or between two privately owned services. There will remain a large field for the development of air transport in which private Canadian companies may participate, and, while preventing duplication of services, the government will continue to encourage private companies to develop services as traffic possibilities may indicate."[15]

Opposition to King's policy mounted during the following year, as the Tories lobbied for a policy more in line with the rest of the British Empire. For his part, King noted the contradictions in the Tory position, as they were also demanding a greater position for Canada vis-a-vis the US.[16] King and Churchill also discussed the matter at the Quebec Conference in August. King emphasized that Canada must maintain a position of independence and therefore could not join a unified Commonwealth plan. He added that his vision vis-a-vis Britain and the US and Empire "was based on the larger conception of the working out of the whole post-war relations. That if the U.S. got the opinion— to use their own expression— that we of the British Empire were ganging up against them, they would immediately take a similar attitude toward the British Empire and it would become a test of strength."[17] King also spoke of the strength of private interests and lobby groups in the US airline industry. He felt that if private concerns in the US believed that either Canada or Great Britain were forming an alliance to the exclusion of American interests, that lobbyists would marshal opposition through a tightly-controlled US media which would have untold affect on both wartime and postwar relations.[18] To make sure the British government clearly understood, King restated Canada's

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[15] Canada, *House of Commons Debates*, Prime Minister W.L.M. King, 2 April 1943, p.1778.

[16] J.W. Pickersgill, *The Mackenzie King Record: Volume 1, 1939-1944*, Toronto: University of Toronto Press, 1960, p.519.

[17] ibid., p.539.

[18] ibid., p.540.

position with Brendan Bracken, British Minister of Information.[19]

If there was pressure from both Tories in Canada and Britain to further the interests of the Empire, private domestic concerns also lobbied to loosen King's April policy statement. In early 1944, CPR President D.C. Coleman expressed interest in developing a transoceanic and transcontinental air service and expand the private sector's service in northwestern Canada. This sparked a review of air-transport policy during the Cabinet debates of the next few weeks.

King was initially sympathetic to the CPR and other private interests who wanted to expand operations, particularly into the north, because he realized that they were better positioned to face the challenges of opening up the north. As Cabinet discussed the matter, however, King became hesitant and increasingly skeptical of private carrier interests and in particular those of the CPR. He became convinced that they were doing exactly what Mackenzie and Mann had done early on in buying up lands and roads. The railway experience had also proved a colossal nightmare as the government had been forced to step in at great public cost and purchase what became the CNR.

In March 1944, Howe restated and expanded the government's aviation policy but stressed the importance of small private carrier, regional, and bush-pilot services. However, Howe dealt a swift blow to the CPR announcing plans for their eventual removal from the civil aviation industry: "after full consideration, the government has decided that the railways shall not exercise any monopoly of air services. Steps will be taken to require our railways to divest themselves of ownership of air lines, to the end that, within a period of one year from the ending of the European war, transport by air will be entirely separate from surface transportation. In the meantime, no new air routes other than government operated routes will be allocated to airlines owned by any railway or other operator of surface transportation. The term 'surface transportation' includes railways, shipping companies, and highway transport companies."[20]

Howe had become increasingly hostile to the lobbying of the private sector in areas where he felt public good justified the presence and operation of public services. Continued demands by Coleman and others for relaxation of

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[19] ibid., p.551.

[20] Canada, *House of Commons Debates*, C.D. Howe, 17 March 1944, p. 1573; subsequently referred to again in Hansard by Mr. Carter, 13 July 1960, p.6342.

control met with resistance from King whose position was clear: "where there were natural monopolies, governments and not private enterprise would have to control, especially with regard to air transport. This had become increasingly clear for both national and international reasons." Furthermore, unbeknownst to Coleman, King had ulterior party motives for supporting the policy he did. King and cabinet both feared that had the government not responded as it had, then the whole airline policy issue would have created a substantial political space for the CCF and some dissenting Conservatives.[21]

The Birth of "Modified Competition"

The Aeronautics Act of 1944 shifted responsibility for civil aviation from the Board of Transport Commissioners to the newly created Air Transport Board (ATB). By the late 1940s CPAL had successfully lobbied for national flag carrier status on a number of overseas routes and had also given up much of its domestic routing to regional and local carriers. Through the 1950s government policy in international routes concentrated primarily on the exchange of third and fourth freedoms with other countries, although a number of fifth freedoms were also granted. Domestic policy remained decidedly nationalistic— it tried to balance regional and national interests with concessions made through a policy of cross-subsidization.

The arrival of the Diefenbaker administration in 1957 marked a significant turning point for civil aviation policy. Under George Hees, Diefenbaker's first Minister of Transport, international ties as well as major national routes were opened up, putting the first cracks in King's wartime policy. Under Diefenbaker, King's trademark reliance on the expert also waned.

Hees was an outspoken critic of existing polices in House of Commons debates. In particular, he considered the TCA a 'monopoly' and argued it was inefficient. For instance, Hees once stated "the thing I have never been able to understand is why the government insists on maintaining this T.C.A. monopoly after about 15 years of operation because any businessman knows that in any kind of business where competition is allowed to have full sway, both the public and the competing firms benefit. Everybody wins. The public benefit because they get cheaper prices and better service. The competing firms benefit because they are forced to remain efficient and to keep on improving their product and their service. Where monopoly is allowed to

[21] Pickersgill, *The Mackenzie King Record: Volume 1*, pp., 648-49.

hold sway, as it has been for 15 years in the case of the T.C.A. then the organization becomes inefficient. Any businessman knows that, and I challenge any member of the house to refute that statement." In place of the TCA, Hees favoured 'all-out competition.' He began gradually, however, first opening up transcontinental routes to competition.[22] Competition could be introduced slowly, he asserted, "without major detrimental effects to the existing operation, providing the changes are made with caution and on a gradual basis."[23]

The late 1950s and 1960s was a period in which governments in Canada still favoured large-scale planning reports in industry. Initially, in transport matters the Diefenbaker government seemed no different than previous administrations. However, the Macpherson Royal Commission, appointed in 1959 to deal with the situation created by the Freight Rates Reduction Act, recommended a complete break with previous policies. This included freedom of rate-making for railways, abolition of concepts of 'unjust discrimination,' and the unification of transport regulation under a single board. The Macpherson report (1961) met with government approval.

Other commissions met with less favourable response. For example, when a British expert, Stephen F. Wheatcroft, conducted a study of competition in the airline industry, Hees attempted to influence the direction and tone of the report. In a letter sent to Wheatcroft, Hees had written: "I am of the view that the time has come for the introduction of some measure of competition on our transcontinental routes. The rapid growth in air line traffic would seem to indicate that competition can be introduced gradually, without major detrimental effects to existing operations, providing the changes are made with caution and on a gradual basis."[24]

The Wheatcroft report, as it subsequently became known, was released in 1958. It identified three alternatives for future domestic air policy: the status quo, all-out competition or a limited competition on some routes. The Report concluded that there were only three routes in Canada that had enough traffic to sustain competition — Toronto-Montreal, Vancouver-Victoria and

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[22] Canada, *House of Commons Debates*, George Hees (Broadview), 6 March 1956 p.1868-69.

[23] Skene, *Turbulence*, p.55.

[24] Canada, *House of Commons Debates*, Letter of George Hees to Stephen F. Wheatcroft, 4 February 1958, entered in the House of Commons by Chevrier, 9 July 1958, p.2055.

Toronto-Winnipeg[25] — but, he added, unless 'strictly limited,' competition would have a 'detrimental' effect on TCA's financial position, at least up until 1961.[26]

The Wheatcroft report gave Hees the wedge he needed to begin opening up key domestic routes to competition from private carriers. The following year the Air Transport Board gave CPAL new rights to run from Vancouver, Winnipeg, Toronto and Montreal once daily.[27] From that moment forward, the domestic airline industry was increasingly characterized by the kind of competition that King so feared and had plagued the rail mode. In essence, the new airline policy set the agenda for what would happen during the late 1970s and early 1980s. Once competition had been introduced into formerly protected transnational routes, pressure to deregulate the whole industry increased.

Similarly, small operations also suffered from the new ad-hoc policies of the administration. With the appointment of a new chairman to the Air Transport Board in 1960, it was immediately recognized that there was a considerable 'backlog' of applications awaiting review for regional air services. The opposition had requested that the chairman, before making any decisions, order a regional air carrier survey be conducted prior to any hearings for granting licenses. A Department of Transport economist was loaned to the Air Transport Board for such a purpose, the survey had been conducted, but when the results produced were found in opposition to the government's policy, the enquiry was terminated and instead the ATB made recommendations to the Minister of Transport "as to policy and hearings."[28] Interference in regional and local services increased as the federal government pushed forward with ad-hoc policies that left the bush pilot and the small regional carrier in a most unstable financial position. Lacking the route 'security' that a clearly-defined policy would have achieved, small operators were unable to the secure bank loans

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[25] Canada, *House of Commons Debates*, Chevrier, 30 August 1958, p.4361.

[26] Canada, *House of Commons Debates*, Chevrier, 9 July 1958, p. 2055; extracts taken from Wheatcroft Report, pp.75-76.

[27] Ronald A. Keith, *Bush Pilot With A Briefcase*, pp., 298-99.

[28] Canada, *House of Commons Debates*, Lionel Chevrier, 13 July 1960, p.6240.

necessary to upgrade equipment and thus effectively cut out of the picture.[29] Simply put, Hees' civil aviation policies destabilized both the transnational and regional passenger services.

In response to his critics, Hees argued, "that the purpose of civil aviation is to make it as easy as possible for members of the travelling public to get from one point to another. This requires the provision of air services, not the protection of air lines to the detriment of the travelling public, which was always the policy of the former government." He stated, "Our policy of *modified competition* is, we believe, more in keeping with today's air needs and is designed to supply better and more service to the travelling and shipping public. We believe that it is the obligation of the government in a matter of this kind. We believe that our policy is the one that is more suited to today's needs (italics mine)."[30]

From the beginning of the Pearson administration in 1963 until 1979 election, the policy of 'modified competition' was expanded. For a brief period there was a considerable effort to slow down the tempo of transformation of the industry, but this attempt ultimately failed. In the end there were an increasing number of opportunities for private air services.

On the surface, the transition from a Conservative to Liberal administration at first seemed like a continuation of an ad-hoc policy of 'modified competition'. James McIlraith, Pearson's first Minster of Transport had promised a clearly defined civil aviation policy in 1963, (which would take its lead from the MacPherson Commission), but it was not until J.W. Pickersgill, his successor arrived, that any serious consideration was given the industry.[31]

Pickersgill 's April 1964 policy statement supported the primary role of its crown corporation, maintaining that public interests would continue to be best served by a mix of both private and public operations.[32] Canadian interests

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[29] Canada, *House of Commons Debates*, Lionel Chevrier, quote of ariticle in *Canadian Aviation* from July 1960 issue, 13 July 1960, pp., 6240-41.

[30] Canada, *House of Commons Debates*, George Hees, 13 July 1960, p.6243.

[31] Canada, *House of Commons Debates*, D.M. Fisher (Port Arthur), 15 November 1963, p.4800.

[32] See, Pickersgill speech of 24 April 1964.

as a whole, it was asserted, were best served by no domestic 'competitive' or 'conflicting' services. It was to be an 'integrated' system to be achieved through 'amalgamation', 'by partnership' or by a 'clear division' of fields of operation.[33]

To achieve this balance, and to ensure that there was at least some degree of coordination in this new competitive age, the government negotiated with the two major airlines to establish a "clear division of their fields of operations so that outside Canada neither airline would serve any point served by the other." Existing routes would be served by the carriers presently operating them, and further that the geographic areas be extended. In this manner the entire world would be carved up into two separate spheres of operation. Under the arrangement CPAL served the entire Pacific region, all of Asia, Australia and New Zealand, southern and southeastern Europe and Latin America. Air Canada was responsible for the United Kingdom, western, northern and eastern Europe, and the Caribbean (the only exception to this was the Netherlands which would continue to be served by CPAL). Since neither airline had any flights to Africa decisions for this continent were postponed. Decisions on US routes, where there were an increasing number of fifth freedoms, and where a new bilateral was currently being negotiated, were also postponed. Henceforth government policy would advance the interests of both carriers.

On domestic routes, for the time being at least, Air Canada remained protected because its operations were still considered to "represent the essential framework of its network of domestic services." Pickersgill, however, was willing to review the matter, and as a result pushed open further possibilities for CPAL, which was simply extending the Hee's initiative. As a compromise to the carrier, the government announced that it was willing to employ a special aviation consultant, an expert, "to advise whether the growth of domestic main line service would now permit some further degree of competition on that basis and, if so, to recommend a suitable procedure for working out, from time to time, such extensions of service." Ultimately a new transcontinental policy was worked out and the new agreement gave CP Air (renamed in 1969) a share of the major scheduled passenger service a policy which was expanded, but survived until 1979.[34]

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[33] Canada, *House of Commons Debates*, J.W. Pickersgill (Minister of Transport), "Division of Fields of Operation Between Two Major Canadian Air Lines," 1 June 1965, p.1814.

[34] Canada, *House of Commons Debates*, Jean Marchand (Minister of Transport), "Statement on International and Domestic Policy", 23 November

With respect to regional services, the government, also sought a coordinated effort from major stakeholders. In a 1969 policy statement on the matter, Minister of Transport Don Jamieson encouraged the 'orderly growth' of the carriers, and provided a wider measure of freedom in operating international charter services. Several years later Jean Marchand would restate the policy and added: "The government does not wish to encourage regional carriers to expect the type of growth which would make them directly competitive with the two major carriers. Such a development could only lead to a breakdown in the existing pattern of viable growth, and the risk of the emergence of undesirable, highly subsidized operations."[35]

The National Transportation Act (1967) established the Canadian Transport Commission with authority over all forms of transport under federal jurisdiction. It also implemented the major recommendations of the MacPherson Commission. Furthermore it recognized a 'new' era of competition within transport which had already transformed the character of much of the transport sector of the economy. Section one of the Act served as the basis for what would slowly emerge by the end of the 1970s as the foundation for the new policy reorientation that would underscore all modes in the 1980s. It read, in part: "that an economic, efficient and adequate transportation system making the best use of all available modes of transportation at the lowest total cost is essential to protect the interests of the users of transportation and to maintain the economic well-being and growth of Canada..."[36] In other words, the NTA formalized Hees' earlier policies. In the 1970s domestic and international civil aviation policies were mainly an outgrowth or extension of the policies began by the Diefenbaker administration.[37]

The final nail in the coffin of King's postwar policy came in 1979 when the government removed CP Air's quota on major domestic transnational

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1973, p.7085.

[35] Canada, *House of Commons Debates*, Jean Marchand (Minister of Transport), "Statement on International and Domestic Policy", 23 November 1973, p.7085.

[36] cited in H.L. Purdy, *Transport Competition and Public Policy in Canada*, Vancouver: University of British Columbia Press, 1972, p.5.

[37] Canada, *House of Commons Debates*, Jean Marchand (Minister of Transport), "Statement on International and Domestic Policy", 23 November 1973, p.8076.

scheduled air passenger services. This allowed CP Air to compete with Air Canada in the domestic market. For the latter, the abandonment of favoured status removed almost all advantages to remaining a crown corporation paving the way for its eventual privatization.

The Birth of the Consumer and a Competitive Age Ideology?

By the early 1980s, Canadian civil aviation policy had pushed beyond the cumbersome concept of 'modified competition'. Thereafter, policy makers flirted with liberalization, eventually settling on wholesale deregulation, or re-regulation of industry. House of Commons debates, centered on issues of regional service, and then increasingly turned to address the concerns of safety in a deregulated environment. What was also at stake, was what was happening internationally, and domestically— the need to give Canadian consumers more 'choices'.

The 1980s began a new era in Canadian transport. But it was an era that had antecedents going back many decades. The arrival of so-called 'consumer interests' essentially both acknowledges and is symbolic of the dominance of a new Competitive Age Ideology (CIA). But at the same time it also serves also as a disappointing reminder of an earlier period in which a different path might have been chosen. By the 1980s and increasingly through the current decade the "entire deregulation premise" as one astute commentator noted, "was based on the goal of the advantage to the consumer."[38]

Canadian civil aviation policy traversed essentially four periods. In the earliest period, from the 1920s through the 1930s, policy focused on stabilization, government control and amalgamations.[39] This period saw the creation of a national infrastructure of airports and aerodromes and thus laid the foundation for new transport networks in the country. These early developments also saw the rise of policies that increasingly recognized the important role civil aviation could play in promoting Canadian nationalism. Finally, this period saw the creation of a federal bureaucracy with national jurisdiction for several former independent departments and private interests were considered secondary to the public good.

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[38] Wayne Skene, *Turbulence*, p.42.

[39] K.W. Studnicki-Gizbert, "The Structure and Growth of the Canadian Air Transport Industry," *Canadian Political Science Association Conference on Statistics, 1960*, papers ed. By E.F. Beach and J.C. Weldon, Toronto: University of Toronto Press, 1962, p.225.

In the second period, from the early 1940s until the late 1950s, a clear domestic and international policy was articulated. It promoted the interests and the main objectives of prominent Canadian nationalists and was thus at its core a national policy. The origins of this national policy lie in the passage of Trans Canada Airlines Act in 1937 and was solidified with Prime Minister W.L.M. King's speech made before the House of Commons in April 1943. King's policy statement remained the most important articulation of government philosophy towards domestic and international air service up until the late 1950s. By that time it was under pressure from private interests to change.

In the third period, beginning in the late 1950s and ending in 1979, the idea of constructing a national identity through transport policies began to wane for a number of interrelated reasons. First, the railways lost their central place in Canadian identity, as their networks had become vastly underutilized in the face of competition from a rapidly-expanding trucking industry. Second, with the construction of the pipeline networks and the Trans-Canada Highway, the last of the great transport projects had been completed. Third, private interests played an increasingly influential role in policy formation.

If there is one lesson that should be learned from the experience of the airline industry, it is that it would be a mistake to overemphasis the role of international market forces in shaping the industry's policies. While many of the challenges the industry faces today are the result of international market forces, much of what created this environment was shaped and determined at home by people acting on a number of motives.

Economic Impact of a Night Restriction at Winnipeg International Airport : A Time Trend Analysis Measuring Potential Impacts[1]

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Abstract: *This paper discusses a portion of an economic impact study that was commissioned by Winnipeg Airports Authority (WAA) to quantify the economic impact of Winnipeg International Airport (YWG) for the fiscal year of 1996.*[2] *That is, to describe and estimate the economic impact if a potential night restriction were imposed on airport operations. This case study will attempt to develop a time trend analysis of potential night restriction impacts on YWG. The direct and total effects of a night closure will be quantified in terms of employment, labour income and airport-related expenditures.*

1.0 Introduction

Part of the economic benefits that accrue to Winnipeg International Airport is a function of its 24-hour operating status. Winnipeg International (YWG) is the only airport operating between Calgary and Toronto that offers a broad range of air passenger and cargo services. The 24-hour airport policy makes YWG attractive to airlines and air cargo operators because it offers flexibility in scheduling their time-sensitive operations. In recent years, these operations have been encouraged to expand their activities as YWG is looking to establish itself as an effective air freighter hub for air transport between North America and countries in Asia, Europe and the Pacific Rim.[3] For this opportunity to become a reality however requires that the 24-hour operating status be maintained.

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[1] This is currently an on-going study. The economic impacts presented are preliminary and are subject to further revision.

[2] See S.J. Shurvell, T.F. Harrison and B.E. Prentice (1998).

[3] Courier traffic is on the upswing at YWG with recent airport expansion including a new $2.5 million Federal Express main sorting facility that opened in 1995, and a new $6.6 million Purolator Courier overnight sorting facility in 1997. The 24-hour airport policy keeps Winnipeg working both day and night.

Based upon past studies[4], a restriction on nighttime activities between 24:00-06:00 would cause a significant contraction of the local economy because many of these operations could not be shifted or rescheduled to another time of day. The direct impacts of a restriction are the losses in employment, income and airport-related expenditures that would be experienced by firms directly involved in 24:00-06:00 operations at YWG.

This paper will help to extend previous potential night restriction impact studies at YWG by presenting: (i) an updated description of nighttime activity which includes a trend analysis of movements by month, nighttime hours and runway utilization (ii) the economic impact if a potential night restriction were to exist for the 1996 fiscal year, and (iii) an all encompassing time trend analysis of past and present economic impact studies related to such restrictions. With nighttime activities expected to grow at YWG, a time line of economic impacts can heighten the awareness of the community and local business of the role played by the airport between the hours of 24:00 and 06:00.

2.0 Nighttime Air Traffic at YWG

This section of the study describes nighttime air activity at YWG. Before calculating potential night restriction impacts, it is important to identify the air movements that occur between the hours of 24:00 and 06:00. The analysis begins with a comparison of total aircraft movements to movements during nighttime hours.[5] The trend of aircraft movements is examined on a monthly and hourly basis to reflect seasonality and peak-noise periods. The data analysis spans the period 1993 to late 1997 to identify any recent time trends.

2.1 Movements by Month

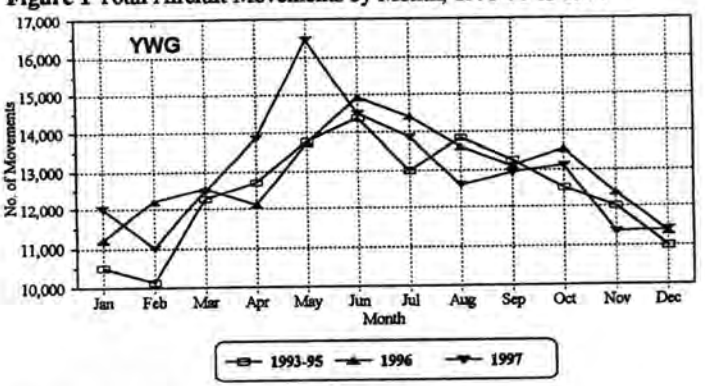
Figure 1 presents data for total monthly movements[6] for 1996 and 1997. These years are plotted against the previous three-year average for 1993-95. A "by month" analysis demonstrates the seasonality of movements

[4] See G. McCoy (1989) and B.E. Prentice, C. Loly, R. Morrisey (1994).
[5] Runway utilization movements comprise arrivals and departures of prop, turbo-prop and jet aircraft. This does not include helicopter movements, over-flights and missed approaches.
[6] Total movements are classified as either local or itinerant movements. A local movement is referred to as an aircraft landing or departing YWG, yet remaining within the same air space. An itinerant movement encompasses all other domestic, transborder and international aircraft arrivals and departures.

at YWG. The above figure provides an overall summary of the total movements by month. For 1996, the majority of total movements per month lie above the previous three-year average. This is a reflection of increased air travel in Canada. Aircraft movements during the winter months are considerably lower than the rest of the year, with December and January the least active months. The most active period commences in May and peaks at approximately 15,000 total movements in June. From June onwards, YWG experiences an overall decline in the total number of local and itinerant movements.

For 1997, the data present a different picture. Interestingly, total aircraft movements are most active in April rather than June and peak at approximately 16,500 in May (representing a 20 percent increase over the same time in 1996). Furthermore, while the 1997 trend lies consistently above the 1993-95 three-year average from January to mid July, it is below the 1996 trend from June to December.

Figure 1 Total Aircraft Movements by Month, 1993-95 to 1997

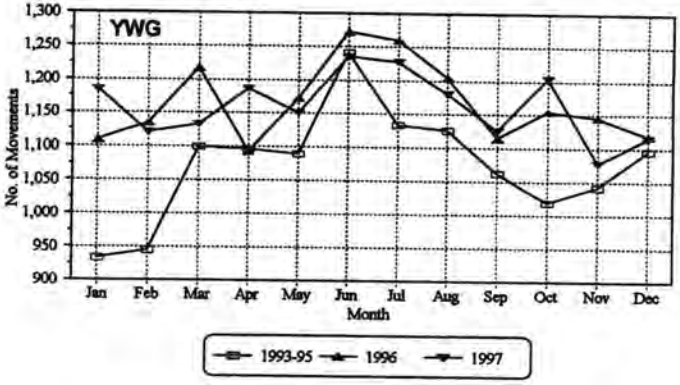


2.1.1 Monthly Movements between 24:00 and 06:00

Figure 2 provides the monthly analysis of movements during nighttime hours. On average, night movements represent approximately 13 to 16 percent of the total air traffic at YWG. The largest number of flights occur during the summer with approximately 1,192 flights each month. June represents the peak period while the winter months constitute a slower period. Nighttime operations have increased in the past two

years. In almost each month during 1996 and 1997, the number of movements is consistently greater than the average three-year period preceding 1996. The bulk of this increase is due to the increase in itinerant movements. This is explained by the concentration of courier firms utilizing Winnipeg as its feeder hub and the discontinuance of Air Canada providing midnight services. Carriers that fly smaller aircraft have filled the void. For 1996, the increase in courier activity has resulted in a greater number of itinerant movements during Feb-Mar, and the period ensuing the summer peak period, during Sept-Oct. The increase in activity during nighttime hours has established a smoother trend between the peak summer months and the slower winter months.

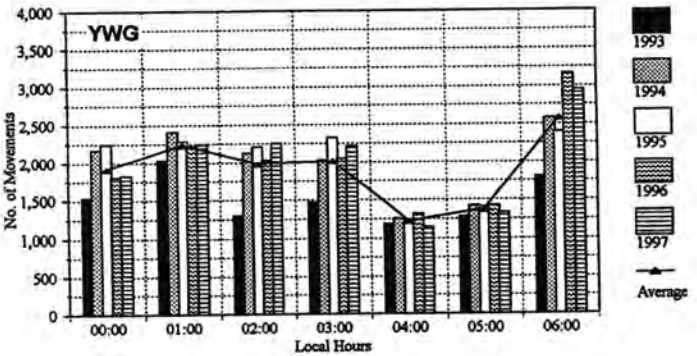
Figure 2 Total Nighttime Movements by Month, 24:00-06:00, 1993-95 to 1997



2.2 Hourly Movements between 24:00 and 06:00

Figure 3 displays total nighttime activity on an hourly basis from 1993 to 1997. The horizontal axis is broken up into hourly increments from midnight to 06:00 a.m. Each bar represents a particular year, while the period average is plotted as a linear line. The peak hours of night activity occur prior to 02:00 and again at 06:00. During these peak nighttime periods, between 2,250 and 2,500 movements occur on average each year. During the hours of 02:00 and 05:00 the total annual movements have ranged between 1,250 and 2,000.

Figure 3 Total Nighttime Movements by Hour, 24:00-06:00, 1993-1997



2.3 Runway Utilization Patterns

The pattern of runway utilization is used to minimize noise externalities during nighttime operations. Although take-offs generally create more noise complaints than landings, the particular runway used is critical to the noise problem (see Fig.4). At night, Air Traffic Control gives preferential runway use that has aircraft arriving from the north and departing to the north.

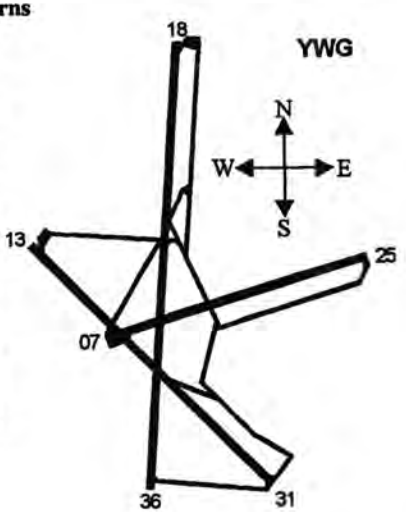
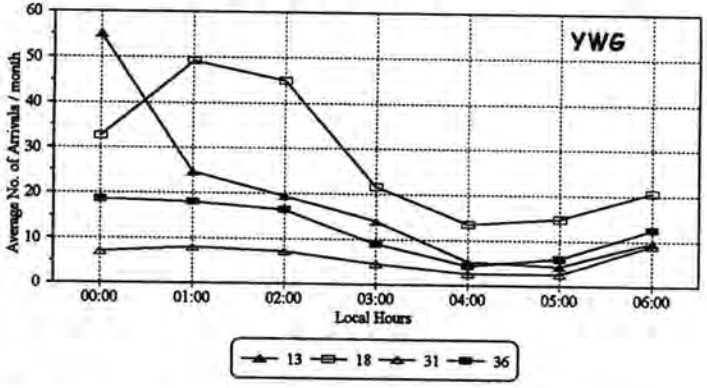


Figure 4 Runway Designation Map

Steering aircraft to the northeast of the airport, displaces departure noise to southern Winnipeg residents. The runways commanding the most attention regarding noise reduction are runways 31 and 36. Runways 13

and 18 are utilized more for arrivals while runways 31 and 36 for utilized more for departures.[7]

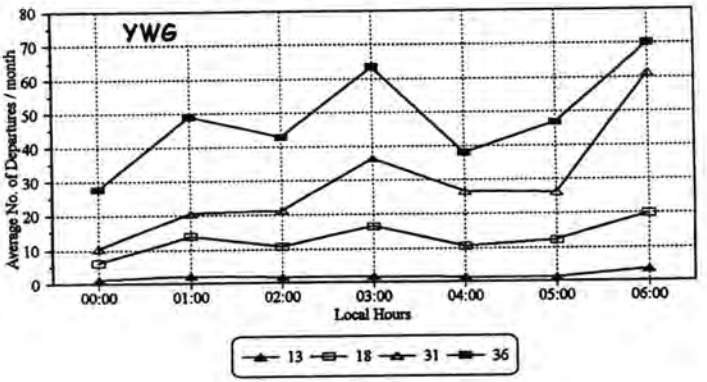
Figure 5 Runway Usage: Average Number of Arrivals per Month, 24:00-06:00, 1993-1997



Figures 5 and 6 outline the average number of arrivals/departures per month using the aforementioned runways. The time intervals are plotted along the horizontal axis, while the average number of arrivals/departures are plotted on the vertical axis. The runway utilization pattern for arrivals decrease for runways 13 and 18 until after 04:00, and increase for departures surging on runways 31 and 36 after 05:00. For example, air freight operations tend to produce more landings during the early morning hours with a surge of take-offs just before dawn. Although the airport does have some discretion regarding runway use, safety factors and wind direction override runway choice.

[7] Departures from a runway typically begin with the acceleration from the extreme end, or threshold, so that the greatest length of the runway is available for takeoff. But, it is possible for aircraft to begin departure on 36 at the intersection of 18/36 and 13/31.

Figure 6 Runway Usage: Average Number of Departures per Month, 24:00-06:00, 1993-1997

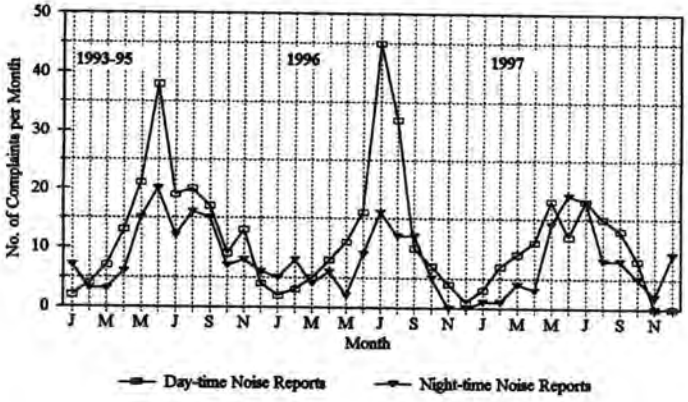


3.0 Noise Complaints

The data trend for noise complaints is not unlike the trend depicting aircraft movements during the year. That is, they exhibit a strong seasonal pattern. Complaints tend to be negligible during the fall, winter and early spring, but peak in the summer months as residents living close to the airport have their windows open at night. Since nighttime activities at YWG tend to peak in the summer months, this accentuates the noise problem. The seasonal peak of nighttime flights occurs at the most sensitive time of year.

Figure 7 indicates noise complaint data for 1996 and 1997. These years are plotted against the previous three-year average for 1993-95. The data report daytime and nighttime noise complaints per month. Daytime complaints are generally exceed nighttime complaints, and very few of either type are reported outside late spring and summer.

Figure 7 Number of Complaints per Month, 1993-95 to 1997



In 1996, daytime complaints increased significantly from 16 in June to a peak of 45 in July. Furthermore, both complaint data were lower than the previous three-year average. Daytime and nighttime reports decreased 16 and 33 percent, respectively. This represents a total decrease of 22 percent. In 1997, total reported complaints declined 8 percent from 1996, and again were less than the previous three-year average. The decline is attributable to enforced noise abatement procedures for aircraft, land-use zoning , runway utilization and community awareness and involvement in the noise issue. While daytime noise reports decreased 21 percent in 1997, nighttime reports increased 16 percent. Unlike previous years, daytime complaints did not peak to the same extent over the June-July period.

4.0 Airport Night Restriction Impacts

A list of 72 airport-related businesses were examined to determine which firms were affected by airport operations between the hours of 24:00 and 06:00. The firms on the list included all airport tenants and relevant non-tenants. The list was subsequently narrowed to 40 firms and organizations to represent the affects of a night restriction at the airport. Firms that are obviously not open at night, such as on-site retail establishments, were removed from the list.

Of the 72 organizations initially contacted, 40 firms (56 percent) replied that their businesses depend on air operations between 24:00 and 06:00. Furthermore, 26 of the 40 firms (65 percent) replied that they could not reschedule their nighttime operations if the airport were closed. Only one firm refused to respond. Also, 24 of 40 firms (60 percent) that depend on nighttime activity at YWG replied that a restriction would curtail their plans for business expansion and investment while one firm did not respond.

4.1 Air Carrier Operations

Air carriers are firms that own and operate their own aircraft. They provide freight carriage service to shippers and also make their aircraft available for chartering during the night. Flight departures often occur during the early morning hours between 04:00-06:00 and require airport operations to be open. Of the air carriers responding to the survey, 78 percent indicated that they could not reschedule their operations outside the 24:00-06:00 window. One air carrier replied that a restriction would cause the loss of a flight per day. Since its departures occur at 05:20, a delay out of YWG would make it impossible to meet subsequent connections to a major U.S. hub. Another firm replied that nighttime activity at YWG enables it to provide unscheduled air ambulance or medivac charter service—while a third reported it allows for early morning charter departures to remote fishing lodges in northern Manitoba.

Airlines also move their aircraft into Winnipeg during the night to perform required heavy or light maintenance. The 24:00-06:00 operating window at the airport allows for adequate "downtime" (time when the aircraft is not available for flight). In Winnipeg, Air Canada has a large maintenance facility. Although most of the operations at the facility take place during the daytime hours, some maintenance is scheduled to take advantage of the lower utilization of aircraft at night.

4.2 Courier Operations

Like air carriers, some courier operations own their own aircraft. This joint carrier/courier classification places these firms as couriers in this study. Couriers are firms engaged in the pick-up and delivery of small packages. While the cost of dedicated freighters is very high, the small size of air-express packages results in attractive economics (i.e. the key

to the air-express market is the high willingness-to-pay for the overnight service relative to the weight). These inter-city couriers require a 24:00-06:00 operating window due to the time-sensitivity of their shipments. The majority of these couriers offer overnight guaranteed delivery to major centres. Consequently, any rescheduling of flights outside of this window is impossible since the goods cannot wait until the next day's passenger flights.[8] Thus, dedicated cargo aircraft flying overnight are required.

A curfew at YWG would severely impact couriers to offer a schedule that would meet the needs of their customers. Cargo movement depends on the flexibility of airlines and courier firms to schedule their flights. If airport operations were closed between 24:00-06:00, courier operators would suffer since most cargo operations commence prior to 06:00. The larger courier firms use Winnipeg as the overnight hub for their nighttime freight operations. One major courier in particular replied that much of the unloaded air freight coming into Winnipeg is minimal. When the plane lands at 10:00 a.m. much of the freight stays on the plane. The stop in Winnipeg is essentially to collect additional feeder material for air transport to other Canadian destinations in the east and west. All couriers indicated that airport activity after 05:00 would seriously delay the sortation, consolidation and delivery of air cargo (creating customer service delays).

A closure would adversely affect the investment and expansion plans of courier operations. The 24-hour operations are one of the main reasons that several leading courier firms decided to locate in Winnipeg. Several courier firms have built new overnight sorting facilities and bases over the past several years. Any uncertainty surrounding the future of the 24-hour operating status would certainly curtail future investment. One major courier firm reported that any restriction would force it to relocate its air operations out of Winnipeg to another Manitoba location.

While intra-city (local) couriers use the airport for pick-ups and deliveries, they do not require the use of the airport between the hours of 24:00 and 06:00. As long as their cargo is at the airport when they

[8] Cargo shippers prefer to have nighttime services, as this allows them to spend an entire day preparing a shipment. They offer the shipment to the carrier for transportation at the end of the day for overnight delivery. Because of this, dedicated air cargo aircraft such as Federal Express and Purolator Courier have emerged. These cargo carriers operate flights in the late afternoon and early evening to meet the needs of shippers. See Tretheway and Oum (1992).

arrive for pick-up in the early morning, say at 8:00 a.m., they are satisfied. These courier operations handle their own transportation arrangements by maintaining their own company fleet or contract out delivery service through the use of owner-operators. However, one intra-city courier replied that it currently retrieves inbound domestic air shipments between 02:00-06:00 and any retrieval after 06:00 would deter its guaranteed overnight delivery service. Thus, couriers not present at the airport are also affected by a closure because many of these smaller operations sub-contract inter-city carriage to the larger affected couriers.

4.3 Air Support Services

Air Support Services consists of aircraft maintenance and repair facilities, aircraft fueling, aircraft loading/unloading, freight forwarders, flight catering services and the providers of any other service that would be affected by a nighttime closure. Included in this category are all government operations.

Canada Customs currently staff officers at the airport around the clock. Chartered flight arrivals during the winter season and chartered commercial trans-border departures to U.S. destinations require customs clearance services. Freight forwarders also require clearances after hours. Although a closure would not impact Canada Immigration since it only operates between 08:00-24:00, it would affect U.S. Customs and Immigration Services. U.S customs start their operations at 04:00 while U.S. Immigration begin operations at 04:30 to clear flight departures at 05:30. While Canada Customs and Canada/U.S Immigration could reschedule nighttime operations at YWG, U.S. customs could not because some airlines require early morning departures. With respect to airport operations and administration, WAA indicated that its primary revenue is received from air cargo activity and that a night restriction would lead to significant financial implications that would be difficult to recover from in any other airport-related activity.

5.0 Sectoral Distribution of Impacts

For simplicity, the airport operational impacts of a night restriction have been conceptually disaggregated into effects on air carrier operations, courier operations and air support services. By dividing the impacts into these categories, it is easier to attach a reliable quantitative value to each

group. The direct, indirect and induced, and total impacts of a night restriction are presented in tables 1-3.

The direct effect of a potential nighttime closure is quantified in terms of airport-related expenditures, employment and labour income. At the present time, nighttime activities at YWG generate approximately $36.4 million dollars worth of direct airport expenditure in Manitoba. Airport-related expenditures provide for 275.5 full-time equivalent jobs and payroll earnings of over $7 million.

Table 1 Winnipeg International Airport, Night Restriction Impacts: Airport-related Expenditures

Linkage	Direct	Multiplier	Indirect & Induced	Total
Air Carriers	$9,165,698	1.5528	$5,066,797	$14,232,495
Couriers	$14,182,977	1.5528	$7,840,349	$22,023,326
Air Support	$13,043,619	1.5005	$6,528,331	$19,571,950
Total	$36,392,294		$19,435,477	$55,827,771

Table 2 Winnipeg International Airport, Night Restriction Impacts: Employment (Person-Years)

Linkage	Direct	Multiplier	Indirect & Induced	Total
Air Carriers	69	1.6704	46	115
Couriers	105.5	1.6704	70.5	176
Air Support	101	1.5634	56.5	157.5
Total	275.5		173	448.5

Table 3 Winnipeg International Airport, Night Restriction Impacts: Labour Income

Linkage	Direct	Multiplier	Indirect & Induced	Total
Air Carriers	$1,172,000	1.5117	$599,712	$1,771,712
Couriers	$3,297,928	1.5117	$1,687,550	$4,985,478
Air Support	$2,707,894	1.4908	$1,329,034	$4,036,928
Total	$7,117,822		$3,616,296	$10,794,118

Upon close examination of the above linkages, the courier industry would suffer the brunt of the direct impact of a nighttime closure. In this 1996 study, courier firms account for approximately 39 percent of airport-related expenditures, 38 percent of employment and 46 percent of the labour income generated between the hours of 24:00-06:00. The

24-hour operating status at YWG is one of the main reasons that several leading courier firms now use Winnipeg as a hub for their Canadian operations. Clearly, the 24-hour operating status must be maintained if courier firms are to maintain their base operations in Winnipeg; otherwise they would be compelled to move.

Air carrier operations and air support services round out the direct impacts. The air support service sector accounts for 36 percent ($13 million) of airport-related expenditures, 37 percent (101 full-time jobs) of employment, and 38 percent ($2.7 million) of the payrolls, while the air carriers account for 25 percent ($9.2 million) of airport-related expenditures, 25 percent (69 full-time jobs) of employment, and 16 percent ($1.2 million) of the payroll generated during nighttime hours. The total economic impact (sum of direct, indirect and induced impacts) is derived through the application of economic multipliers. The multiplier effect is the induced impacts or "second-round" impacts that accompany a change in economic activity. The effect occurs with any change in aggregate expenditure. For example, the economic impact multipliers for Manitoba's transportation industry are presented in Table 4.

Table 4 Manitoba Economic Impact Multipliers Transportation Industry, 1994

Airport-related Expenditures	Employment (Person-Years)	Labour Income
1.5528	1.6704	1.5117

Data Source: Manitoba Bureau of Statistics, 1994.

The airport-related expenditure multiplier of 1.5528 indicates that 1-dollar of direct expenditure leads to a total impact of $1.5528. Furthermore, each incremental dollar spent induces $0.5528 of second-round spending in the economy. Similarly, each new direct job leads to 0.6704 other jobs in the economy while $0.5117 of additional labour income results from each incremental dollar earned in the transport sector.

The total economic impact of a night restriction at YWG is over $55 million in airport-related expenditures, 448.5 full-time equivalent jobs, and $10.8 million in labour income. The direct and total effects are summarized in Table 5.

Table 5 Winnipeg International Airport (YWG): Direct and Total Effects of a Night Restriction			
	Airport-related Expenditures	Employment (Person-Years)	Labour Income
Direct	$36,392,294	275.5	$7,117,822
Total	$55,827,771	448.5	$10,794,118

Following the statistical calibration used in the 1994 study, the economic impacts of a potential night restriction are easier to comprehend if they are expressed on a more distinctive basis (i.e., expenditure per landing, aircraft landings per job, and labour income per landing). Table 6 relates the changes in airport-related expenditures, employment and labour income to the average number of landings that occurred at YWG during the 24:00-06:00 period in 1996.

Table 6 Direct and Total Impacts at YWG Expressed in terms of Landings			
	Airport-related Expenditures	Employment (Person-Years)	Labour Income
Direct	$6,125/landing	21.6 landings/job	$1,198/landing
Total	$9,395/landing	13.2 landings/job	$1,817/landing

Each aircraft that lands during this period contributes $6,125 directly to the economy ($9,395 total), and $1,198 in wages and salaries ($1,817 total). In terms of jobs, for every 21.6 landings another Winnipegger is employed at the airport, while 13.2 landings create the equivalent of 1 full-time job in the Manitoba economy.

6.0 Time Trend Analysis

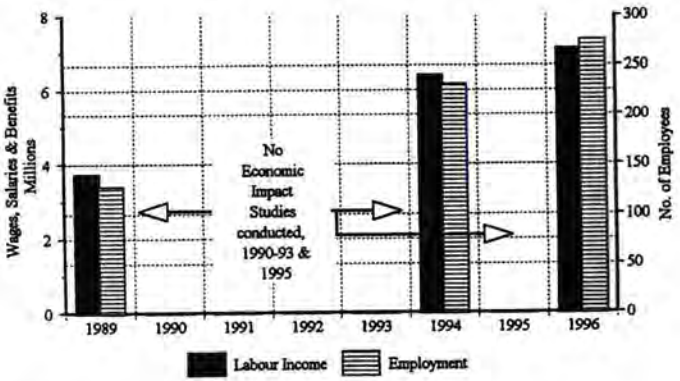
Although economic impact studies are static analyses, they can provide a wealth of information when examined in a dynamic context. A time trend measuring potential impacts of an airport curfew is able to accomplish two things: (1) measure the associated impact for the year under study, and (2) measure the cumulative effect associated with impacts over past periods.

If a curfew were to be implemented at YWG during nighttime hours, there would be a cumulative impact that YWG would be giving up. While the direct impacts of a closure are the losses in employment and labour income, the real losses are the cumulative losses that would be

given up in the expectation of future jobs and income that are not realized. In this way, one is not looking only at the impacts for a specific year, but the expectation of future losses.

Figure 7 presents the time trend of direct impacts associated with a night restriction. The trend shows the potential cumulative labour income and employment losses associated with a closure between 24:00 and 06:00.

Figure 7 Time Trend of Direct Impacts, 1989-96



While no economic impact studies were conducted for 1995 and the preceding 1990-93 period, the dynamic analyses reveals an increasing trend of direct employment and payroll income associated with YWG during nighttime hours. With nighttime activities expected to grow at YWG, a time line of economic impacts can heighten the awareness of the community and local businesses of the role played by the airport between the hours of 24:00 and 06:00.

7.0 Conclusions

The economic impact of nighttime operations at YWG are significant for the City of Winnipeg and the Province of Manitoba as YWG is positioning itself to become an air cargo hub. For this opportunity to become a reality requires that the 24-hour operating status be maintained.

A drawback of economic impact studies arise from their static nature. Static analyses measure short-term effects that tend to become dated very quickly. Yet, such studies provide a great deal of information when examined in a dynamic context. That is, they can be used to measure the long-term "cumulative effect". By consistently updating airport impact studies every few years, the importance of nighttime operations can be revealed through a comparative analysis of past and present impacts. A time trend measuring potential impacts reveals the growth of airport operations during nighttime hours.

Bibliography

Prentice, B.E., Loly, C. and Morrisey, R., "Economic Impact of a Night Restriction at the Winnipeg International Airport", *University of Manitoba Transport Institute, July, 1994.*

McCoy, G., "Night Restriction Study, Winnipeg International Airport", *Ottawa: Transport Canada, Airports Authority Group, 1989.*

Manitoba Bureau of Statistics, *"Manitoba Economic Multipliers", July, 1994.*

Shurvell, S.J., Harrison, T.F., Prentice, B.E., Economic Impact Study: Winnipeg International Airport (YWG) 1996, *University of Manitoba Transport Institute (UMTI), 1998.*

Tretheway, M.W. and Oum, T.H., Airline Economics: Foundations for Strategy and Policy, *Centre for Transportation Studies, UBC, 1992.*

Winnipeg Airports Authority, *Monthly Environmental Status Report, November 30, 1997.*

Winnipeg International Airport, *Noise Management Program, May 30, 1997.*

Winnipeg International Airport, *Tower Sheet Statistics, Monthly Aircraft Movements, 1993-97.*

Winnport, Winnport Logistics Ltd. - *International Air Cargo Brochure, 1998.*

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FORETELL™: Integrating ITS with Advanced Weather Prediction

Nearly 6600 fatal accidents in the U.S. (over 3900 in rural areas) occur annually during inclement weather. In addition, 402,000 injury crashes occur nationwide, with one-third happening in rural areas.1 To combat unsafe road conditions, state highway maintenance agencies in the United States and Canada spend over $1.5 billion to control snow and ice each year. Canadian municipalities alone spend C$762 million (US$ 533 million) for snow and ice control.2 Cities and counties in the U.S. spend an additional $700 million for similar operations. The expenditure by these agencies accounts for a significant portion of their annual maintenance budgets. 3

In order to maintain the roads, detailed road and weather condition information is required, but has not been available until now. The *FORETELL™* Program initiative, brought forth by a public-private partnership between several mid-western U.S. states, the Federal Highway Administration and the private partner lead, Castle Rock Services, seeks to address these needs. In addition, the Ministry of Transportation of Ontario (MTO) and Environment Canada (EC) are participating as affiliate members in the program.

This paper will examine the needs of transportation agencies for detailed road and weather information and how *FORETELL™* will meet these needs.

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1 Based on Fatal Accident Reporting System (FARS) and General Estimates System (GES) database tabulations.
2 Public Institutions Division, Statistics Canada.
3 SHRP Storm Monitoring and Communications Project, Volume 1.

Maintenance Operations

Maintenance officials have long known that subtle differences exist between the weather conditions and road conditions. Sources of weather condition information have been available to maintenance personnel for decades, while manual observations by maintenance personnel has been main source for road condition information. Due to a lack of detailed and comprehensive information, these differences were simply another factor that had to be addressed.

FORETELL ™ seeks to change this. The onset of snow may not immediately result in accumulation on the road. Heat from the sun, retained by the road, provides an opportunity to melt snow and prevent freezing. Residual chemical treatment on the road surface can also assist in delaying the onset of accumulation.

Information regarding factors such as these are critical to highway maintenance personnel in determining the operational plans during adverse weather. Roads which retain the heat or have sufficient residual treatment can have future treatments delayed while roadways of a more immediate concern can be addressed. Greater resolution of weather information would allow maintenance personnel to determine which roads will be affected by inclement weather and when it will occur.

In the past, snow and ice control operations used fixed routes, traced by operators regardless of the need. Materials were spread on these routes as a precautionary measure based on weather information that was unable to pinpoint areas of need or concern. New technologies and better information have resulted in a change in operational procedures.

Road maintenance personnel are now beginning to fight inclement weather with three primary approaches:

- de-icing and plowing – typically considered reactive responses; and
- anti-icing – considered a proactive response before the storm hits.

It is generally accepted that effective anti-icing operations can substantially reduce the cost of maintenance operations during a storm.

Both de-icing and anti-icing are used in support of snow and ice control service level objectives. Effective use of both de-icing and anti-icing provide DOT's with two major capabilities:

- The capability to maintain roads in the best conditions possible; and
- The capability to do so in an efficient manner.

However, to be effective, detailed and accurate information regarding the amount of precipitation, type of precipitation, start and end times of the storm and precisely where the precipitation will fall is needed. Once the precipitation reaches the road surface, the resulting effect is also a critical piece in operational decision-making.

Current Information Sources

Location-specific road and weather data can effectively enhance state transportation agencies maintenance and operations activities. It assists them as they make decisions related to resource (manpower and materials) allocation and it helps them meet their mission of providing for safe traveling conditions.

Highway maintenance officials are limited in the information they are currently able to obtain. Typically, information obtained includes:

- weather forecasts from the National Weather Service (NWS);
- weather forecasts from private weather services;
- road condition observations by highway patrolmen; and
- road condition forecasts from road weather information systems (RWIS).

The NWS provides weather forecast information twice daily, with 24 to 120 hour forecasts. Severe weather warnings and watches are reported as conditions necessitate. These forecasts and weather warnings help to ensure the safety of the public. Apart from very specific detailed information during severe weather events, the products disseminated by the NWS are often not sufficiently specific as to the times, coverage area and intensity of a storm to provide the detail needed by maintenance personnel.

Private weather services often recycle the data disseminated by the National Weather Service, with some "tweaking" of the reports for their daily forecasts to maintenance divisions. State DOT officials have indicated that the very low accuracy of the predicted start and end times of storms, and even the severity of a storm, hinders their abilities to proactively address road conditions.

Road condition observations by staff is time consuming, expensive and requires labor that could be used for other purposes. Additionally, the failure of staff to identify and report unsafe conditions can result in liability cases being brought against the agency, as was the case for MTO in Ontario.4

RWIS data provides the ability to gauge certain current road condition parameters and has shown to provide some cost reductions. Some private service providers implement these units for DOTs and then produce a single road condition forecast for the next 24 hours, not taking into account for the continuously changing nature of weather conditions. The U.S. DOT Weather Information System Team reports that "RWIS data are mostly too sparse to improve the weather-risk assessment of travel and route markets".5 The data is obtained for fixed sites, often tens of miles apart, and cannot provide the necessary detail to cover large areas with tremendous accuracy.

Thus, there exist two distinct information bundles that require improvement. The first is reliable, detailed weather information that can be used by maintenance personnel. Due to the dynamic nature of weather, forecasts made several hours earlier can be in significant difference to the actual time, type and intensity of precipitation. These inaccuracies can lead to misuse and inappropriate actions to be undertaken. In turn, public safety could be compromised and increased operational costs incurred. Secondly, detailed road condition information is needed. Perhaps even more important to maintenance personnel than meteorological information is reliable road condition information.

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4 Saunders, J., Globe & Mail Newspaper, "Court puts roads on slippery slope to salt", Toronto, December 29, 1997.
5 U.S. DOT Weather Information System Team White Paper (Draft), March 1998.

The Decisions

Winter maintenance requires good judgement. It requires that available information sources be used methodically, and that the operations be anticipatory or prompt in nature. Road maintenance personnel have multiple decisions to make regarding the appropriate response to winter storms. To better allocate resources geographically, these decisions include:

- whether to call out any additional vehicle operators;
- whether to split shifts to prepare for long duration snowfalls;
- what materials should be applied to the road surface and in what quantities; and
- when, and which areas will experience the most intense precipitation or icing.

Figure 1 illustrates the decision tree used in snow and ice control components by maintenance personnel.

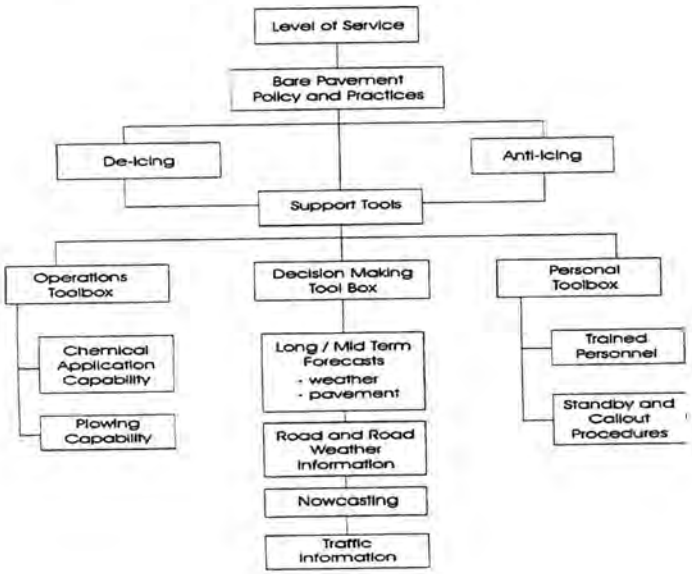
In order to make these decisions, accurate, detailed and reliable road and weather information is required by maintenance staff. For example, start and end times of storms will allow decision makers to decide if the next shift is required, or when they would be required. Atmospheric and road surface temperature trends could aid in deciding which chemical treatment to use so that the most effective materials be used. The detailed location of road icing or precipitation would assist in reducing unnecessary spreading of chemicals.

The timing of operations can have a dramatic impact on the effectiveness and efficiency of snow and ice control. The application of a chemical freeze depressant onto the pavement at the start or just prior to a winter storm inhibits the development of a bond between the snow or ice and the pavement surface.6 Periodic re-applications of the chemical during the storm continue the effect. This treatment requires detailed knowledge of precipitation start times, affected areas, intensities and types of precipitation.

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6 Minnesota Department of Transportation, "Evaluation of Road Weather Information Systems in Minnesota".

Figure 1 Decision tree for Snow and Ice Control



The snow and ice control decision-making toolbox includes road, weather and traffic information, as well as information from evaluations of treatment effectiveness. Decisions on initiating snow and ice control are based on when and where precipitation is expected to start, what form it will be, probable air and pavement temperatures, anticipated temperature trend, expected sky conditions, wind speed and direction and the intended timing of the treatment.

Maintenance personnel are unable to obtain such information. The *Manual of Practice for an Effective Anti-icing Program: A Guide For Highway Winter Maintenance Personnel* - FHWA-RD-95-202 states "...important climatic factors are type and rate of precipitation...together with pavement temperature, they are the most important variables to consider when performing anti-icing operations."

Actions are often based on reactions to winter storms, or utilize general weather forecasts not tailored to specific operational needs. Studies suggest that tailored information would allow more time for planned responses in advance of a weather event. Personnel could be advised of actual requirements with more certainty of need, reducing unproductive call-outs and standby time, resulting in budgetary savings.

Of course, actual savings are dependent on the current practice and willingness to change, for example, what level of service is sought, what resource is used to provide that level of service, whether it relies more on a set of de-icing or anti-icing strategies, what information sources are used, etc. The potential savings that can be realized through improved information and modification in operations can be substantial.

The Solution

FORETELL™ will assist in the decision making process by providing detailed road and weather condition information to maintenance staff. Surveys and interviews with maintenance operators and managers from FORETELL™ states have identified decision criterion that impact their ability to efficiently and effectively perform their duties. More effective timings for forecasts, critical temperature thresholds, more accurate estimates of start and end times of storms and more detailed road and weather condition parameters are just some of the needed information.

Road and weather conditions will be determined using data integrated from RWIS sensors, mobile platforms, personnel observations and mesoscale weather data to provide forecasts at greater levels of detail than currently available. Forecasts will be updated 4 times daily (instead of once a day) for the following 24 hour period. These forecasts will be segmented into hourly

intervals and will provide state and local maintenance personnel the opportunity to gauge the severity of an approaching winter storm and determine an appropriate operational strategy. Hourly "nowcasts" will also be disseminated, thus allowing maintenance personnel to obtain current condition information, as reinforcement to the conditions provided in the earlier forecast.

These forecasts and nowcasts will enable maintenance personnel to continuously receive updated detailed road and weather condition information. This will ensure that operational decisions can be modified throughout the life of a storm to make most efficient and effective use of the available resources. They will assist in avoiding chemicals being spread which later create icy conditions or areas of blowing snow being treated, causing snow accumulation on the roadway.

FORETELL™ is also developing and deploying next-generation pavement forecasts using energy balance, solar gain and crosswind models to predict roadway conditions. And *FORETELL*™'s mobile platforms, GPS-equipped vehicles with the capability to collect and transmit air temperatures, wind speeds, pavement data and maintenance operations reports in real time via satellite data links, will expand the level of information base for providing detailed road weather condition forecasts.

FORETELL™ assists transportation agencies by providing information tailored to meet their specific needs, thereby helping them to use labor, equipment and materials as cost-effectively as possible. For example, by knowing when and where freezing precipitation will occur, maintenance forces can anticipate how much labor and what kinds of equipment and materials will be needed to deal with the anticipated weather and accumulation. Associated benefits include:

- Input to the decision making process, related to highway operations and maintenance;
- Shared data resources among state, federal and local transportation agencies;
- The ability to translate the weather and pavement condition information into advisories for the ground traveling public;
- Savings from reduced overtime and crew call-outs;

- Less chemical and material usage and more effective maintenance strategies; and
- Increased management efficiency in costly winter maintenance and annual repair/rehabilitation programs.

In addition, benefits to the economy, environment and the traveling public can be obtained as a result of better winter road maintenance operations. These benefits include:

- Improvement in the safety of travelers from safer road conditions;
- More efficient throughput of traffic during inclement weather;
- Reduced salt and other chemicals entering the watercourse and soil;
- Faster response to weather related emergencies; and
- Fewer closures for businesses and absenteeism of workers.

With the tremendous costs for snow and ice control and the potential benefits that could be incurred, it is intriguing to see that the needs of a significant market of potential users have been left unassisted for so long.

As envisioned, *FORETELL™* will serve as a one-stop information outlet. It will fill the current gap between which road and weather information is presently available, and that which is desired by transportation system operations and maintenance personnel. Information that has previously not been available will now allow these transportation professionals to perform their duties more effectively.

HEAVY TRUCK SAFETY ON LOW VOLUME HIGHWAYS: QUESTIONS CONCERNING POLICY AND ENFORCEMENT

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HEAVY TRUCK SAFETY ON LOW VOLUME HIGHWAYS: QUESTIONS CONCERNING POLICY AND ENFORCEMENT

Jeannette Montufar[1], Alan Clayton[2], and Al Popoff[3]

Introduction

This paper: (1) discusses public policy areas used to address truck safety on the low volume highway situation common to Manitoba and Saskatchewan; (2) examines evidence of the effects of these policies on truck safety on low volume highways; and (3) makes observations and poses questions about the role and contribution of different policy areas in enhancing tuck safety in the low volume highway context.

Of central concern to the paper is this question: Is the current emphasis and balance of the policies and programs to enhance heavy truck safety on the broad national and North American front the most appropriate and economic path to emulate in the low volume highway context of the Prairie region?

Five policy areas concerning truck safety are considered in the paper: (1) the National Safety Code (NSC) and its enforcement; (2) truck size and weight (TS&W) regulations; (3) the special permitting of large truck operations; (4) road and traffic engineering standards; and (5) intelligent transportation system applications to commercial vehicle operations (ITS-CVO).

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For the purposes of this paper: (1) a "heavy truck" is loosely defined as a commercial vehicle with a gross weight of more than the 4,500-kg threshold currently applicable to the National Safety Code; (2) "safety" is measured, evaluated or reflected in terms of collision statistics, carrier and vehicle standards, or inherent vehicle safety characteristics; (3) a "low volume highway" is identified as a highway with average annual daily truck traffic (AADTT) of less than about 1,000; and (4) "policy questions" relate only to publicly-enunciated policies.

Background

The safety performance of heavy trucks has emerged as a cornerstone of concern of most transportation agencies. A recently announced goal of the U.S. Office of Motor Carriers is to "reduce the proportion of trucks and buses involved in fatal crashes to 7 percent by the year 2003" and ultimately achieve a "crash-free commercial transportation environment" [1]. Transport Canada's recently released Position Paper regarding the review of the Motor Vehicle Transport Act (MVTA) indicates that the newly proposed MVTA amendments "will focus on motor carrier safety performance..." [2].

Areas of intense policy and program activity directed at truck safety are: (1) aspects of the National Safety Code--the MVTA review states that "the National Safety Code forms the basis of a national safety regime"; and (2) in the U.S., applications of intelligent transportation systems to commercial vehicle operations (ITS-CVO).

While these safety initiatives are good in intention, many of the economic, operational, and political circumstances which gave rise to them are founded in circumstances which are most typically associated with commercial truck operations on high volume, high standard highways, in congested areas (*e.g.*, loose truck tires in southern Ontario). Yet much of the highway mileage in the Prairie region of west central North America involves low traffic volumes, relatively low design and maintenance standards, and covers large areas of sparsely populated land.

An extensive literature review of studies completed over the last three years about truck safety and low volume highways was conducted. The literature on this issue is minimal. Hummer et al. [3] indicate that "researchers have typically focused attention on heavy vehicle safety on freeways and on

highways in urban industrial areas. Consequently less is known about the extent of collisions on two-lane roads in rural and suburban areas involving heavy vehicles, and about factors influencing such collisions and potential countermeasures".

The National Safety Code and Truck Safety on Low Volume Highways

The NSC is a truck safety initiative that resulted from the deregulation of the Canadian trucking industry in 1987. The code was designed to establish a set of minimum performance standards for the safe operation of commercial vehicles. The 16 standards included in the NSC are: (1) single driver's licence; (2) knowledge and performance tests; (3) driver examiner training; (4) classified driver's licence program; (5) self-certification; (6) medical requirements; (7) carrier and driver profiles; (8) short-term suspensions; (9) hours of service; (10) security of loads; (11) commercial vehicle maintenance; (12) commercial vehicle on-road inspections; (13) daily trip inspection report; (14) carrier ratings; (15) facility audits; and (16) first aid training.

Areas of continuing disagreement and controversy concern NSC standards relating to hours of service, carrier profiles, carrier ratings and facility audits. There is also controversy regarding detailed activities and determinations in the area of vehicle inspections and the merit of related programs such as Roadcheck. In addition, there is broad concern about non-uniform enforcement of NSC standards, both among and within jurisdictions [4].

Making "safety law" is probably much easier than enforcing it effectively. It has been argued in the area of weight limit regulation that "without effective enforcement .. laws are meaningless" [5]. It is suggested that the same proposition is at least somewhat true for laws directed at truck safety, modified by the fact that other factors such as insurance premiums, carrier reputation, and driver and carrier ethical considerations also influence the safety performance of trucks. These factors are present quite independent of the existence or lack thereof of laws and their enforcement.

Historically, truck safety laws have been enforced in roadside inspection programs. In Manitoba and Saskatchewan, the principal roadside inspection effort is conducted by weigh scale/inspection officers, typically operating at fixed inspection sites, and secondarily in roving inspection. With the

development of the National Safety Code, on-site compliance reviews have also arisen as an important component of the enforcement effort.

There is a dearth of literature concerning how the NSC and its enforcement impacts truck safety on low volume highways. In a study by Montufar and Clayton about heavy truck accidents and the National Safety Code in Manitoba [4], a general consensus of Manitoba-based truck load carriers is that "the NSC has not had an effect on their operations because the safety standards included in the Code were already being applied by the companies since before the implementation of those standards". All of the carriers indicate concerns about the requirements of the hours of service regulation. One carrier states that "the way in which the hours of service regulation works does not promote truck safety because drivers are required to operate during times when they should be sleeping and are forced to rest during times when they could be driving".

One of the most important aspects of the NSC is the Commercial Vehicle Safety Alliance (CVSA) on-road inspection program directed at identifying heavy vehicle defects. Issues and questions concerning the design, conduct, results, and impacts of this inspection program relating to the low volume highways of the Prairie region are discussed below:

- Recent research indicates that the role of vehicle defects in truck accidents on the low volume highways of Manitoba and Saskatchewan is probably minimal. In Manitoba, vehicle condition (as defined by accident reports) is a contributing factor in about 1 of 10 provincial highway HTAs--principally jack-knifing (one-quarter) and shifting load (one-quarter), with no other factor being identified in more than one percent of all provincial HTAs. Vehicle condition is a contributing factor in 1 of 7 provincial highway HTAs in Saskatchewan [4, 6]. There is no evidence in the accident information system in Manitoba that vehicle defects play an important role in truck accidents. Given this, is the current level of emphasis on vehicle defect identification and correction encompassed in the NSC and its enforcement a cost-effective enhancement of truck safety on low volume highways in Manitoba and Saskatchewan?

- A comparative analysis of CVSA inspection data for Manitoba between 1991/92 and 1995/96 showed a significant decrease in the number of

defects identified between the two time periods. However, the analysis could not establish if this decrease was due to a decrease in the intensity of inspection (some officers suggested this to be the case), an improvement in the mechanical fitness of the fleet (one would hope that this would be the outcome of a continuing inspection program), or both, or neither. This finding suggests other concerns. Do inconsistencies among inspection officers, years, and jurisdictions lead to significant and un-justifiable variations in inspection results? What will such variations mean for carrier profiles and carrier ratings which may be based at least in part on the results of these inspection programs?

- Many trucks operating on the low volume highways of Manitoba and Saskatchewan operate at night hours, often never coming near an open weigh scale. One third of provincial highway heavy truck accidents (HTAs) in Manitoba and 10 percent of Winnipeg HTAs occur between 8:00 p.m. and 6:00 a.m. Do the vehicle inspection programs conducted in the low volume highway circumstance, principally at weigh scales, and principally in daylight hours, reflect the reality of the vehicle population and its use in the region? Could a lack of representativeness significantly bias the results of these inspection programs, and in turn carrier profiles, and carrier ratings?

- In Alberta and Saskatchewan, farm trucks are explicitly excluded from NSC provisions, and in Manitoba, they are excluded in a practical sense. In Manitoba, as of August 1997, there were 40,578 registered trucks with gross vehicle weights over 4,500 kg. These are the trucks encompassed by the NSC. Of this total, one-half were farm trucks. This implies that if "the National Safety Code forms the basis of a national safety regime" as stated in the Position Paper by Transport Canada, one-half of the trucks registered in Manitoba are, in a practical sense, excluded from this initiative.

- Consideration is now being given to increasing the threshold of the registered gross vehicle weights (RGVWs) of vehicles to be encompassed in the NSC (say for example, from 4,500 to 15,000 kg). If this were to happen in Manitoba, the fleet that would remain encompassed in the NSC (excluding the one-half of the total fleet which are farm trucks), would be reduced from 20,418 to 10,619. How effective could the NSC be if it did not practically address the issue of

farm trucks and did not address matters related to trucks of less than 15,000 kg RGVW?

Other policy questions concerning the NSC and its enforcement are: (1) Are all aspects of the NSC relevant (or equally important) to all areas, highway types, and operational circumstances? (2) Should the same criteria or requirements of a particular national standard be universally applied? (3) Should not the requirements of particular standards--like hours of service--be firmly founded in scientific fact concerning the effects of fatigue on driver performance and truck accidents? (4) Are the laws enforced at all? (5) How intensely? (6) How consistently? (7) What is the level of compliance being sought? (8) Is the enforcement effort involved with the NSC wisely balanced among the myriad of other laws which influence truck safety--such as truck speed, truck driver alcohol use, or the actions of other non-truck drivers and vehicles involved in "truck" accidents? Respecting this last question, Sweatman et al. [7] observe that "the most significant (enforcement-related) countermeasures, in terms of their specific likelihood of success plus potential for reducing overall truck road hazard .. (is) .. electron enforcement of speed and alcohol .. enforcement at black spots .. (and) truck load security".

TS&W Policy and Truck Safety on Low Volume Highways

North America has a myriad of TS&W policies promulgated by the provinces, states, U.S. and Mexican Federal governments and major urban areas. These regulations affect what trucks look like and how they are operated. They also significantly influence the volumes of trucking activity, vehicle loading, and in turn, the safety performance of trucking. Because of these regulations, some of the resulting vehicles are simply "plain dumb" in their configuration characteristics (*e.g.*, in the U.S., some of the so-called Bridge Formula B trucks). In some situations, there are many more trucks than are necessary handling the freight to be handled; in other situations, there are trucks handling freight where logic would say that rail would be much more efficient, and could relieve truck traffic from the highways; and in other situations, the industry is obliged to utilize vehicles which unnecessarily raise the center of mass of the unit, or limit the vehicle's stability because of restrictive width limitations. The critical point is that TS&W policies have a tremendous effect on truck safety--some positive, some negative. Much of this effect might grossly over-ride the impacts of

other truck safety initiatives which may be considered to be more important.

With the development of the RTAC Memorandum of Understanding (MOU) on truck size and weight, Canada explicitly incorporated provisions into its national set of TS&W regulations specifically aimed at enhancing truck safety. This was done by encouraging the design and use of inherently more stable vehicles. A most significant aspect of the MOU was the provision of a substantial payload advantage to the (more stable) B-train combinations over the (less stable) A-train combinations. Other regulatory details concerning tractor wheelbases and overhangs were also directed at creating more inherently "stable and safe" trucks. These RTAC regulations have had an important impact on the truck fleet and truck characteristics in the Prairie region of Canada, and its low volume highways.

For example, the following fleet change has been observed at the Headingley weigh scale west of Winnipeg between 1974 (commencement of the Western Canada Highway Strengthening Program) and today. Combinations with two-axle tractors decreased from about 10 percent of the fleet in 1974 to 0 percent in 1997; combinations with three-axle tractors increased from 90 percent of the fleet to effectively all of the fleet in 1997. Five-axle tractor-semitrailers (3-S2s) decreased from about 90 percent of the fleet in 1974 to 60 percent in 1997. Six-axle tractor-semitrailers (3-S3s) accounted for one percent of the fleet between 1974 and 1988. Since the signing of the RTAC MOU in the late 1980s, this has increased steadily from one percent to one-quarter of the fleet in 1997. A-train double trailer combinations increased from nothing to about 16 percent of the fleet by 1984, falling back to about 1 percent today. Eight-axle B-trains accounted for 4 percent of the fleet shortly after becoming an effective option in 1988/89, and have increased to about 13 percent today.

While the fleet has emerged in the direction desired by the RTAC MOU--replacing less productive vehicles with more productive ones, and replacing less stable A-trains with more stable 8-axle B-trains--there is no evidence indicating how this fleet change has manifested itself in changes in truck safety as measured by truck accidents.

Cross-border trucking is also increasing between the low volume highways of the Prairie provinces with adjacent northern States. Contrary to the objectives of the RTAC MOU provisions, the TS&W regulations of these

northern States favor A-trains over B-trains. This is evident in the trucks used in many cross-border movements.

A policy question to consider in the TS&W area for the Prairie provinces is whether or not modifications to the RTAC MOU provisions should be made to enhance cross-border truck movements. Examples might include: permitting the use of split tandems (a common aspect of U.S. trucking); accepting/promoting the use of 14-foot semitrailers (common in western U.S.); permitting the freer/easier use of U.S. short and long wheelbase tractors (which do not comply with RTAC MOU provisions); allowing for the use of lift axles. Each of these matters involve safety as well as productivity concerns--and in both cases, the interests of the Prairie provinces may benefit from a deviation from the basic "performance-based" provisions of the national RTAC MOU TS&W standards.

Policies Concerning Special Permits and Low Volume Highways

Canada's Prairie provinces, and many of the states in the north Prairie region have policies and programs that provide for the use of special permits for overweight/overdimension trucking, applied to single trips, seasons, commodities, or year-round activities. Most of these jurisdictions are sparsely populated, have low truck volumes, and extensive road systems.

Currently, most of these permitting programs are not founded in performance-based regulation and control. Saskatchewan is the one principal exception. An example of the type of effect this has had is that, of all of the western region provinces and states which permit triple trailer operations, only Saskatchewan requires the use of C-dollies as the connection device between the trailers. All others permit the use of A-dollies, which are generally considered to be less stable.

The Saskatchewan Department of Highways and Transportation reports that the specially-permitted large/heavy trucks that operate in the province have an accident rate of 0.5 accidents per million vehicle-kilometers. This is approximately 3 times better than the accident rate for the regular fleet [8]. An unpublished study by VEMAX Management in Saskatchewan indicates that truck safety would be improved by shifting regular truck operations from high traffic periods to low volume, night time hours and allowing the operation of turnpike doubles [8].

There are technical disagreements about speed control policies for special permit trucks. Morrall and Barton [9] recommend that long combination vehicles (LCVs) should operate at the same speed limits as other trucks in the traffic stream on two-lane highways. This is because a speed differential between various vehicle types would increase delay and hence the demand for overtakings. In Saskatchewan, the government requires that LCVs operating on special permit travel at 90 km/hr instead of the posted speed limit of 100 km/hr. This is strictly enforced by tachometer readings. This will also be applied to two-lane highways to compensate for the increased passing time involved with longer vehicles [8].

In a study of long combination vehicles on two-lane highways, Morrall and Barton [9] indicate that truck drivers of LCVs prefer to operate on highways with passing lanes due to an increased safety perception. Passing/climbing lanes are a very important factor that determines the traffic volume level below which LCVs may be allowed to operate on two-lane highways. For example, according to Morrall and Barton, "the maximum traffic volume below which rocky mountain doubles may operate on a conventional two-lane highway is 425 veh/hr for a road section with 100 percent passing zones. On the same highway, with a two-kilometer passing lane every 10 kilometers, rocky mountain doubles could operate at traffic levels up to 734 veh/hr and still ensure a passing opportunity of 30 percent". In general, LCVs may be allowed to operate on two-lane highways depending on the quantity of passing zones, the presence or absence of passing lanes, and traffic volume, provided the highway operates at a Level of Service C or better. "From a passing operations perspective, the introduction of passing lanes could double the traffic volume under which LCVs could operate".

The principal policy questions concerning special permit trucking are: (1) What opportunities exist to increase the use of large/heavy special permit truck operations in the Prairie region in a manner which would both improve safety and enhance productivity? (2) Under what conditions and with what expectations could the use of specially permitted LCVs be allowed to operate on the two-lane, undivided, low-volume highways common to much of the Prairie region? (3) How should the detailed provisions of the oversize/overweight permit policies of different jurisdictions be better harmonized to ensure even safer operating standards? Wise policies in this arena can offer the prospect of replacing current trucks and operations controlled by current TS&W and NSC standards with substantially more

productive and safer vehicles and operations.

Policies on Road and Traffic Engineering on Low Volume Highways

The road design, road maintenance, and traffic engineering standards applied to the highways on which trucks operate also have serious implications for truck safety performance. These matters have been extensively investigated and reported in the literature.

A key consideration here is the fact that low volume highways--and in particular much of the low volume mileage common to the Prairie region--involve design, maintenance and traffic engineering standards which are clearly and appropriately lower than those provided in high volume situations (*i.e.*, undivided highways, lower lane widths, more restrictive sight lines, less forgiving roadside environments, less responsive road maintenance service).

Many of these standards may be important causal factors for heavy truck accidents, and determining factors for the severity of those accidents. From recent literature, critical facts about truck accidents in Manitoba and Saskatchewan, and some of their implications for the potential advantage of greater activity in engineering-related road and traffic engineering policies concerning truck safety, are discussed below:

- Heavy truck accidents (HTAs) in Manitoba and Saskatchewan are heavily concentrated in a geographical sense--in urban areas, on specific road sections, and at intersections. There were as many police-reported HTAs which occurred in Winnipeg as on provincial highways in Manitoba between 1986 and 1995. Nearly 10 percent of provincial HTAs in Manitoba occurred on the 77-km perimeter highway surrounding Winnipeg, which accounts for 0.4 percent of Manitoba's provincial highway system. The HTA rate in Winnipeg is up to 20 times the equivalent rate on provincial highways [4]. Similarly, between 1988 and 1997, almost one-third of all HTAs in Saskatchewan occurred in the urban centers of Saskatoon and Regina [6]. Intersections account for one-quarter of provincial highway HTAs in Manitoba and 60 percent of HTAs on Winnipeg streets. In the case of Saskatchewan, approximately 15 percent of all HTAs on provincial highways occur at intersections. Geographic concentrations of

accidents are evidence of "black-spot" situations. Black spots suggest opportunities for more intensive policy initiatives concerning road design, maintenance, and traffic engineering standards.

- Potentially adverse environmental/highway conditions (ice, snow, wet pavements) are associated with 40 percent of the HTAs on provincial roads in Manitoba and Saskatchewan, and on Winnipeg streets. Policies concerning road maintenance, on-line information systems for drivers, driver training, and road design, could be a valuable area of action to reduce HTAs on the low volume highways in the prairie region.

- Multiple vehicle accidents account for two-thirds of provincial highway HTAs in Manitoba and 90 percent of HTAs on Winnipeg streets. Also, a culpability study of 45 truck accidents conducted in Saskatchewan showed that 39 of those accidents were caused by the actions of the other vehicle [10].

  Which of these multiple vehicle accidents have absolutely nothing to do with the fact that one of the vehicles involved was a truck? Of the remainder, which have--and which have not--something to do with the truck-related safety policies being pursued? It is hypothesized that many HTAs may have little, or nothing, to do with a truck in the first place, or the policies being pursued to address truck safety--and will not be affected by these policies. Clarification of the role of trucks in "truck accidents" would seem to be a necessary pre-requisite for the evaluation and selection of appropriate truck safety policies for the low volume highway situation.

ITS Applied to CVO for Low Volume Highways

Policy and programming initiatives concerning the application of intelligent transport systems to commercial vehicle operations (ITS-CVO) are being undertaken in many jurisdictions throughout North America. Enhancing truck safety is a major thrust of these initiatives.

Examples of planned and operating activities in this area are: (1) driver/vehicle real-time safety monitoring systems that continuously monitor and electronically record information about the driver (*e.g.*, hours of service, medical information, and commercial license information), and about the

vehicle (*e.g.*, mechanical conditions). Portions of these systems are already at the deployment stage in some states; (2) hazardous material information systems for incident management response contain timely, accurate information on cargo contents and location due to the tracking capabilities of technology; (3) site-specific highway warning systems for trucks provide truck drivers with information specific to the vehicle in relation to the geometric and topographic features of a highway. This technology is already being applied in some segments of I-70 in Colorado; (4) automated technologies which allow truck drivers to communicate with dispatchers or police in emergency situations; and (5) automated technologies which provide real-time out-of-service (OOS) verification at the roadside are being tested in Minnesota, Wisconsin, and Idaho at the East Boise port of entry. These technologies include video identification and a database created using key OOS data on specific vehicles [11, 12].

Much of this effort has been concerned with high volume, high congestion, high road design standard circumstances. Little has been directed at the low volume highway circumstance common to much of the Prairie region, and there is little related literature.

Policy choices to make concerning the programs of application of ITS-CVO to the low volume highway situation are: (1) Which technologies, geared towards improving truck safety, could be applied to low volume highway situations? (2) What safety benefits might be achieved from their application? It may be possible that in the case of the low volume highways of Manitoba, for example, a more beneficial policy choice could be to invest in the application of some aspects of ITS-CVO for commercial vehicle safety improvements rather than on developing carrier ratings.

Concluding Remarks

Of central concern to this paper was whether or not the current emphasis and balance of national and North American policies and programs directed at enhancing heavy truck safety is appropriate and economic for the low volume highway context of the Prairie region.

From consideration of the literature and other evidence concerning truck accidents on the low volume highways of Manitoba and Saskatchewan, there appear to be opportunities to reduce truck accidents in both provinces

through: (1) directed, corrective measures in road and traffic engineering at locations of high accident concentration; and (2) continued development and expansion of special permit programs to allow for greater use of oversize/overweight trucks meeting exceptionally high safety performance standards.

No evidence has been uncovered in Manitoba to indicate that the adoption and enforcement of NSC standards concerning vehicle inspections has contributed to a reduction or other improvement in truck accidents.

The effective exclusion of the significant populations of farm trucks from certain provisions of the NSC raise questions about the importance of these provisions for truck safety on Prairie region highways.

We think that an inappropriate share of truck safety policy debate and program activity has been allocated to NSC-related concerns. This will intensify as and if the areas of driver and carrier profiling, facility audits, and carrier ratings, are pursued to their ultimate conclusion. We suggest that the increasingly data-hungry and litigation-prone requirements of the driver and carrier profiling and rating provisions of the NSC may be well on the way to creating a new regulatory quagmire similar to that during the heyday of economic regulation of the trucking industry. An interesting new development concerning the collection and processing of safety-related databases is that several North American jurisdictions are now out-sourcing this responsibility to third party groups, who may well be more interested in data processing or insurance than truck safety per se.

We are of the view that the enforcement programs relating to truck safety matters on the low volume highways of Manitoba and Saskatchewan are potential beneficiaries of selected application of ITS technologies. In Manitoba, for example, we believe that there are purposes to be served by using ITS technologies to assist enforcement officers in monitoring trucking activities and planning more effective enforcement strategies.

Finally, there is a strong need for objective research on many issues regarding truck safety on low volume highways. There are many unanswered policy questions related to truck safety that have to, at some point, receive proper attention from provincial and federal governments of Canada.

References

1. U.S. DOT Federal Highway Administration, Office of Motor Carriers, "The National Agenda for Motor Carrier Safety: Creating a Crash Free Environment", 1995 National Truck and Bus Safety Symposium, http://www.fhwa.dot.gov/omc/agenda3.htm
2. Transport Canada, "Review of the Motor Vehicle Transport Act: Position Paper", Ottawa, Ontario, February 1998.
3. Hummer Joseph, Khattak Asad, and Kantor Paula, "Collision Factors and Potential Countermeasures Related to Heavy Trucks on Two-Lane Roads", *International Large Truck Safety Symposium Proceedings*, Knoxville, Tennessee, October 27-29 1997.
4. Montufar Jeannette and Clayton Alan, "Heavy Truck Accidents and the National Safety Code in Manitoba", UMTIG, July 1997.
5. Transportation Research Board Record 225, "Truck Weight Limits: Issues and Options", Washington, D.C., 1990.
6. Popoff Al, "Truck Collisions in Saskatchewan 1988 to 1997", Saskatchewan Highways and Transportation, March 1998.
7. Sweatman et al., "NSW Heavy Vehicle Crash Study: Final Technical Report", Australian Department of Transport and Communications, Federal Office of Road Safety, August 1990.
8. Popoff Al, Truck Safety Project Manager, Logistics Planning and Compliance Division Saskatchewan Department of Highways and Transportation.
9. Barton, Raymond and Morrall, John, "A Study of Long Combination Vehicles on Two-Lane Highways", Transportation Research Board, Washington, D.C., January 1998.
10. Popoff Al, "Fatal Collisions Involving Large Trucks--Saskatchewan 1995-1996", Saskatchewan Highways and Transportation, May 1997.
11. *Strategic Plan for Intelligent Vehicle-Highway Systems in the United States*, U.S. Department of Transportation/ITS America, Washington, D.C., May 1992.
12. U. S. Department of Transportation, *Intelligent Transportation Systems (ITS)Projects Book*, Federal Highway Administration Report No. FHWA-JPO-97-007, Washington, D.C., January 1997.

Incorporating Risk Analysis in Municipal Hazardous Materials Network Design

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1. Introduction

Very large, and ever-increasing amounts of hazardous materials (Hazmat) are transported daily on the transportation networks. Hazmat accidents can have very serious environmental and economic consequences. To improve the safety of Hazmat transportation, many cities restrict the roads that may be used for Hazmat trucks. Hazmat network design is to choose those arcs (roadways) to include in, or add to, the Hazmat network so that the overall environmental, social and economic cost is as small as possible while the shipping demands are satisfied.

The fundamental part of Hazmat network design process is risk assessment. Network design decision affects the Hazmat traffic pattern, in turn affects the total amount of risk imposed on the municipality and its spatial distribution. Because the consequence of a Hazmat release is often affected by many factors and complex processes, risk assessment often needs to incorporate complex mathematical models that predict the interaction between Hazmat and environment. One such example is air-borne substances. When air-borne substances are released, it can have very severe consequence in the nearby downwind areas, and scant effect on upwind direction. Therefore, it is necessary to calculate the distribution of air-borne pollutants in risk assessment. The distribution of air-borne pollutants can be predicted with dispersion models. However, it is computationally prohibitive to incorporate dispersion models in network risk assessment if we calculate it numerically. We overcome the computational complexity by adopting a raster GIS framework. We will

demonstrate how the dispersion models can be implemented in GIS, and how they can be used, with census information, to extract, for every location, the amount of population that will be affected by each level of concentration.

Risk minimization network design is a two-tiered problem. The total amount of risk imposed on the community is not only affected by the network design decision, but also affected by how drivers select their paths. It is usually up to the drivers or their companies to select the travel route on the Hazmat network. It is very difficult (and undesirable) for the regulators to tell each driver which path to go on every shipment. Therefore, the designer has to consider the behavior of drivers in the network design process. We developed a procedure to solve this network design problem in such a fashion that the total amount of risk is minimized while the drivers are allowed to select their own paths. We test the procedure on both random and real-world networks.

The rest of the paper is organized as follows. The second section demonstrates the method we use to incorporate the dispersion models in risk assessment. The third section describes the Hazmat network design algorithm and shows our experimental results. The last section is conclusions and further studies.

2. Risk Assessment

Hazmat risk is often measured using the probabilities and consequences of accidents. The traditional way of estimating the consequences of Hazmat release on networks involves drawing a band of fixed width around links and counting the number of persons living within this band as the link consequence. This method assumes that all persons within the band will be impacted equally and no one outside of the band will be impacted. For emergency evacuation in response to an actual accident, this approach is direct, and may be safe if the evacuation area is sufficiently large. This approach is, however, inappropriate for calculating the risks associated with airborne Hazmat. It does not consider the important effects of wind direction and velocity on dispersion. Neither does it consider the effects of distance on the level of impact.

When the wind is blowing, airborne substances can have significant impact downwind and scant impact upwind. Thus, the impact band may be very wide downwind and of negligible width upwind. Estimates made by drawing a band of fixed width around the road may be quite

erroneous. This is because the probability of a consequence (such as fatality) depends on the concentration of contaminant. Persons exposed to a higher concentration of hazardous gases suffer greater consequences. Airborne contaminants are borne by the wind, their concentration varies with its direction and velocity. Concentration also varies with distance from the source; it will be higher near the source and lower as the gas disperses with distance. It is therefore important to differentiate between the probabilities of a consequence at different locations and to apply these levels to the number of persons exposed at each location. We can do this using dispersion models, commonly used to calculate the concentration levels at different distances from a pollution source. The Gaussian plume model (GPM) is the most popular dispersion model used by micro-meteorologists and air pollution analysts; we adopt it for this analysis. The Gaussian plume model is formulated as (Boffey and Karkazis 1995):

$$C(x,y,z,h_e)=\frac{Q}{2\pi u\sigma_y\sigma_z}e^{-\frac{1}{2}(\frac{y}{\sigma_y})^2}\left[e^{-\frac{1}{2}(\frac{z-h_e}{\sigma_z})^2}+e^{-\frac{1}{2}(\frac{z+h_e}{\sigma_z})^2}\right]$$

where:

C is the concentration level,

x is distance downwind from the source,

y is the distance perpendicular from the source,

z is the elevation of the destination point,

h_e is the elevation of the source,

Q is the release rate of pollutant,

u is average wind speed,

Here, σ_y and σ_z are diffusion parameters in the y and z directions. Both σ_y and σ_z, are affected by atmospheric stability, in turn affected by time of day, solar radiation strength, wind velocity, and cloudiness. They are determined empirically. In North America, Pasquill-Gifford curves, empirically derived log-log plots of σ_y and σ_z as a function of downwind distance and stability category, are commonly used (Angle and Sakiyama 1991). In dispersion formulae it is convenient to have analytical

expressions for σ_y and σ_z. Many of the empirically determined forms can be represented as power-law expressions:

$$\sigma_z = a * x^b$$

$$\sigma_y = c * x^d$$

where a, b, c and d are parameters corresponding to different atmospheric stability categories. Pasquill-Gifford System classifies the atmospheric stability into six categories, each having a different set of parameters (Turner 1970).

GPM has been used to calculate the concentration dispersion for point-based leaks of airborne Hazmat (Chakraborty and Armstrong 1995). However, to apply this model to calculate the risk associated with each link in the network requires integrating the GPM over the length of each link. This is computationally prohibitive if it is calculated numerically. Some researchers approximated the vertical and horizontal dispersion parameters as linear functions of downwind distance, assuming b and d to equal 1.0 (Patel and Horowitz 1994). This is a damaging assumption because b and d do differ by atmospheric stability category; assuming them to be 1.0 entirely ignores the matter of atmospheric stability and reduces the flexibility of GPM for incorporating place specific data derived from empirical studies.

We overcome the GPM's computational complexity by adopting a raster GIS framework (Peuquet 1984). The raster framework transforms a continuous space into a discrete one by modeling it as a tessellation of square grid cells called pixels. Raster is commonly used to approximate continuous surfaces in GIS. Raster GIS are organized as a number of layers (maps), one assigned to each characteristic of interest. All layers are in perfect geographical registration, meaning that each pixel, on each layer, represents exactly the same location. As in a matrix, each pixel is addressed by its row and column number. The key advantage in using raster GIS is that it allows us to implement complex mathematical models in their original form, instead of simplifying their parameters. In many cases, simplification of model parameters reduces the accuracy greatly and limits the applicability of the models.

The raster data model treats locations and links simply. Each pixel represents a location that might be impacted. Network links are

represented by strings of adjacent pixels, each a potential accident source. In raster GIS, assessing a link's risk is a straightforward six-step process:

Step 1. Calculate Concentrations from Single Link Pixel

Treating one link pixel as a source, i, use the GPM to calculate, for each location in the landscape, j, the contaminant concentration, C_{ij}. The calculations can be made using the raster GIS's map algebra functionality, but this is tedious for such a complex function. We found it expedient to make these calculations with a program exploiting the raster's direct matrix counterpart. After calculation, concentration levels, pixel by pixel, are assigned to one layer of the GIS. For a single source pixel, we have contoured these values for easy visualization (Figure 1).

Step 2. Calculate Consequence Probabilities

The probability that an individual at location j will experience an undesirable consequence (such as evacuation, or injury, or death) as a result of a release at i, p_{ij}, is a function of the concentration C_{ij}:

$$p_{ij} = \gamma(C_{ij})$$

This function is clearly substance-dependent, and the exact form is known only for few Hazmat. The procedure we describe does not depend on the shape or the parameters of the function. As long as γ is known, it is straightforward to use it in risk assessment thanks to the raster representation employed. If it is not known, we can use a generic function and perform parametric analysis on its parameters. For demonstration purposes, we employ a very simple consequence probability function in this paper:

$$p_{ij} = C_{ij} / MAX,$$

where MAX is the maximum concentration computed by GPM. This implies that the consequence probability is a linear function of concentration level. (In reality, this function is likely to be S-shaped.) In essence, this is to assume that the consequence of airborne contaminants on human health is simply proportional to the product of their concentration level and the populations exposed to them. This interpretation may be helpful in reading our maps.

Step 3. Calculate Expected Consequences

Combine the concentration at each destination location with its population to produce the expected consequence at that location. The expected consequence of a release at point i on the population at location j is:

$$\kappa_{ij} = p_{ij} * N_j$$

where:

N_j = the population at j

Using 1996 Census of Canada data for 839 Enumeration Areas (EAs) of Edmonton, we map pixel population densities on a separate layer (Figure 2).

Overlay operations are a powerful analytical feature of raster GIS; through them, distinct layers interact with each other. Algebraic operations between map layers are performed by relating the values in each pixel in one layer to the corresponding pixel in the other layer(s). To calculate the expected consequences at any pixel, we perform a multiplication overlay, calculating the product of the consequence probability and the population in corresponding pixels, creating another layer of pixel by pixel expected consequences for the point source (Figure 3).

Step 4. Total Expected Consequences for one Landscape Point

Calculating the total expected consequence for a given landscape point j resulting from the travel of one Hazmat truck on a link merely involves calculating the expected consequences on j from all pixels of the link and adding them (Figure 4):

$$l_j = \sum_i \kappa_{ij} \quad \forall_j$$

where the sum is over all link pixels.

Step 5. Calculate the Total Expected Consequences for the Link

For a link, sum total expected consequences over all pixels in the landscape:

$$K = \sum_j l_j$$

Using a raster summation function, sum pixel by pixel total expected consequences and assign them to the link.

Step 6. Calculate Total Link Risk

We redefine link risk as the product of link shipments, accident probability and the total expected consequences for the link:

$$R = S * P * K$$

We performed this for each link in the Edmonton arterial network which has 1238 links and 736 nodes. For long-term planning purposes, the problem is complicated by varying winds; we use an eight-direction annual "wind-rose" to accommodate average conditions and portray the network with link widths proportional to average risk (Figure 5).

3. Hazmat Network Design Procedure

Network design deals with the selection of those arcs (e.g., roadways) to include in, or add to, a transportation network accounting for the effects that the design decision will have on the operating characteristics of the transportation system (Magnanti and Wong 1984). Hazmat network design focuses on the selection of those arcs from the existing network for Hazmat routes so that the total amount of risk is as small as possible. Different parties affected by the Hazmat network have different objectives. For example, the primary concern of the network designers/regulators may be the total amount of risk resulting from the traffic, while the primary concern of drivers may be the travel time because this is an important part of shipping cost. If the two parties can behave in a fully coordinated fashion, the problem is a two-objective problem and can be solved with one of the multi-objective methods. One such example is the maximum-covering shortest path problem introduced by Current, ReVelle and Cohon (1985), where the objective is to maximize the number of people who live within certain distance from the path and minimize the travel distance. The problem we face involves more than one party. For the administrator and driver to behave like one party, the administrator would have to tell each driver which path to take on every shipment. This option is not popular politically, nor feasible to enforce. Therefore, unless the driver voluntarily takes both objectives seriously, the problem involves two parties whose objectives conflict with one another.

If there is only one origin and one destination, the problem is simple. Depending on how much emphasis the designer wants to put on each

objective, this problem can be formulated as a single objective or multi-objective path-finding problem and it can be solved with a shortest path algorithm. However, when there are many origin-destination (OD) pairs, the designated network is much larger and more fully connected. The drivers will choose the path favorable to them and compromise other objectives. We develop a procedure for designing the network in such a fashion that the total risk is as small as possible even if the drivers choose shortest paths on the designated network.

3.1 The Network Design Procedure

The problem can be described as follows. Let N=(V, E) be an undirected network where $V=\{v_1,\ldots,v_n\}$ is the vertex set, and $E=\{(v_i,v_j):v_i,v_j\in V,\ i\neq j\}$ is a set of edges. On some vertices there are certain amounts of Hazmat need to be shipped to destination points. The objective of Hazmat network design is to minimize total amount of risk imposed on the community. We assume that the objective of the drivers is to minimize the travel time when selecting their travel paths. We also assume that the amount of Hazmat flow is much smaller than the link capacity and the accident probability on each link is not affected by the amount of Hazmat traffic on this link.

For the regulator, the idealized optimal solution is that every drive takes the minimal risk path, so that the total amount of risk is minimized. However, because the drivers may take different paths, the minimal risk path network (MRPN, the union of all minimal risk paths) does not necessarily ensure the total amount of risk is minimized. In some instances, the paths the drivers take happen to be the same paths the administrator would like them to take. But more often MRPN is a well-connected network in which the drivers are able to take shortcuts, thus increase the risk. Therefore, the administrator will need to consider the how the drivers will travel in the network he designated.

Our algorithm is a link removal algorithm. First, select a starting network (this network can be the result of a screening process). Second, based on the starting network, find out which links are on the shortest paths of all flows. These paths are the actual travelling routes by drivers. Then try every link on the paths and remove the ones that will reduce the total risk. We tested four implementations of the algorithm. They differ in the initial network and in the way the removal links are selected. The first two implementations use MRPN as starting network and uses first improvement and maximum improvement greedy respectively. The third and fourth algorithms start from the whole network. We name these four

implementations MRPN-First, MRPN-Most, WHOLE-First and WHOLE-Most respectively.

3.2 Computational Experiments

The algorithm is first tested on randomly generated networks. For these networks, we first generate a uniformly distributed grid network with n nodes on each side. Each node is 50 units away from its closest neighbors. Therefore, the network has $|V| = n^2$ nodes and $|E| = 2*n*(n - 1)$ edges. Then we perturb the x coordinate of each node by a random number less than 25 and repeat the process for the y coordinate, to introduce some irregularity into the network. The link length is equal to the Euclidean distance between its end points. The amount of risk at each node is the maximum possible distance from the network center subtracted by the distance between the node and the center. Therefore, the farther the node is from the center, the smaller the risk is. This is realistic because the population density usually decreases when going away from the city center. The risk for each link is calculated by averaging the risk of its two end nodes. The travel speed is assumed to be uniform in the whole network. Therefore, link travel time can be represented by its length. The Hazmat origin and destination points are selected randomly from the nodes. The amount of flow between each origin and each destination is one unit.

The size of the network design problem is mainly determined by the size of the entire network and the number of OD pairs. We tested the algorithm with three problem settings. In each setting, we generated 20 problems (incidences). The first problem configuration has ten origin points and three destination points (10x3 OD pairs) on a 64-node network. The second configuration has 15x6 OD pairs on the same 64-node network. The third configuration has 10x3 OD pairs on a 144-node network. We recorded the solutions (distance and risk) for both the starting and solution networks.

In all three problem settings, MRPN-Most produces the best average results. We scaled the solution values from the second problem setting and use it as an example to explain the experimental results. In this setting, the possible minimal risk is 100, with a corresponding distance value of 100. If all drivers take the shortest paths in MRPN, they can save an average of 17.6% in travel, while increasing the risk by 31.5%. If the drivers are allowed to travel in the entire network, the average travel distance and risk are 78.1 and 141.1 respectively if all of them take shortest paths. In the solution network from MRPN-Most algorithm, the

average risk is 117.4 and the average travel distance is 103.9. Comparing the distance and risk in the solution network and the MRPN, we can see that because the two parties do not cooperate, both sacrifice in their objectives. Therefore, non-cooperation results in a lose/lose situation for all parties involved.

3.3 Applying the Methodology in a Real Network

The Edmonton arterial road network has 736 nodes and 1238 links. The link length is the actual link length calculated in GIS. The link risk is shown in Figure 5.

We solved two problems in using the Edmonton network. First we use eight randomly generated points as origin points and eight random points as destination points. Then we use eight realistic points as both origin and destination points. These points are major entry and exit points to Edmonton and main industrial areas. In both problems, the amount of flow from every origin to every destination points is one unit. We solve both problems with all four implementations.

In the realistic problem, MRPN-First and MRPN-Most produced the same results (Figure 6). By restricting the roads for Hazmat trucks, the total amount of risk is reduced by as much as 60.4%, whereas the total travel distance is only increased by 34%. A similar amount of trade off is also found in the random problem. Both MRPN-First and MRPN-Most are significantly better and faster than WHOLE-First and WHOLE-Most on both realistic and random problems.

4. Conclusions

This paper describes a procedure for designing hazardous materials network for municipalities incorporating risk analysis. We demonstrate a GIS-based approach to extend the dispersion models to evaluate the risk from a transport network, and use it (with census information) to extract for every location the amount of population that will be affected by different levels of concentration in the case of a release accident. This approach provides more realistic risk evaluation for air-borne Hazmat. This approach can be applied to incorporate other complex mathematical models and real-time data in risk assessment.

We designed a greedy heuristic algorithm to solve the network design problem that is viewed as a game between two players with conflicting objectives. We implemented four versions of the algorithm and find that the versions that use the union of minimal risk paths as starting network

performs much better in both solution quality and speed than the ones that use no screening process. The algorithm is able to produce results that are close to the ideal minimum risk values. The network design process is able to reduce the total amount of risk imposed on the city significantly.

A Hazmat network has to be updated regularly because new roads are built, and industrial structure and demographics change. The application potential of Hazmat network design methods is substantial. We propose the following topics for further study:

1) Develop a network design procedure that takes the spatial distribution of risks (i.e., risk equity) into consideration;

2) Implement multiple risk measurements and assessment methods in the network design framework. This will allow the decision-makers and the public to compare different alternatives and view the solutions from different angles;

3) Dominant weather conditions are different from season to season. Therefore, it may be beneficial for some municipalities to design seasonal Hazmat networks. However, the true cost-benefit of seasonal Hazmat network needs to be explored;

4) Although we use real network and demographic data in our previous studies, we were not able to get actual Hazmat transportation data for a city. We would like to test our procedure with real flow data.

References

1. Angle, R.P. and S.K. Sakiyama (1991) Plume Dispersion in Alberta, Alberta Environment, Edmonton, Alberta, Canada

2. Boffey, B. and J. Karkazis (1995) "Location, routing and the environment," in Z. Drezner (ed.) Facility Location, A Survey of Applications and Methods, Springer-Verlag New York, Inc.

3. Current, J.R., C.S. ReVelle and J.L. Cohon, 1985 "The maximum covering/shortest path problem: a multi-objective network design and routing formulation", *European Journal of Operations Research* **21**, 189-99

4. Chakraborty, J. and M.P. Armstrong (1995) "Using geographic plume analysis to assess community vulnerability to hazardous accidents," Computers, Environment, and Urban Systems, 19, 1-17

5. Magnanti, T.L. and R.T. Wong, 1984, "Network design and transportation planning models and algorithms", *Transportation Science* **18**, 1-55

6. Patel, M.H. and A.J. Horowitz (1994) "Optimal routing of hazardous materials considering risk of spill," Transportation Research A, 28, 119-132.

7. Peuquet, D.J. (1984) "A conceptual framework and comparison of spatial data models," Cartographica, 21, 66-113.

8. Tomlin, C.D. (1990) Geographic Information Systems and Cartographic Modelling, Englewood Cliffs, NJ, Prentice-Hall

9. Turner, D. B. (1970) Workbook of Atmospheric Dispersion Estimates, Office of Air Programs Publications No. AP-26, US EPA, Research Triangle park, North Carolina

CANADIAN PORTS LEGISLATION DOES ONE SIZE FIT ALL?[i]

Jonathan Seymour

Summary

The 1995 National Marine Policy[ii] and the Canada Marine Act[iii] were intended to extricate the federal government from its traditional role as the primary service provider in the port sector. This is to be achieved by consolidating Transport Canada's existing multiplicity of port systems into a single system encompassing a core group of eight national ports, and divesting the remainder. In place of the broad spectrum of federally mandated alternatives available under the existing Acts, the choice is reduced to one – Canada Port Authority (CPA) status, or nothing.

But, instead of eight CPAs, there will be eighteen[iv]. This includes every port within the Canada Ports Corporation (CPC) system (except Churchill) and every Harbour Commission. These additional ports have been included irrespective of whether they meet the criteria for CPA status established by the National Marine Policy.

Faced with CPA status or no federal standing, the outcome is, perhaps, not surprising. Loss of federal status affects a port in a number of ways. The first one of importance is the loss of federal paramountcy. Provincial and municipal regulations do not generally apply to a federal port. This is especially significant in land use planning, and the avoidance or limitation of municipal property taxation. The second is the withdrawal of delegated federal powers over the harbour area, where there is no constitutional right of substitution. This specifically relates to administration of the water surface and the water column, functions performed by harbour masters.

Any Transport Canada port not opting for CPA status will lose these advantages. Because the ports within the CPC and Harbour Commission systems have opted for CPA status, the affected ports are all within Transport Canada's Harbours & Ports system. In most instances the loss of federal mandate is insignificant, but for some of the larger ports within the Harbour & Ports system there are major concerns.

In the west, the port of Victoria is unique, mainly because it should have become a Harbour Commission or CPC port long ago. The issues emphasized above affect it seriously[v]. Nationally, there are a number of ports with heavy concentrations of traffic, including some with large movements of oil and other hazardous materials, where termination of delegated federal authority will create an authority vacuum and enhance the potential for a major incident. In Pacific Canada this includes Victoria and Kitimat[vi]; in the east, this includes the major oil ports of Port Hawkesbury/Canso, Come By Chance and Argentia.

This is not a legislative issue *per se*. The Canada Marine Act (Bill C-9) is extremely flexible. It contains provisions that allow a non-CPA to continue as a public port, and the delegation of federal powers over navigation in harbours that have been de-designated. But, even though Transport Canada will have the legislative capacity to maintain a category of second ranking ports, the department has consistently re-affirmed its intention to stick with the National Marine Policy, i.e. CPAs or nothing. Consequently, the available provisions will only be used to smooth the devolution of a public harbour or port facility out of the federal domain.

The planned deproclamation process, to be applied to second rank public harbours in its current guise, is an abrogation of federal responsibility. It will leave an authority vacuum that cannot be filled by others. The intention to deproclaim every public harbours outside of the CPA system needs to be revisited.

1. The National Marine Policy

The federal government's national marine policy was announced in December 1995. The primary objective was to extract the federal government from its roles as a provider of marine services and a commercial regulator, with the intention of limiting its primary functions in the future to policy and the regulation of safety and security. In the process, the cost of supplying services would shift from taxpayers to users - resulting in a commercial and, therefore, a more responsive supply system. Although the national marine policy sought to address issues relating to marine pilotage and ferry services, its primary focus was on devolving the port system and the St Lawrence Seaway. The National Marine Policy identified three primary categories of ports and prescribed specific steps for each category[vii]:

1.1 Ports within the National Ports System

Ports categorized as part of the national system were required to be financially self-sufficient, vital to Canada's domestic and international trade, have a diverse traffic base, serve a large market area, and be linked to major rail lines and highways. The policy outlined a new management system to be implemented by a Canada Marine Act. Essentially, autonomous, user-focused Canada Port Authorities (CPAs) would replace the existing port governance model under the Canada Ports Corporation/Local Ports Corporation (CPC/LPC) system. Eight ports were identified as mandatory CPAs - seven LPCs plus one Harbour Commission.

1.2 Regional/Local Ports

Transport Canada's intention was to transfer ports of regional or local significance to provincial governments, municipal authorities, community organizations, private interests or other groups over a six year period - helped along by a $125 million Port Assistance Fund. The policy allowed second line (i.e. non-mandatory CPA) ports to apply for CPA status - if they could meet the criteria above. Assuming the criteria were properly applied, this would limit successful applicants to some Harbour Commissions and CPC divisional ports, plus a minimal number within the Harbours & Ports (H&P) system[viii].

For those Harbour Commissions, CPC divisional ports and Harbours & Ports locations not achieving CPA status, the associated real property (port facilities plus land, if/where applicable) would be transferred, and the location would be removed from Transport Canada's jurisdiction under the Canada Marine Act as the successor legislation to the Canada Ports Act, the Harbour Commissions Act(s), and the Public Harbours and Port Facilities Act.

1.3 Remote Ports

Transport Canada would continue to provide service at remote ports recognizing its obligations to isolated communities reliant on marine transportation and existing Transport Canada infrastructure.

1.4 Public Harbours to be Deproclaimed

In addition to the three main categories - i.e. mandatory CPAs, local/regional ports, and remote ports - Transport Canada identified 200 locations designated as public harbours under the Public Harbours and Port Facilities Act with little or no commercial traffic and no Transport Canada public port facilities within the harbour boundaries. The intention was to de-designate (i.e. deproclaim[ix]) all of these locations.

2. Canadian Port System - Historical Development

A brief examination of the history of the port system in Canada is necessary. Otherwise, the port devolution proposals contained in the National Marine Policy - and the problems they create - are not easily understood. Figure 1 shows, in outline, how the various parts of the aggregate port system relate to each other, and includes the reforms of 1982 and 1998.

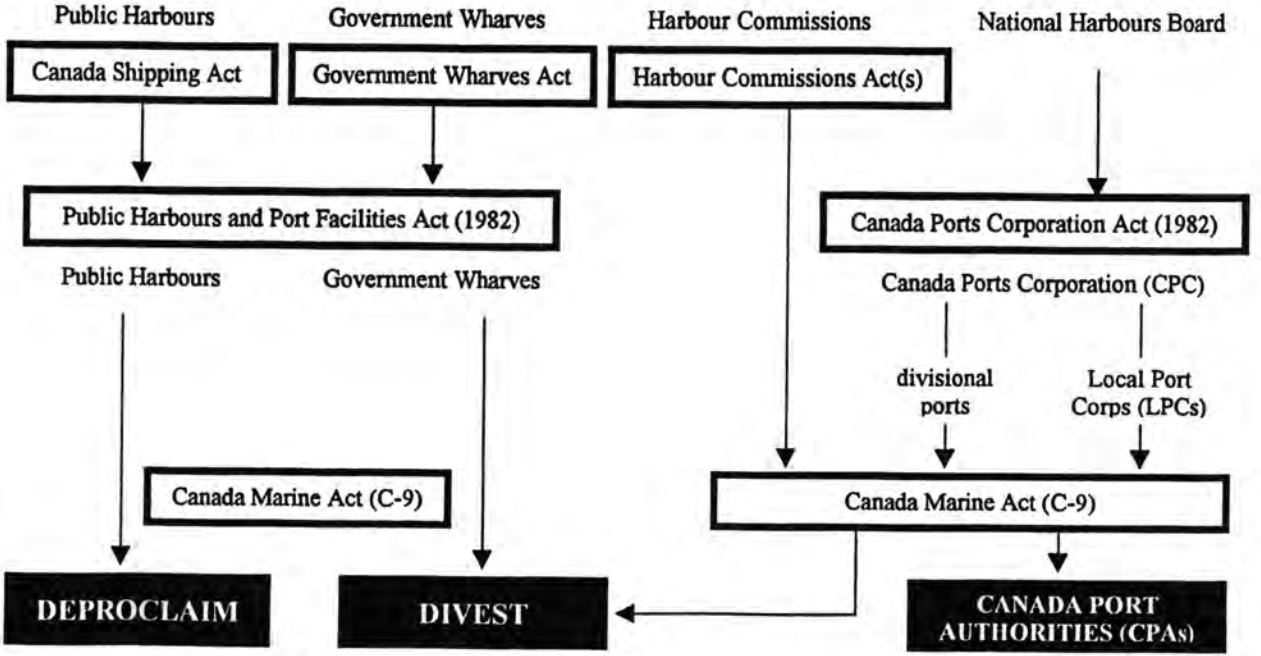
2.1 Public Harbours

Public harbours have been managed as a system since the last century. They were a part of the Canada Shipping Act until 1982, when Section XII of the Act was repealed and the public harbours mandate amalgamated with the government wharves mandate in the Public Harbours and Port Facilities Act. In a sense, public harbours localized and delegated **federal navigation authority** to port-specific harbour masters but within a national system. The ability of the Governor in Council to designate (proclaim) and to de-designate (deproclaim) a public harbour has always been part of the relevant legislation.

2.2 Government Wharves

Government wharves share much of the same history as the public habour system, but they were separately legislated as the Government Harbours & Piers Act until 1982. The Act provided for the orderly management of federal port facilities, the appointment of wharfingers, and the **control of real property** and its use as an extension of the federal mandate over navigation. In 1982, the Act was significantly amended, public harbours were incorporated, and its title was changed to the Public Harbours and Port Facilities Act. The ability to transfer, sell or otherwise dispose of real property has been an integral part of the legislation since inception.

FIGURE 1. THE CANADIAN PORT SYSTEM – HISTORICAL DEVELOPMENT



After amalgamation, the Public Harbours Regulations and the Government Wharves Regulations continued to regulate the two areas on an entirely distinct basis.

2.3 Major Ports

Major ports have always operated outside of the Public Harbours and Government Wharves systems. Originally, the management structure was through autonomous harbour commissions. Widespread financial difficulties in the 1920s and 1930s resulted in the federal government stepping in. This process was formalized in 1936 by the creation of the National Harbours Board (NHB). A number of ports continued as harbour commissions. Toronto and Hamilton still have their own Acts, while the mandate for the remainder was eventually modernized by the 1966 Harbour Commissions Act.

In 1982, the National Harbours Board Act was significantly amended and re-titled the Canada Ports Corporation Act. The new legislation created the Canada Ports Corporation (CPC). It also allowed ports within the CPC system to achieve a degree of autonomy as Local Port Corporations (LPCs) - provided they met criteria regarding financial self-sufficiency and local interest. In the west, Vancouver and Prince Rupert became LPCs with their own letters patent, as did Montreal, Quebec City, Saint John, St John's and Halifax. The remaining CPC ports continued as divisional ports under the full control of the CPC.

2.4 1982 Legislative Reform

The 1982 port reform was intended to provide a common national policy binding the three Transport Canada port systems together while allowing ports to develop and change both within a system and between systems. It also permitted varying degrees of local autonomy - subject to financial strength and local interest. For LPCs, however, the continued existence of the CPC as its parent and the need, as crown corporations, to meet the requirements of Transport Canada and Treasury Board under the Financial Administration Act was felt to be a major impediment to effective autonomy and commercial responsiveness. The intended flexibility to move between port systems has never been used.

2.5 Proposed Legislative Reform – 1997 and 1998

In essence, the 1995 National Marine Policy and the Canada Marine Act are intended to turn ports of national significance into Canada Port Authorities (CPAs) with the remainder of Transport Canada's public port facilities sold (i.e. real property divested) and its public harbours de-designated (i.e. localized jurisdiction over navigation abolished through deproclamation).

Turning Habour Commissions and LPCs into CPAs requires an act of parliament. As pointed out above, however, the disposal of public wharves and de-designation of public harbours can be done under the existing provisions of the Public Harbours and Port Facilities Act.

With the divestiture program under the Public Harbours & Port Facilities Act proceeding apace, it can be argued that, without the passage of the Canada Marine Act and the formal approval of parliament, the process lacks legitimacy. Bill C-9 contains a number of provisions designed to formally express the policy intent and to facilitate its implementation. These have been absent during the intervening period.

3. Jurisdiction & Tenure

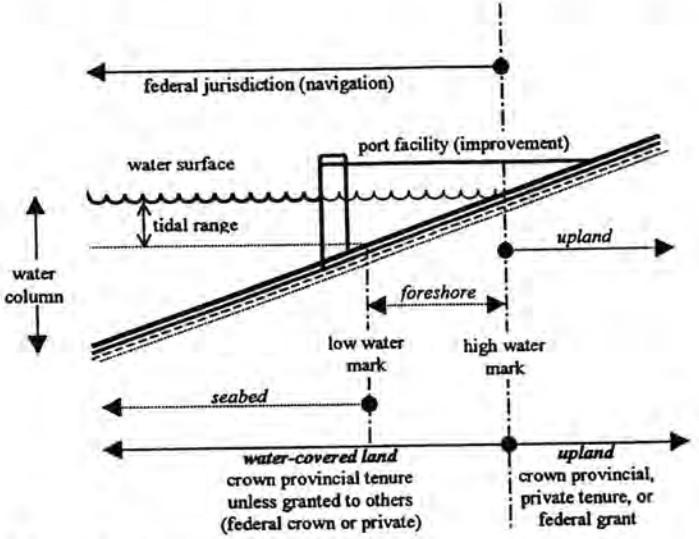
Misunderstandings often arise when discussing Canadian harbours, ports and port facilities. These are usually a result of confusing property and navigation rights, the blurring of federal, provincial and municipal powers and, finally, because there are many significant variations between individual ports and between the different port systems. Figure 2 seeks to identify and explain some of these jurisdictional interfaces.

3.1 Navigation

The federal government has jurisdiction over **navigation**. This covers both the surface of the water and the water column. It is not a property right. In effect, a public harbour designation both localizes and delegates this federal authority to the harbour master. Any vessel has the **right to navigate** through the water over a water lot. Trespass can only occur if the vessel ceases to navigate. An upland property owner fronting onto tidal water has **riparian rights** (or more correctly, littoral rights) that include the right of unimpeded access. Neither the provincial government nor a local government has any jurisdiction over navigation and commercial shipping activity. A local government may deal with some

boating/nuisance issues but only if the relevant bylaws are carefully worded.

FIGURE 2. LAND, FACILITIES & WATER – JURISDICTIONS



3.2 Land Tenure

Ownership of water covered land is generally vested in the crown in the right of the province. Water covered land includes foreshore, i.e. land exposed at low tide. On occasions, the crown provincial may grant water-covered land to private interests. More commonly the province will lease out water covered land for a limited term. The province of British Columbia has entered into head lease arrangements for seabed with other government agencies - including the Fraser River Harbour Commission and the North Fraser River Harbour Commission. The *Six Harbours Agreement* of 1924 transferred water covered land (seabed) at six specified harbours in British Columbia from the crown provincial to the crown federal.

3.3 Improvements

Ownership of a port facility (improvement) can rest with anyone - public or private. Public wharves and other public port facilities come under one of several different federal port systems. Federal ownership of the improvement may or may not include full tenure over the associated upland or water covered land. Most federal government port facilities currently being divested by Transport Canada are located on provincial crown land and the transferee must enter into an agreement for tenure with the province[x].

3.4 Port Systems on the West Coast

Figure 3 provides a west coast overview of the three port systems under Transport Canada. It references the constituent ports, and compares the control they have through delegated authority and/or tenure over land and improvements. Figure 3 also defines the ports and harbours in the context of the National Marine Policy and the Canada Marine Act. The two CPC/LPC ports and three of the four Harbour Commissions have comprehensive port management systems. They have tenure over (some) seabed, upland and improvements/facilities plus inclusive control over navigation in its broadest sense. The remaining Harbour Commission, North Fraser, has no absolute tenure and few port facilities (with no public wharves, its facilities consist mainly of dolphins).

The Victoria-Esquimalt Harbour is another exception. Although it is one of the *Six Harbours* where clear title to the seabed rests with the federal government, it has never had the comprehensive operating mandate of either an LPC or a Harbour Commission. Attempts to bring Victoria into either system have failed because of paramountcy issues between the three levels of government with respect to tenure, land use planning and property taxation. No other port within the Transport Canada - Harbours & Ports western mandate has the potential to achieve a comprehensive system of port management soon after divestiture or deproclamation.

4. Port Divestiture

4.1 The Process

Divestiture is the process established under the National Marine Policy in order to get Transport Canada out of the ownership and operation of real property at ports classified as local or regional. The intent was to transfer

FIGURE 3. PUBLIC PORT CATEGORIES ON THE WEST COAST UNDER THE NATIONAL MARINE POLICY AND THE CANADA MARINE ACT

Port Categories per the National Marine Policy, C-44 and C-9	CPC ports (Local Port Corps)	Harbour Commissions	Transport Canada Harbours & Ports	federal tenure			
				seabed	upland	facilities	public harbour
NATIONAL PORTS proposed CPAs Bill C-9 schedule	**Vancouver** [1] **Prince Rupert** [1]	**Fraser Port** [1+2] **Nanaimo** **Port Alberni** North Fraser [2]		√ √ √ √ √	√ √ √ √ √	√ √ √ √ √	√ √ √ √ √ √
LOCAL/REGIONAL PORTS non-CPAs land and facilities for divestiture and/or public harbour for deproclamation			**Victoria** [3] examples: Campbell River [3] Horseshoe Bay [3] Stewart [3] Sidney Kitimat [3] Squamish [3]	√	√ √	√ √ √ √ √	√ √ √ √ √ √
DEPROCLAMATION designated public harbours with no traffic or port facilities; immediate (1996) deproclamation			Comox [3] Hot Springs Cove [3] Ocean Falls [3] Nanoose Bay [3+4]				√ √ √ √

Notes:
(a) the remote port category has been excluded from this table
(b) the names of the ports where the seabed is (in part or whole) under federal tenure under the Six Harbours Agreement are bolded

1 mandatory CPAs
2 provincial water lot headlease
3 designated public harbour – Public Harbours & Port Facilities Act
4 Nanoose Bay not deproclaimed – DND objections

the land and facilities to others over a six-year period - either as an operating port or for mixed or alternate uses. Divestiture has nothing directly to do with the deproclamation of public harbours.

Although the divestiture process itself is quite complicated, the policy intent and the final results in British Columbia are not. Where a facility is used as a public good, then a local government (a municipality or regional district) will usually be the purchaser. Where the user group is more specific, the affected interests are jointly forming non-profit societies to take over the port facility. There are also a limited number of instances where a facility is passing into the hands of a single user.

4.2 Divestiture versus Deproclamation

The National Marine Policy categorized ports as follows mandatory CPAs, regional/local ports for divestiture (or upgrade to CPA status), remote ports, and public harbours for immediate deproclamation.

The document did not speak to the significant number of the ports within the regional/local category that are public harbours slated for eventual deproclamation. Nor did it recognize that a number of the ports classified as regional/local, and therefore slated for divestiture, were actually designated public harbours with no Transport Canada port facilities inside their boundaries - and therefore with nothing to divest.

5. Public Harbours

5.1 Designation and Termination

The procedures for designating a public harbour or public port facility and for terminating a designation are straight forward; they are set out in Section 8 of the Public Harbours and Port Facilities Act as follows:

8. (1) The Governor in Council may, by order,
   (a) declare any area covered by water within the jurisdiction of Parliament, the limits of which area are defined by the order, to be a public harbour,
   (b) alter the limits of any public harbour, and
   (c) declare any port facility to be a public port facility.
   (2) The Governor in Council may, on the recommendation of the Minister, by order, terminate the application of this Act to any public harbour or public port facility, if the Governor in Council is of the opinion that the

termination will enable the improvement of the administration of the port or facility.

(3) Every order made pursuant to this section shall be published in the Canada Gazette.

Harbours were designated as public harbours whenever traffic volumes called for local monitoring and control, and when the dues collectable would financially support the appointment of a harbour master to perform those local functions. Once designated a public harbour, a location was never de-designated unless it was absorbed into another part of the national port system. The 1996 order de-designating 199 public harbours was, in fact, long overdue housekeeping.

5.2 Designation and Termination in the Future

The procedures noted above will be replaced by those contained in the Canada Maritime Act, which are as follows:

65. (1) The Governor in Council may, by regulation, ...

(c) designate as a public port any navigable waters within the jurisdiction of Parliament, including any foreshore.....

(2) Every port...that on the coming into force of this section was a public harbour... to which the *Public Harbour and Port Facilities Act* applied is deemed to have been designated under subsection (1).....

(6) The Governor in Council may, by regulation, repeal the designation of a public port... made or deemed to have been made under this section.

Three things are apparent. First, by definition any public harbour (or public port) is designated with respect to navigable waters that are **under the jurisdiction of Parliament**. Termination of a designation does not alter the fact that these waters were under, and remain under, the jurisdiction of Parliament, i.e. federal authority. Second, the requirement imposed upon the Governor in Council to justify the termination of a public harbour designation, on the basis that it will improve the administration of the port, is eliminated under C-9. Third, the consultation period, subsequent to the mandatory publication of the order terminating the designation in the Canada Gazette Part I, disappears. Instead, the regulation repealing a designation will likely be published in Part II as a matter of record only.

5.3 Public Harbours - a System

Prior to 1996, harbour dues were collected on a system-wide basis. A call at any public harbour and the collection of harbour dues for that call was, in effect, a credit towards a system-wide maximum number of calls (traditionally two, but subsequently raised to three and then five) in any year. Harbour dues were not connected directly to the services received in any specific port but rather to the services supplied by the system as a whole - a system that included navigation-related services both within harbours and en route.

This systemic approach started to disappear with the transfer of the Canadian Coast Guard (CCG) to the Department of Fisheries & Oceans (DFO), when Harbours & Ports ceased to be part of CCG and remained with Transport Canada. Subsequently, introduction of the Marine Navigation Services Fee by CCG, and abandonment of the system-wide credit for harbour dues in Harbours & Ports tariff completed its demise.

6. The Deproclamation Vacuum

6.1 Nanoose Bay

200 public harbours were listed in the National Marine Policy for immediate deproclamation, but only 199 were. The Department of National Defence successfully objected to the deproclamation of Nanoose Bay. Nanoose Bay is used extensively by naval vessels. While control of naval traffic resides with the Queen's Harbour Master (QHM), he has no jurisdiction over the navigation of civilian vessels nor over civilians until they actually come into direct contact with naval vessels – unless he has been effectively designated the harbour master in the context of the Transport Canada public harbour. The QHM was not satisfied with the residual authorities available if the harbour was to be deproclaimed (e.g. CCG enforcement) on the basis these were entirely reactive, after-the-fact and therefore of no value in preventing interference with naval activity.

As a result, the Canada Marine Act was adjusted in draft to allow the Minister of Transport to designate traffic control powers to others (including federal departments such as the DND) whether or not the public harbour/public port was de-designated. But it is understood that Transport Canada will only consider using these provisions where there are over-riding safety or security issues.

6.2 A Perceived Vacuum

The concept that each and every public harbour could be deproclaimed without any significant impact on safety and the environment was not discussed in the National Marine Policy. Inquiries to Harbours & Ports - Pacific Region resulted in suggestions that provincial statutes and/or municipal bylaws could be used as the authority to handle nuisance and other local issues, and the collection of fees could be based on property rights. The expectation seems to be as follows: providing the fees are seen to be reasonable and the paying entities were consulted, then the operational authority, the collection authority, and the quantum of the fees will not be challenged (whether or not, legally, they could be). This may work for a location where the primary issue is sea-doo nuisance. But, for other locations, such as Victoria and Kitimat, the approach can probably best be described as wishful thinking.

6.3 Collateral Coverage

The Department of Justice (DoJ) on behalf of Transport Canada - Harbours & Ports has conducted a review of what it calls *collateral* legislation. The initial study was completed in January 1997. It purportedly shows that de-designating public harbours, withdrawing harbour masters, repealing the Public Harbours & Port Facilities Act and its Regulations (including successor provisions in and under C-9) would have no impact - because there are ample authorities elsewhere, and existing overlapping agencies would cover the functions involved. A request for a copy of the DoJ study was refused.

It may be correct for DoJ to suggest that the regulations covering every aspect of the harbour master's duties have collateral (or potentially collateral) legislation elsewhere - federal, provincial or municipal - or private sector duties of care. That, however, is not the point. Many of the legislated alternatives are reactive, regionalized and item specific. The harbour master and the application of the public harbours regulations are locationally specific, cover a wide range of issues, and essentially provide pro-active pre-planning, monitoring and pre-emption/first response functions. In many instances, particularly for those, which fall outside the emergency procedures of individual terminals, it is the harbour master who initiates contact with the other agencies who have a broader authority to take action and the responsibility to do so.

6.4 Conclusion

The issue is not collateral legislation. The issue is pro-active implementation

By definition, devolution involves the transfer of powers.

The divestiture process has its problems, but these can be accommodated by junior levels of government, provided they are prepared to recognize the public interest component associated with the port facilities involved in the specific divestment, and react accordingly.

By comparison, the planned deproclamation process, to be applied to second rank public harbours in its current guise, is an abrogation of federal responsibility. It will leave an authority vacuum that cannot be filled by others. Transport Canada's intention to cancel delegation of federal powers by deproclaiming all public harbours outside of the CPA system needs to be revisited.

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i Much of the content of this paper is the product of research done for the Port of Kitimat Stakeholders in 1997. The input and assistance of the stakeholders is gratefully acknowledged.

ii Transport Canada, National Marine Policy, December 1995

iii The original Bill C-44 was passed by the House of Commons on April 16, 1997, but stalled in the Senate and died on the order paper when parliament prorogued. The House of Commons passed its successor, Bill C-9, on December 4, 1997. The Senate is expected to consider the Bill in April 1998.

iv Schedule to Bill C-9

v MTR Consultants Ltd, Victoria/Esquimalt Harbour Divestiture Project, Draft Report, February 1998

vi Jonathan Seymour & Associates Inc, Kitimat Public Harbour Deproclamation Project, July 1997

vii Throughout this paper (and also in the National Marine Policy document, itself) the port systems and categories are invariably simplified. There are good reasons for this. Ports are by definition location-specific. The trades and interests they service vary widely, and their facilities and transportation infrastructure are diverse, as are the ways they fit within the social and economic fabric of the local (or regional and national) community.
The existing port systems and those proposed by Transport Canada are attempts to classify ports in a meaningful way, so that they may be slotted into legislation or otherwise dealt with coherently. Unfortunately, these classifications often do not work particularly well. For example, ports of national significance are not always included in the (senior) national port system, while ports of regional or local significance often are. Overall, the result is a patchwork - where the position of a port on the patchwork is a product of history, politics, power and ego. All rigorous attempts to define Canada's port system as a whole tend to be riddled with exceptions and run the risk of adding confusion rather than illumination.

viii In British Columbia, three ports under the Public Harbours and Port Facilities Act could potentially lay some claim to CPA status - Victoria, which is unique in a number of respects, plus Kitimat and Squamish, as both have direct connections to national or inter-provincial rail systems.

ix Transport Canada consistently uses the terms *deproclaim* and *deproclamation*. These terms have no meaning in law. A public harbour under the Public Harbours and Port Facilities Act has its status revoked through de-designation, as will the successor public port entities under the Canada Marine Act (Bill C-9).

x There is a school of thought that maintains the federal government has no right to transfer its port improvements to anyone, as the original land use agreement with the province conferred only a limited and non-transferable tenure to the federal government. This, of course, does not apply to the facilities situated on lands where tenure was transferred under the *Six Harbours Agreement*.

AUTOMATED QUALITY-CONTROL EVALUATION OF TRAFFIC VOLUME ESTIMATES FOR MANITOBA HIGHWAYS

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INTRODUCTION

Purpose

The purpose of this paper is to research, develop, and analyze an automated quality-control system that systematically evaluates traffic volume estimates for Manitoba Highways. This method identifies Annual Average Daily Traffic estimates that may have been poorly produced and explains the potential sources of error of those estimates.

Background

The University of Manitoba Transportation Information Group (UMTIG) is responsible for the operation and maintenance of the Manitoba Highways Traffic Information System (MHTIS). A key element of this responsibility is to expand short-term counts into estimates of Average Annual Daily Traffic (AADT) for each of the links in the Manitoba Highway Network.

Provincial highway AADT estimates are used by the Manitoba Department of Highways and Transportation, along with transportation consulting firms for such tasks as planning, design, project selection, policy making and highway engineering. Therefore, the use of AADT's to guide decisions is critical. Inaccurate AADT estimates may result in costly errors. As well, the AADT forms the basis for the calculation of a number of other key traffic statistics such as average summer daily traffic (ASDT), percent trucks, and design hourly volumes.

Data was provided by both permanent and coverage counters. In 1995, fifty-five permanent traffic counting stations continuously record traffic volumes from which the AADT is determined. Coverage counters were

used to monitor an additional 1,991 sites. Typically, sites with over 175 vehicles per day are counted every second year while lower volume sites are counted every four years. Short period counts, normally 48 hours in length, are expanded directly by comparing data collected during the samples with the hourly data from the station's volume control station. (UMTIG, 1996)

Objective and Scope

This paper devises concepts to systematically evaluate the link AADT estimates at highway intersections in Manitoba. By assigning AADT as flow along a network, dependency between linked estimates can be established. Following the link-to-link continuum, the network's intersections serve as a tool to observe the flow characteristics. Ideally, the number of vehicles entering the intersection should equal the number leaving it. This is the basis of the "intersection-balancing" concept developed in this research. A methodical process is created to identify potential sources of error, if any, at each link of the imbalanced intersection. As appropriate, the technique is to operate on a Geographical Information System (GIS), namely TransCAD.

The scope is limited to the AADT component of the MHTIS estimates. The technique is applied to the 1994 and 1995 estimates. While this research considers various theoretical statistical aspects of analysis, the main concern is about practical and feasible improvements to the real traffic estimates that the MHTIS must produce.

METHODOLOGY

Research Approach

The intersection-balancing concept uses network principles to analyze the continuity of flow at a node. Hence, a network framework for the highways in Manitoba needs to be established before the analysis can begin. The methodology of this research is portrayed in Figure 1.

The analysis first requires a database of all intersections in Manitoba. Highway information from the existing MHTIS database is combined with road maps through a GIS. The GIS relates attribute information with locational characteristics to create a network. Then, the MHTIS information is sorted by the intersection search algorithm devised specifically for this research. The intersection search compiles a list of all

nodes with more than three links to produce an intersection database that contains a record for each intersection. Once the intersection database is completed, the intersection balancing tests are performed. The next step in the methodology is to evaluate the AADT estimates of the links of imbalanced intersections. The AADT estimates for links of intersections imbalanced beyond an acceptable level of confidence are systematically analyzed to isolate possible sources of error. The most common possible sources of error are identified and each AADT estimate undergoes an evaluation.

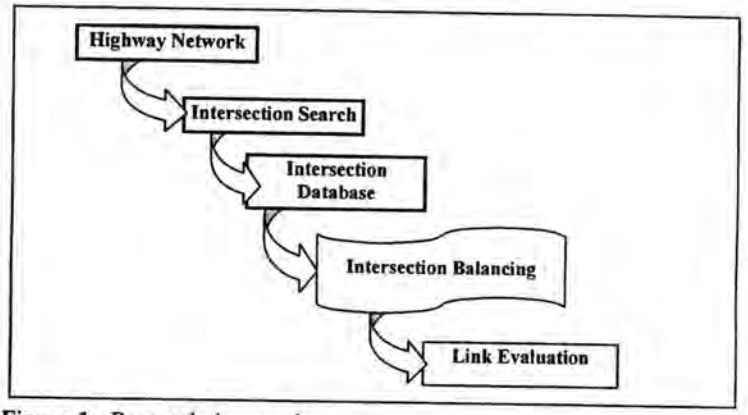


Figure 1: Research Approach

Network Concept

The activity, or use, of a transportation system, can be quantified by measuring the flow through the system as the total number of vehicles using the facility at a given time. The AADT represents the number of vehicles expected to pass a certain point on an average day of a given year. Short term counts use counting devices to monitor traffic at a point from which annual traffic estimates are made for the specified station. The flow determined for the point at which the sample was performed is then taken as an estimation of traffic using the highway.

The transportation system's elements are taken into account using a network approach encompassing spatial and flow characteristics. Nodes represent particular points in space and may be vertices of highway intersections or points connecting adjacent highway sections. A single node i is defined as an element in the list of nodes for a system, N = [1, 2,..., i,..., n]. Highway segments are represented as links connecting ordered pairs of nodes (i, j), or as an element k, of the list of links for a

system, M = [1, 2,..., k,.., m]. Traffic flow on the roadway is measured as combined AADT in vehicles per day, in other words two-way traffic. The flow of traffic is assigned to a link as undirected arc flow, f_k. Counts are usually combined, meaning that the count is the sum of vehicles passing that point from opposite directions. Therefore, half of the combined AADT would be the average flow in each direction. Following the network model, Manitoba's provincial trunk highways are depicted in Figure 2. To illustrate the magnitude of flow along the roads, the AADT is scaled in vehicles per day.

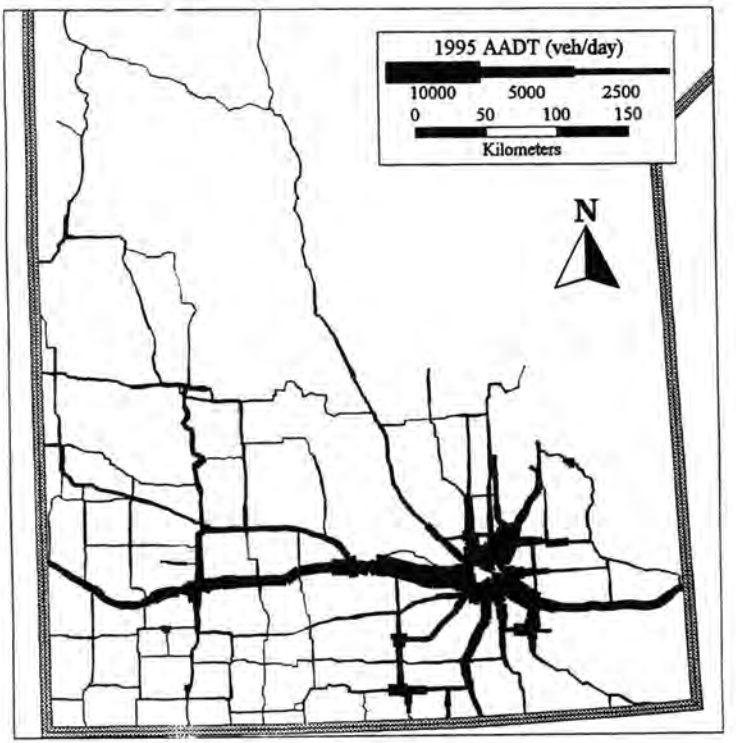


Figure 2: 1995 Combined Average Annual Daily Traffic on the Manitoba Highway Network (*University of Manitoba Transportation Information Group)*

Inherent Variation of Estimates

The continuity of the number of vehicles passing through an intersection is expected to be represented by the estimated volumes. However, the AADT's for each link are estimated independently from adjacent links that may have used count data from different sampling periods and were expanded using different control stations. The degree of variance associated with each estimate influences the results of a comparison with other estimates. Thus, the intersection-balancing technique must acknowledge a minimal level of imbalance.

To understand variations in the data, the day-to-day inherent variation of traffic was determined using permanent counter data as shown in Figure 3 (Clayton, Alam, Lucas, et al., 1993). These observations show that the coefficient of variation of daily traffic volumes commonly decreases as a function of the average daily traffic. Generally, as the magnitude of a traffic volume estimate increases, the variance associated with the estimate decreases.

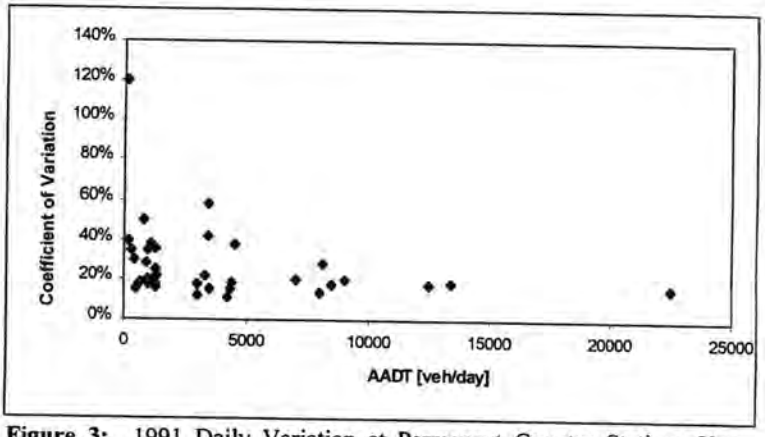


Figure 3: 1991 Daily Variation at Permanent Counter Stations Year Round *(Clayton, Alam, Lucas, et al., 1993)*

Intersection Balancing

Balancing Concept

A principal characteristic of flow in a network is that it is conserved at a single node. In other words, the total flow entering the node subtracted from the total flow leaving the node will equal a fixed external flow, *b*. For node *i*, this is denoted algebraically as,

$$\sum_{k \varepsilon M_{Oi}} f_k \; - \; \sum_{k \varepsilon M_{Ti}} f_k \; = \; b_i$$

where $M_{oi} = [k \mid o_k = i]$ is the list of arcs that originate at node *i* and $M_{ti} = [k \mid t_k = i]$ is the list of arcs that terminate at node *i* (Jensen, 1980).

The node may act as either a source or a sink allowing a surplus or deficit of flow as fixed external flow. In contrast, the node may act as a transshipment node where the flow into a node will equal the flow out of a node. A highway intersection, with links measuring flow as vehicles over time, is considered as a transshipment node. In this case, the fixed external flow, b_i, will equal zero, giving the expression,

$$\sum_{k \varepsilon M_{Oi}} f_k \; = \; \sum_{k \varepsilon M_{Ti}} f_k$$

where the ideal conservation of flow is satisfied.

The transshipment node may distribute, contribute, or transmit the flow. The distributive node consists of one arc terminating and two more arcs originating. The contributive node sees two or more arcs terminating and one originating. Finally, the transmission node has an equal number of arcs terminating and originating. To perfectly satisfy the conservation of flow, flow on the originating arcs must equal flow on the terminating arcs. In other words, the number of vehicles entering an intersection will equal the number of vehicles leaving the intersection.

The conservation of flow equation is evaluated by equating the flows entering the node to the flows leaving the node for each of the distributive, contributive and transmission properties. If the equation is satisfied, then the flow is conserved, and the node is said to be "balanced". Conversely, if the equation is not satisfied, conservation of flow is not achieved, and the node is said to be "imbalanced".

Balancing Rules

Consider a node from the highway network in Figure 4. The node has four connecting links, A, B, C, and D with undirected flows, f_A, f_B, f_C, and f_D respectively.

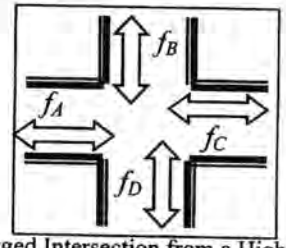


Figure 4: Four-Legged Intersection from a Highway Network

All possible combinations of flow entering and leaving a node with four links produce seven equations. To satisfy conservation of flow, an intersection must satisfy one of these equations.

$$f_A + f_B + f_C = f_D \quad (1)$$
$$f_B + f_C + f_D = f_A \quad (2)$$
$$f_A + f_C + f_D = f_B \quad (3)$$
$$f_A + f_B + f_D = f_C \quad (4)$$
$$f_A + f_B = f_C + f_D \quad (5)$$
$$f_B + f_C = f_D + f_A \quad (6)$$
$$f_B + f_D = f_A + f_C \quad (7)$$

Since the combined AADT is being evaluated, the flow is undirected. Consequently, the distributive and contributive properties become complementary resulting in equations (1) through (4) which equate one arc with the three arcs. The transmission rule equates two arcs with the remaining two arcs to produce the relationships (5) through (7).

For a three-legged intersection, there are only three possible combinations of flow because there is one less link. For this case, the equations (8) through (10) result.

$$f_A + f_B = f_C \quad (8)$$
$$f_B + f_C = f_A \quad (9)$$
$$f_A + f_C = f_B \quad (10)$$

Each rule is applied to each intersection in the system. The volume difference between the flow entering and leaving the node is quantified by the balancing rules. This is termed the "measure of imbalance". In short,

it is the deficit or surplus in traffic needed to conserve flow at that intersection.

From the arbitrary order of assignment of nodes at the intersection, these tests do not determine if volume distribution is lacking or overcompensating. These tests indicate only that the intersection does not exactly comply with the conditions of flow. As a result, the absolute value of the difference is used. A zero value indicates that the rule was satisfied while another sum indicates a discrepancy at that intersection concerning that particular rule. The rule with the lowest volume difference between the conserved flow and the real flow is considered the most likely flow pattern through the intersection. In reality, the intersection may follow another rule. An intersection with highly inaccurate AADT estimates could produce a very low volume difference for a flow pattern other than that which corresponds with the true flow property. This method assumes that, regardless of the variation associated with AADT estimates, the intersection-balancing tests will ascertain the actual flow pattern for each intersection. In effect, the evaluation takes for granted that the AADT estimates will be reasonable within the intersection-balancing framework.

Measure of Imbalance

The measure of imbalance of each intersection cannot be compared directly because each intersection has a different amount of total activity. For example, consider two different AADT estimates, one of 5000 vehicles per day and another 500 vehicles per day. If a surplus of 100 vehicles per day results at both sites, the percent difference for the high volume count would only be 2 percent compared to the 20 percent for the low volume count. For this reason, volume differences of all intersections in Manitoba cannot be compared directly to one another.

The volume difference is normalized according to total traffic entering and leaving an intersection using the "Imbalance-Activity Ratio". The Imbalance-Activity Ratio is the imbalance expressed as a percentage of the total activity.

$$\text{IMBALANCE-ACTIVITY RATIO} = \frac{\textit{Imbalance}}{\textit{Total Activity}} = \frac{\textit{Imbalance}}{f_A + f_B + f_C + f_D}$$

The total activity at an intersection is taken as the sum of the AADT estimates of each link connecting at that node. The Imbalance-Activity Ratio as a function of the total activity at an intersection forms the basis of determining which intersections are poorly balanced.

Link Evaluation

The last step in the quality-control method is to evaluate the individual AADT estimates of the links of imbalanced intersections. First, the relationship between imbalanced intersections in the system is established succeeded by investigating the potential sources of error. The current MHTIS methodology is fully documented and standard procedures allow for the reproduction of estimates. However, to produce an AADT estimate from the raw data obtained from short-term counts involves the manipulation of numerous databases, along with subjective components of the estimation methodology. The link evaluation attempts to explain the imbalance at the intersection due to a poor AADT estimate, then to recommend measures that may improve the estimate in the future. Note that this method never alters an AADT estimate.

The first type of imbalance would be caused by an error in the arithmetic while producing the AADT estimate. The production of an estimate from the raw data obtained from short-term counts involves calculations using values from many different databases. Several problems can occur during this process, whereby some may be due to system operating errors while others may be a result of human error (Yeow, 1997). The other type of imbalance may occur in decisions made during the AADT estimation methodology. AADT estimates are produced using a "factorless expansion method" that relates short-term count data with that obtained by permanent counter station (PCS) or Traffic Pattern Groups (TPG). Ultimately, the choice of the short-term count location along with the assignment of a TPG and PCS is subjective and can result in the creation of poor estimates. For example, if a low volume rural road is assigned to a permanent counter situated on a high volume urban commuter, the daily and monthly traffic patterns would not coincide and should not be related.

For each intersection, or system of intersections the following points are investigated:

Related Intersections

- Is AADT for the shared link too high or too compared to a value that would "balance" the network system?

Count Station Location

- Is each count station location near the intersection?
- Are there urban or municipal streets that were not inputted into the analysis that could contribute unaccounted traffic flow, thereby causing an imbalance?
- Was a count completed on each link or is there a link assigned the AADT of another link?

Traffic Pattern Group
- Does the TPG assigned to each link in the intersection coincide with one another?
- Can any discrepancies be explained?

Control Station Assignment
- Is the control station for each link assigned correctly?

Year of Estimate
- Are all AADT estimates at the intersection for the same year?

Volume Range
- Is there an AADT estimate that is relatively low compared to the AADT of the other links?

Upon completion of the above questions, there should be an indication of which link, or group of links, of the imbalanced intersection is poorly estimated. If necessary, the raw count data is accessed and the estimated is reproduced to ascertain that a calculation error did not occur. As a result of this analysis, the potential sources of error of poor AADT estimates are explained, and additional action can be recommended.

ANALYSIS

Intersection Search

The intersection search identified 835 highway intersections in Manitoba. Of those, 177 intersections where four-legged, while the remaining 658 intersections were three-legged. The intersection search also calculated the total activity of each intersection by summing the AADT from each corresponding link of the node. The magnitude of total intersection activity varied from 250 to 55,780 vehicles per day. The distribution of activity showed that 51.9 percent of intersections have a total activity of less than 2,500 vehicles per day and that 95.9 percent have a total activity of less than 25,000 vehicles per day. The large number of lower volume intersections reflected the low volume of traffic common to most Manitoba highways.

Intersection Balancing Test Results

The intersection balancing rules calculated the quantity of imbalance, in vehicles per day. Figure 5 shows that 80.2 percent or 670 intersections were imbalanced by 500 or fewer vehicles per day, while 9.1 percent or 76 intersections had volume differences greater than 1000 vehicles per day.

The Imbalance-Activity Ratio was calculated for each intersection in order to normalize the balancing test results with respect to the volume of vehicles passing through each intersection. The results presented in Figure 6 show that 37 percent or 309 intersections had an imbalance-activity ratio less than 0.05. In addition, 84.9 percent or 709 intersections were balanced within 20 percent of the intersection's total activity.

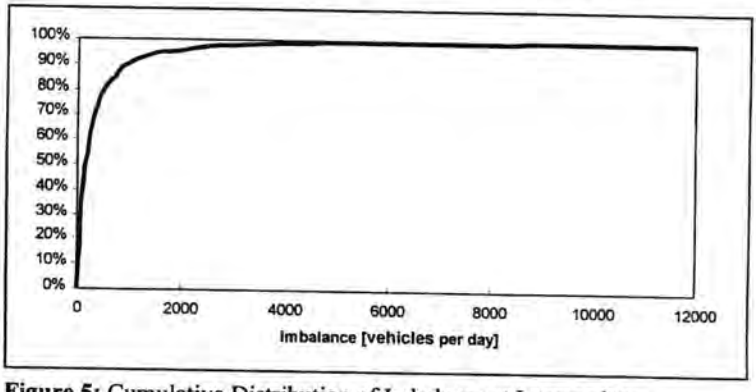


Figure 5: Cumulative Distribution of Imbalance at Intersections

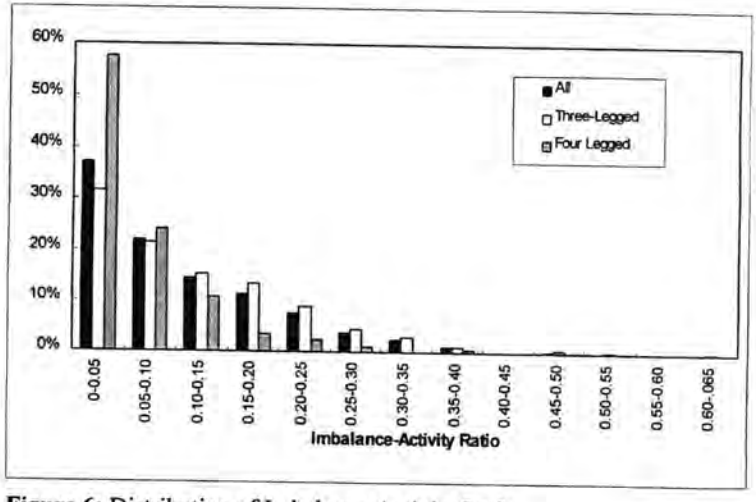


Figure 6: Distribution of Imbalance-Activity Ratio

Upper Bound Limit

Poorly balanced intersections were determined by developing an upper bound limit. A boundary envelope defined the limiting values of the Imbalance-Activity Ratio associated with the total activity at each intersection. The Upper Bound Limit Theory postulates that an exponential function can describe a phenomenon where the degree of freedom of the independent variable decreases as the independent variable itself increases (Fekpe, 1993). This method was applied based on the principle that the variance of AADT estimates decreases with increasing traffic volume as previously discussed. The Upper Bound Limit, shown in Figure 7 for this data set, was described by the equation,

$$\text{Imbalance-Activity Ratio} = 0.72e^{-0.00009(\text{Total Activity})}$$

which fitted the selected upper bound points with a coefficient of determination, r^2, of 0.99.

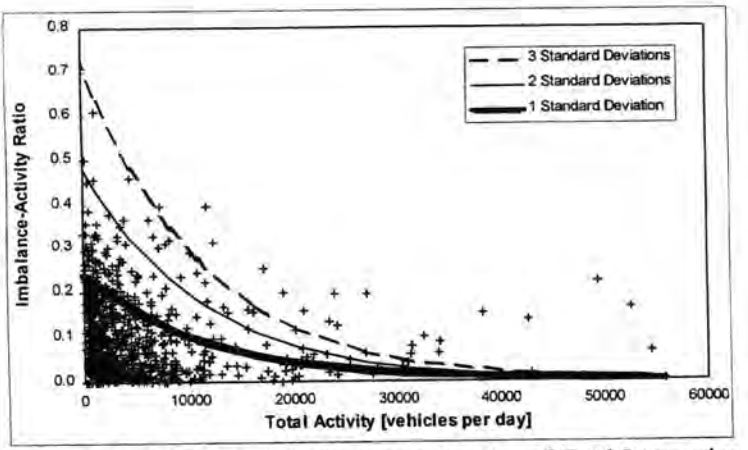


Figure 7: Imbalance-Activity Ratio as a Function of Total Intersection Activity

The Upper Bound Limit curve expresses the maximum possible Imbalance-Activity Ratio as a function of total intersection activity. Employing statistical analysis, the measure of imbalance was treated as a normally distributed variable with a mean of zero and a given standard deviation. To reproduce the normal distribution function, the Imbalance-Activity Ratio was assigned a mean of zero and a standard deviation that

decreased as the total activity increases. The probability of obtaining a value that differs more than two standard deviations from the mean is only about 5 percent. Furthermore, almost the entire probability mass, 99.8 percent of the observations, is located within about three standard deviations from the mean. The upper limit bound is then considered to be the equivalent of three standard deviations from an Imbalance-Activity Ratio of zero. The boundary curves defining the number of standard deviations from the mean are also drawn in Figure 7.

Intersections falling outside the envelope defined by the upper bound limit were considered poorly balanced and recommended to undergo supplementary analysis in the link evaluation process. From this analysis, 23 intersections were deemed unacceptably imbalanced beyond three standard deviations and 51 were considered imbalanced beyond 2 standard deviations.

CONCLUDING REMARKS

The evaluation of link estimates revealed that the intersection-balancing method was successful in identifying AADT estimates that were poorly estimated or that were in error in the database. The sources of imbalance that were recognized in the analysis are due to the limitations of the intersection balancing method and of the AADT estimation methodology.

Case studies revealed a large number of intersections that were imbalanced due to missing links on the network system. The absence of a traffic volume entering an intersection creates a larger imbalance than that created by variation alone. The majority of the missing links occurred near cities where a city street terminates and a provincial highway begins. Because both provincial highways near cities and the city streets adjoining those highways have large AADT's, a missing link creates a large imbalance. This reflects the limitation of the geographical file used in the analysis. The intersection search sorted links and identified intersections from the MHTIS highway database that does not include municipal roads or city streets. As a result, the intersection database is flawed at locations near cities.

The next major source of imbalance arose on links where AADT for that section of road was assigned the AADT of another section. This was done because a short-term count was not performed for that link. Since traffic volume varies from link to link, the AADT assignment to one link from another link may not be reasonable in some cases. The assignment

process should take the most consistent representative AADT for links with no estimates. These highway links appeared in every volume range and the length ranged from less than 100 meters to longer than 2 kilometers. Moreover, the geographic file requires separate highway control sections into links and nodes. It is possible that this convention contributed to the assignment of AADT from different links.

Recommendations:

- The link evaluation component of the quality-control methodology should be automated to identify possible sources of error of AADT estimates with greater ease. The link evaluation presently requires that an analyst study the results after imbalance intersections have been identified.

- The integration of traffic information systems of different jurisdictions (Province of Manitoba, the City of Winnipeg, and the City of Brandon) would allow a better application of the intersection balancing method.

- The assignment of AADT's to links in the highway network on which there was not a coverage count should be reviewed so that those links can provide better information. The importance and length of these control sections should be considered as well. Methods that may include averaging or balancing intersections connected to these links should be explored.

- Further development of automated quality-control techniques based on network principles would enhance the AADT estimates. These include a route-consistency method that would treat AADT estimates as continuum of traffic flow from one link to the next. Adjacent AADT estimates that have differing magnitudes would be investigated. This system could incorporate the knowledge of historical traffic patterns so that large differences in volumes from previous years could be identified and accounted for.

- The expansion of MHTIS methods to include the analysis of the accuracy of AADT estimates would provide users of traffic statistics with a better understanding of the integrity of the AADT estimates.

REFERENCES

1. Albright, David. "Standardization of Traffic Volume Data". Transportation Research Board, January 1991.
2. American Association of State Highway and Transportation Officials. "Guidelines for Traffic Data Programs". 1992.
3. Booy, C. "Probability and Statistics for Engineering Decisions". Course Notes. Department of Civil and Geological Engineering, University of Manitoba, August, 1993.
4. Clayton, Alam, Lucas, Brian, et al. "Design, Development and Implementation of a Traffic Monitoring System". University of Manitoba Transport Institute, April 1993.
5. Clayton, Lucas & Alam. "System Specifications". University of Manitoba, August 1994.
6. Fepke, Edward S.K. "Characteristics of Heavy Vehicle Weight Distributions and Pavement Loading. Doctor of Philosophy Thesis. Department of Civil and Geological Engineering, University of Manitoba, September 1993.
7. Hillier, Frederick S. and Lieberman, Gerald J. "Introduction to Mathematical Programming". McGraw-Hill Publishing Company, 1990.
8. Jensen, Paul A. "Network Flow Programming". Wiley & Sons, 1980.
9. Morlok, Edward K. "Introduction to Transportation Engineering and Planning". McGraw-Hill, 1978.
10. University of Manitoba Transportation Information Group. "Traffic on Manitoba Highways 1995". June 1996.
11. Whitehouse, Gary E. "Systems Analysis and Design Using Network Techniques". Prentice-Hall Inc., 1973.
12. Yeow, Jessie Mei-Li. "Enhancing Estimates of Annual Average Daily Traffic (AADT) On Manitoba's Provincial Highways". Master of Science Thesis. Department of Civil and Geological Engineering, University of Manitoba, 1997.

Le problème du commis-voyageur

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1. INTRODUCTION

De tous les phénomènes étudiés par la recherche opérationnelle moderne, le problème du commis-voyageur (TSP= *traveling salesman problem*) demeure l'un des plus communs. Cet article présente, dans un premier temps, la formulation de ce problème et ses principales approches de résolution développées depuis que Sir William Rowan Hamilton s'y est penché en 1859. Ensuite, une technique de résolution pragmatique (par courbes spacefilling) est exposée. Puis, l'implantation des principaux heurisitiques sur le logiciel Excel est expliquée. Enfin, le document discute de quelques perspectives liées au TSP.

2. PRÉSENTATION DU PROBLÈME DU COMMIS-VOYAGEUR

2.1 Applications

Le problème *général* du commis-voyageur implique pour cet individu la création d'une tournée passant au moins une fois par chaque ville devant être desservie (GSP= *general salesman problem*). Le commis-voyageur vise dans cet exercice la minimisation de ses frais de déplacements (essence et distance). La formulation du problème "pur" du commis-voyageur (TSP) exige que chaque ville ne soit visitée *qu'une seule fois*.

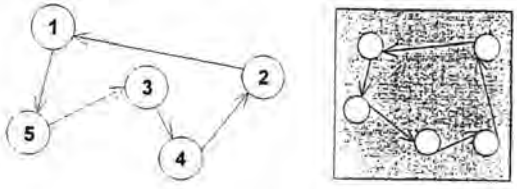


Figure 1: Exemples d'application du TSP

Plusieurs applications s'y apparentent[1]: problèmes de livraison et cueillette (avec clients ciblés), câblage informatique (longueur minimale de câble), perçage de trous dans une plaquette (les déplacements de la perceuse devant être minimisés), ordonnancement des travaux sur une machine (selon les précédences), etc.

2.2 Formulation du problème

Cette section formule quelques variantes du problème du commis-voyageur. Une bref résumé de la nomenclature des graphes sera suivi d'énoncés de TSP et d'une formulation mathématique.

2.2.1 Nomenclature

Soit un graphe G non-orienté (symétrique) où tous les noeuds sont interreliés (graphe fortement connexe, voir Figure 2). Soit d(i,j) la distance entre les noeuds i et j. La théorie des graphes nous indique que:

- Un cycle qui traverse chaque noeud au moins une fois est appelé un cycle de commis-voyageur.
- Un cycle qui traverse chaque noeud exactement une fois est appelé un cycle hamiltonien; celui-ci contient exactement N liens, où N est le nombre de noeuds.

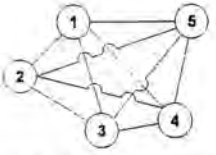


Figure 2: Graphe non-orienté G

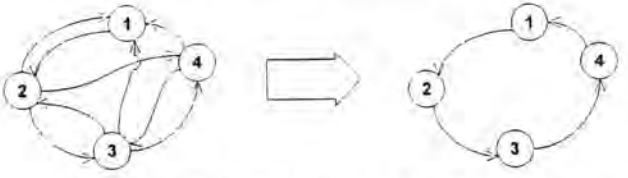


Figure 3: Graphe orienté où il existe un cycle hamiltonien

Le problème du commis-voyageur "pur" (TSP) implique la recherche d'un cycle hamiltonien dans le graphe. L'existence absolue d'un tel cycle nécessite la non-négativité des distances, ce que nous supposerons ici. Pour résoudre le problème du commis-voyageur, nous devons trouver un cycle hamiltonien pour lequel la condition suivante est atteinte[2]:

$$d(i,j) \leq d(i,k) + d(k,j) \quad \forall\, k \neq i, k \neq j$$

C'est-à-dire que la distance entre les noeuds i et j n'est jamais supérieure à celle passant par un noeud k, pour toutes les paires i,j du cycle. Même si le problème apparaît "simple", sa complexité de calcul augmente

rapidement: le nombre de cycles possibles est $(n\text{-}1)!/2$ pour un graphe symétrique (le double pour un graphe asymétrique).

2.2.2 Symétrique vs asymétrique

Le graphe G peut également être orienté. Il est dit asymétrique si les distances entre deux noeuds diffèrent selon la direction (ATSP = *asymetric traveling salesman problem*). S'il reste fortement connexe, alors un cycle hamiltonien existe et il est possible de résoudre le problème du commis-voyageur. Sinon, on peut vérifier l'existence d'un cycle hamiltonien à l'aide d'une formule de la forme suivante, où d est le degré de chaque noeud (nombre de liens connectés):

$$d(x_i) \le i \le \frac{n}{2} \Rightarrow d(x_{n-i}) \ge n-i, n \ge 3, d(x_1) \le d(x_2) \le \ldots \le d(x_n)$$

2.2.3 Contraintes ajoutées

Des contraintes peuvent s'ajouter aux conditions précédentes[3]. Par exemple, si le commis doit absolument visiter une ville avant une autre pour une séquence cueillette-livraison, il s'agit d'un nouveau cas, appelé *sequential ordering problem* (SOP). De même, si son véhicule possède une capacité limitée, il faut envisager la prise en compte des quantités à livrer et à cueillir. Le cas est appelé *capacitated vehicle routing problem* (CVRP).

2.2.4 Formulation mathématique

Le TSP peut être formulé comme un problème d'affectation[4], où les c_{ij} sont les coûts (distances) entre les noeuds i et j:

$$\text{Min} \sum_i \sum_j c_{ij} x_{ij}$$

$$\text{sujet à } \sum_i x_{ij} = 1, j = 1, \ldots, n \text{ et } \sum_j x_{ij} = 1, i = 1, \ldots, n$$

x_{ij}=1 si le lien i,j fait partie d'un cycle hamiltonien
x_{ij}=0 si le lien i,j ne fait pas partie d'un cycle hamiltonien.

Par cette formulation, on remarque que le TSP s'apparente à certains problèmes de transport[5] (distribution, localisation, utilisation d'équipements, etc.). En fait, il suffit de poser des coûts-distances infinis sur certains liens pour retrouver des formulations classiques.

2.3 Approches de résolution

De par sa nature, le TSP (ou l'ATSP) atteint une complexité exponentielle (NP-difficile). Comme la plupart des problèmes d'optimisation

combinatoire, il peut être approché de deux façons: les algorithmes *exacts* et les algorithmes *heuristiques*[6].

2.3.1 Par algorithmes exacts

Le problème du commis-voyageur, tel qu'exprimé à la section 2.2.4, peut être approché à l'aide de la programmation linéaire classique. En plus de la minimisation du coût total, la difficulté provient de la vérification systématique de l'existence du cycle hamiltonien, un problème NP-difficile.

Quelques auteurs ont proposé des algorithmes de programmation linéaire en nombres entiers: Dantzig, Fulkerson et Jonhson (1954) ainsi que Miller, Tucker et Zemlin (1960). Cependant, la croissance exponentielle du temps de calcul en fonction du nombre de noeuds semble en faire reculer plus d'un, qui se dirigent vers les heuristiques.

2.3.2 Par recherche locale (*Local Search*)

Un heuristique simple à envisager est la recherche locale. Il s'exprime comme suit (de façon très schématique)[7]:

Choisir une solution initiale (un noeud ou un cycle)
Choisir un noeud voisin tel que son branchement aura pour effet de minimiser le coût total
Changer de noeud

Les questions liées à ce genre d'heuristique sont nombreuses: Quelle solution initiale doit-on choisir? Quels noeuds sont "voisins"? Quelle fonction de voisinage doit-on utiliser? Dans quel ordre doit-on parcourir les noeuds? Les résultats obtenus à l'aide de ces heuristiques dépendent de ces questions. Ils présentent cependant l'avantage d'être simples et applicables à tous les genres de problèmes. Ils servent également de balises aux autres algorithmes dans l'examen des performances de calcul.

2.3.3 Par "recuisson" simulée (*Simulated Annealing*) et acceptation de seuil (*Threshold Accepting*)

La recuisson est un phénomène physique permettant d'obtenir de bas états énergétiques dans les solides. Dans le cas présent, une analogie peut être faite entre le problème physique et le problème mathématique du TSP: les solutions correspondent aux états du système, le coût est équivalent à l'énergie, le paramètre de contrôle est la température et la solution heuristique correspond à un état gelé[8]. Voici, en quelques phrases, le principe de cet algorithme:

Choisir une solution initiale et une température initiale

Tant que le critère de température n'est pas atteint, faire C ou D
Choisir un voisin qui fait baisser l'énergie
Si le voisin fait augmenter légèrement l'énergie, on peut le choisir en vertu d'une probabilité
Réduire la température et recommencer

Cette "recette" permet la sélection d'un noeud voisin même si son choix fait momentanément augmenter le coût total. En fait, on suppose que ce risque (établi par une probabilité) aura des effets bénéfiques globaux. Cet algorithme souffre des restrictions habituelles: choix d'une solution initiale, choix du nombre d'essais sur les voisins, choix d'un critère d'arrêt.

Une autre approche, par acceptation de seuil (*Threshold Accepting*), est très similaire à la recuisson simulée. Dans cet algorithme, l'acceptation d'une nouvelle solution ne dépend pas d'une probabilité, mais d'un seuil. Les solutions intermédiaires sont donc acceptées si le coût total n'est augmenté que d'une valeur ne dépassant pas le seuil.

2.3.4 Par algorithmes génétiques (*Genetic Algorithms*)

Les algorithmes génétiques sont obtenus par analogie avec la structure génétique biologique et les chromosomes. Ils reposent sur les principes de compétition entre les individus, et sur l'influence génétique apportée par les "bons" individus jusqu'à ce que la population soit adaptée à leur environnement[9]. De façon simpliste, voici leur fonctionnement lié au TSP:

Générer et caractériser une population N (noeuds)
Déterminer la correspondance (*fitness*) des individus par rapport à la population
Déterminer une probabilité de choix d'un individu en fonction de ses caractéristiques
Générer une solution itérative en sélectionnant des individus et en vérifiant leurs caractéristiques dominantes
Répéter les générations jusqu'à l'obtention d'une solution satisfaisante.

À l'heure actuelle, certains problèmes d'adaptation du TSP aux algorithmes génétiques ont été résolus, tel que la représentation chromosomique des cycles et la fonction de correspondance (*fitness*). Cependant, les opérations de mutation et de permutation génèrent quelquefois des solutions irréalisables.

2.3.5 Par recherche "taboue" (Tabu Search)

Les algorithmes de recherche taboue sont également appliqués au TSP[10]. Ces heuristiques exploitent leur "mémoire" du problème, c'est-à-dire la

connaissance d'un certain nombre de paramètres provenant des étapes de résolution précédentes. L'essentiel de l'approche réside dans la génération de mouvements (*moves*) dans des directions déterminées en fonction de la "mémoire" du processus:

Utiliser une solution initiale
Examiner la mémoire du processus
Décider d'un mouvement vers un voisin (ou groupe de voisins)
Examiner les bénéfices du mouvement
Nourrir la mémoire et répéter

2.3.6 Courbes "spacefilling"

Un article[11] de John J. Bartoldi III, de l'Université Georgia Tech, évoque la possibilité de construire des tournées de véhicules à partir de courbes dites *spacefilling*. Ces courbes ont été créées au début des années 1900 par des mathématiciens tel que Peano, Sierpinski et Hilbert. La courbe de Spierpinski, par exemple, est continue en tout point mais jamais différenciable. Cette courbe, tout comme les autres *spacefilling*, eut, avec une seule dimension, remplir un espace à deux dimensions.

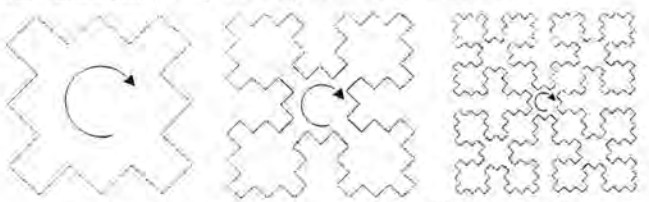


Figure 4: Construction de la courbe "spacefilling" de Sierpinski

La fabrication de la courbe de Sierpinski (Figure 4) se fait à l'aide de figures récursivement imbriquées l'une dans l'autre. L'espace est divisé en quadrant dans lesquels sont insérées des copies réduites de la figure précédente, auxquelles des raccordements sont effectués. La limite infinie de cette courbe couvre l'ensemble de l'espace bidimensionnel.

On peut imaginer un vendeur compulsif qui visite chaque point de l'espace. L'auteur suggère qu'il utilise ce genre de courbe pour le faire, ce qui est une solution satisfaisante. Au cas où le nombre de points est limité, le vendeur peut continuer à parcourir ces points selon un ordre respectant la courbe *spacefilling*.

Si on détermine un point de départ sur la courbe (par exemple, le coin inférieur gauche), il est possible de caractériser à l'aide d'un indice I

chaque point de l'espace, selon qu'il se trouve près (vers 0%) ou loin (vers 100%) du point de départ suivant l'ordre de parcours.

L'algorithme de fabrication des tournées se résume aux énoncés suivants:

Pour chaque localisation X,Y de l'espace, calculer l'indice I associé à sa position sur la courbe de Sierpinski.
Trier ces indices I en ordre croissant. Il s'agit de l'ordre de visite des localisations de la tournée.

Une méthode simple par décomposition en triangles rectangles permet de calculer rapidement un indice qui permet le classement en ordre croissant des localisation sans toutefois obtenir un indice I exprimé en pourcentage (voir Figure 5). On obtient un algorithme qui ne requiert que 2n valeurs (les coordonnées). Les distances entre les noeuds (d'ordre n^2) ne sont pas requises.

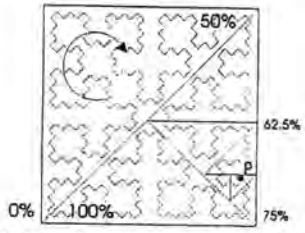


Figure 5: Calcul de la position sur la courbe "spacefilling"

3. IMPLANTATION D'HEURISTIQUES SUR EXCEL

Cette section décrit l'implantation de quelques heuristiques sur le tableur Excel[12]. Après une brève description des composantes de l'application, quelques comparaisons seront effectuées sur les performances des algorithmes.

3.1 Application Excel

Le logiciel Excel est un tableur liant les fonctions de Windows (graphisme, impression) aux possibilités de traitement des chiffres (et des caractères), en plus de fournir des facilités graphiques et un langage de programmation orienté-objet.

3.1.1 Page de simulation

L'application Excel montée pour le contexte du TSP se compose de deux feuilles de calcul utilisées pour l'interaction: la feuille de simulation et la feuille de comparaison.

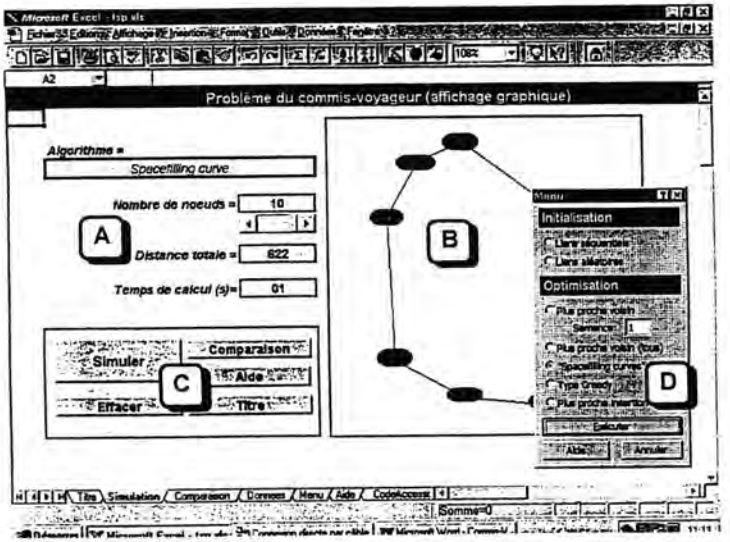


Figure 6: Page de simulation

La page de simulation (Figure 6) comprend quatre parties principales:

A. La *zone d'information* indique le nom de l'algorithme utilisé, la distance totale pour la solution affichée ainsi que le temps de calcul (en secondes). On peut également y modifier le nombre de noeuds (ce nombre varie entre 3 et 10).

B. La *zone d'affichage* indique la localisation des noeuds à l'intérieur de la boîte. On peut déplacer les noeuds en les "draguant" à l'aide de la souris. Cette zone affiche également la solution pour l'algorithme en cours.

C. La *zone de contrôle* permet de sélectionner l'action à prendre. On peut y initier une simulation, produire une comparaison, ou effacer les liens (et la solution en cours).

D. La *boîte de dialogue de simulation* offre la possibilité de choisir le mode d'initialisation ainsi que l'algorithme de simulation à utiliser.

3.1.2 Page de comparaison

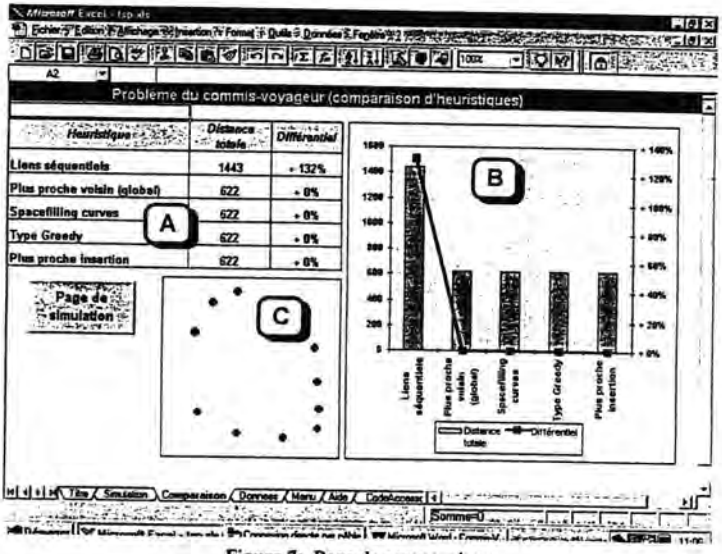


Figure 7: Page de comparaison

La page de comparaison (Figure 7) se divise en trois sections:

A. Le *tableau des résultats* indique la distance totale obtenue pour chaque heuristique (exécutés en cascade). Le différentiel est basé sur la plus petite valeur calculée.
B. Le *graphique* affiche les résultats du tableau.
C. La *zone réduite d'affichage* réplique la position des noeuds sur la page de simulation afin de permettre l'impression de la page de comparaison en un jeu complet.

3.2 Programmation des heuristiques

3.2.1 Choix des heuristiques

Les heuristiques sélectionnés proviennent de l'article de Bartholdi[13]. De plus, des processus d'initialisation ont été ajoutés pour offrir d'autres solutions faisables (cycles hamiltoniens):

Liens séquentiels. Les noeuds sont reliés par ordre de numéro croissant, et le dernier est relié au premier (1-2-3-4-5-6-7-8-9-10-1).

Liens aléatoires. Des liens sont créés par sélection aléatoire d'un noeud non-visité.

Plus proche voisin avec semence. L'algorithme *Nearest Neighbor* est utilisé avec sélection d'un noeud initial.
Plus proche voisin (global). L'algorithme *Plus proche voisin avec semence* est utilisé séquentiellement pour l'ensemble des noeuds; la meilleure solution est retenue.
Spacefilling curves. Une courbe de Spierpinski, avec calcul de l'indice I, est utilisée pour classer les noeuds et déterminer un cycle optimal.
Type Greedy. Un algorithme de type Greedy (avec ajout des liens les plus courts) est utilisé.
Plus proche insertion. Un algorithme de type *PlusProcheVoisin* détermine les meilleures insertions en vue d'obtenir le cycle optimal.

3.2.2 Langage de programmation

Le langage de programmation utilisé est Visual Basic pour Applications (VBA), compris dans le logiciel Excel. Il s'agit d'un langage interprété, fondé sur BASIC auquel des notions orientées-objet ont été ajoutées[14]. Ce genre de langage est polyvalent et malléable. On peut y définir des variables à longue dénomination, utiliser les concepts de procédures et fonctions et employer les fonctions de feuille de calcul d'Excel. Il permet également l'utilisation de boîtes de dialogue en tant que feuilles du classeur.

3.3 Comparaison et analyses

Cette section contient des comparaisons et analyses, basées sur un petit problème de référence. Les résultats proviennent de l'utilisation de l'application Excel décrite ci-haut.

3.3.1 Problème de référence: *Molbatt*

Le microbrasseur *Molbatt* effectue une livraison quotidienne à l'aide d'un seul véhicule. L'entreprise possède de nombreux clients parsemés sur le territoire de Carréville, mais ne les dessert pas à chaque jour. En effet, les bières *Molbatt* et *Molbatt Légère* n'occupent pas une importante part de marché; les ventes sont sporadiques et le microbrasseur ne peut pas visiter ses clients régulièrement: ceux-ci appellent au bureau des ventes, où l'employé de service prépare la tournée du lendemain. Il est rare qu'il y ait plus de 10 clients à desservir par jour

3.3.2 Examen d'une semaine de livraison

Le sénateur John Molbatt, dirigeant de l'entreprise, demande une analyse détaillée pour une semaine type de 5 jours. Les algorithmes suivants sont examinés: *Plus proche voisin* (**PPV**), *Plus proche insertion* (**PPI**), *Type*

Greedy (**TG**) et *Spacefilling curves* (**SC**). L'entrepôt de *Molbatt* est associée au noeud numéro 1.

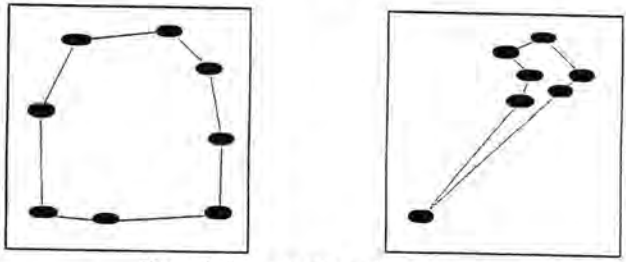


Figure 8: Tournées du lundi et du mardi

Le lundi (Figure 8), les 7 clients sont répartis en cercle à travers le territoire. Tous les heuristiques donnent une solution "optimale" de 668 (unités pixélisées). Ils n'ont aucun mal à résoudre ce problème où la solution est triviale.

La tournée du mardi compte 6 clients localisés dans une grappe au bout de la ville. Le tableau suivant rend compte des résultats.

Tableau 1: Résultats du mardi

Heuristique	Distance totale	Différentiel
Plus proche voisin (global)	548	+ 0%
Spacefilling curves	548	+ 0%
Type Greedy	642	+ 17%
Plus proche insertion	642	+ 17%

Les algorithmes PPV et SC donnent de bons résultats dans ce cas. Les heuristiques PPI et TG dépendent de leur classement de liens et doivent débuter avec le lien le plus court, ce qui joue en leur défaveur.

Tableau 2: Résultats du mercredi

Heuristique	Distance totale	Différentiel
Plus proche voisin (global)	622	+ 0%
Spacefilling curves	681	+ 9%
Type Greedy	676	+ 9%
Plus proche insertion	690	+ 11%

Le mercredi (Figure 9), il y a 9 clients répartis en deux grappes distinctes. Cette fois-ci, le PPV donne une distance de 622, contre 9% de plus pour TG et SC. Le PPI est très sensible à la position du lien de départ (7-2). Les résultats apparaissent dans le Tableau 2.

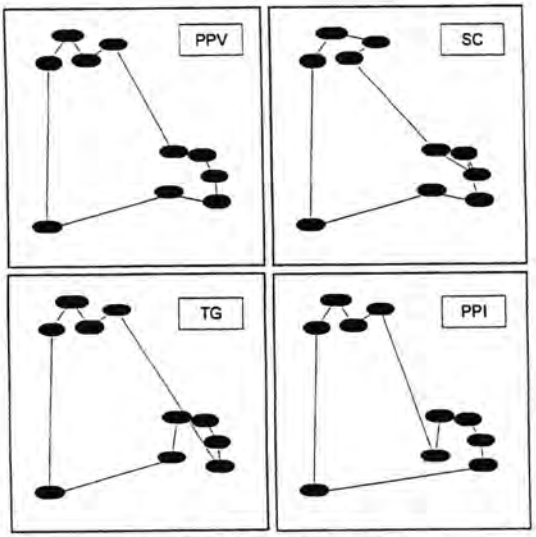


Figure 9: Tournées du mercredi

Tableau 3: Résultats du jeudi

Heuristique	Distance totale	Différentiel
Plus proche voisin (global)	643	+ 0%
Spacefilling curves	771	+ 20%
Type Greedy	674	+ 5%
Plus proche insertion	674	+ 5%

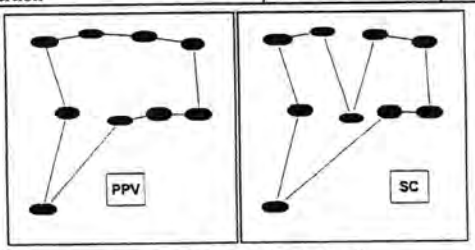


Figure 10: Tournées du jeudi

Le jeudi (Figure 10), la clientèle se répartit selon deux lignes horizontales sur le territoire (le long de deux artères importantes). Les algorithmes PPV, PPI et TG se comportent bien sur ce genre de schème, car ils sélectionnent le plus proche voisin. Cependant, le *spacefilling curve*, en vertu de l'indice de Sierpinski (qui dépend du parcours de la courbe), propose un détour par le client 9 et dépasse le résultat optimum de 20%..

La clientèle du vendredi (Tableau 4) est constituée des points de vente de la chaîne de dépanneur *CoucheToiPas*, qui sont répartis uniformément sur le territoire de Carréville. Pour cette configuration, les algorithmes PPV et SC demeurent les plus appropriés, avec un gain d'environ 10% sur TG et PPI.

Tableau 4: Résultats du vendredi

Heuristique	Distance totale	Différentiel
Plus proche voisin (global)	809	+ 3%
Spacefilling curves	789	+ 0%
Type Greedy	885	+ 12%
Plus proche insertion	885	+ 12%

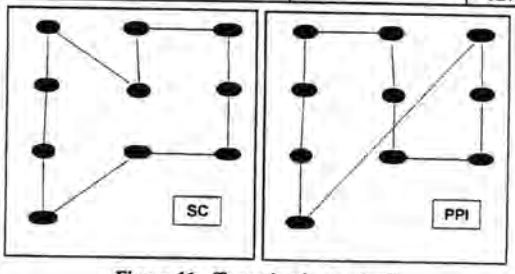


Figure 11: Tournées du vendredi

3.3.3 Conclusion sur l'utilisation des algorithmes

Somme toute, l'algorithme *Plus proche voisin* s'est avéré valable pour toutes les configurations présentées. L'examen des *points* plutôt que des *liens* semble un atout; la plupart des heuristiques (recuisson, seuil, génétique) utilisent la notion de voisinage. Les algorithmes de type *Greedy* et *Plus proche insertion* devront être raffinés ou faire l'objet d'essais successifs avec d'autres liens de départ (et non le plus court) afin d'éviter les différentiels excessifs.

L'algorithme *spacefilling curve* exploite les propriétés géométriques de la linéarisation de l'espace. En ce sens, ils demeurent une excellente alternative dans le cas où les points sont distribués à peu près uniformément sur le territoire (et si le temps de calcul est une composante importante).

4. CONCLUSION

Le *traveling salesman problem*, dans sa forme actuelle, fait face à un paradoxe de résolution. En effet, il est indéniable que la puissance et la capacité des ordinateurs ne cessera indéfiniment d'augmenter. Cependant, la qualité et la taille des systèmes d'information associés feront en sorte

d'augmenter la quantité de données servant *d'input* au problème. Ainsi, même avec les *CRAY* les plus puissants, il semble que l'aspect données-solution demeurera problématique.

Certains auteurs estiment que le débat ne se situe pas à ce niveau[15]. En effet, ils en concluent que les préoccupations des chercheurs opérationnels ont quitté les éléments de base, soit l'obtention de données fiables, suffisamment complètes pour que la résolution du problème s'impose d'elle-même. Le TSP est un exemple patent où le processus d'initialisation est très important, et une bonne connaissance des données composant la solution de base est primordiale. L'utilisation de méthodes d'optimisation légères[16], où toutes les subtilités sont maîtrisées par le chercheur, semblent être une solution souhaitable pour le spécialiste en TSP.

5. RÉFÉRENCES

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[1] EVANS, J., MINIEKA, E., *Optimization Algorithm for Network and Graphs*, Dekker, 1992, p. 317.

[2] *id.*, p. 327

[3] REINELT, G., Universitat Heidelberg, http://www.iwr.uni-heidelberg.de/iwr/comopt/soft

[4] LANGEVIN, A., SOUMIS, F., DESROSIERS, J., *Classification of Traveling Salesman Problem Formulations*, Centre de recherche sur les transports, Montréal, publication no. 682, 1988, p. 2.

[5] MANDL, C., *Applied Network Optimization*, Academic Press, 1979, p. 123.

[6] LAPORTE, G., *The Traveling Salesman Problem: An Overview of Exact and Approximate Algorithms*, Centre de recherche sur les transports, publication no. 744, 1991, p. 6.

[7] TELFAR, G., Institute of Statistics and Operations Research, Wellington, Nouvelle-Zélande, http://www.isor.vuw.ac.nz

[8] ROBINSON, Guy, Northeast Parallel Architecture Center, Syracuse, http://www.npac.syr.edu

[9] (inconnu), Imperial College of Science Technology and Medecine, London, United Kingdom, http://www-des.doc.ic.ac.uk

[10] TELFAR, G., Institute of Statistics and Operations Research, Wellington, Nouvelle-Zélande, http://www.isor.vuw.ac.nz

[11] BARTHOLDI III, J., *A Routing System Based on Spacefilling Curves*, Georgia Tech University, April 1996.

[12] Excel est une marque déposée de Microsoft Corporation.

[13] BARTHOLDI III, J., *A Routing System Based on Spacefilling Curves*, Georgia Tech University, April 1996.

[14] CHAPLEAU, R., TRÉPANIER, M. (1997). Transportation Object-Oriented Modeling: an Extension of the Totally Disaggregate Approach, International Association of Travel Behavior Research, Austin, Texas.

[15] VOELLER, J., *Data-centered thinking*, Journal of Computing in Civil Engineering, volume 10, numéro 1, janvier 1996.

[16] ORMEROD, R., *Putting soft OR methods to work: informations system strategy development at Richards Bay*, Journal of Operations Research Society, volume 47, numéro 9, septembre 1996.

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