Canadian Transportation: Competing in a Global Context

La Compétitivité des Transports au Canada dans un Contexte Global



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Le Groupe de Recherches sur les Transports au Canada

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Canadian Transportation: Competing in a Global Context

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du 27ème Conférence Annuelle du Groupe de Recherches sur les Transports au Canada

La Compétitivité des Transports au Canada dans un Contexte Global

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Edited and Compiled by Nigel Waters, Ph.D. Vice-President, Program and Publications

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President's Message

Welcome to CTRF's 27th Annual Conference. Bienvenue à tous.

The theme of this year's conference is Canadian Transportation: Competing in a Global Context. It is instructive to note that the last time CTRF met in this part of Alberta - in Calgary - was in April, 1973. This was on the eve of the Western Economic Opportunities Conference, which took place in July of that year. Those of you who can remember that far back will recall that the focus of the WEOC was regional economic development. I'll bet this is the first time that you've seen that phrase in quite a while.

We have moved from a focus on how we can best invest the economic rent from western natural resources to how we can survive and remain competitive with the rest of the world. This shift has also altered our view of the transportation sector from an engine of regional economic development to a strategic element in the competitiveness of the Canadian economy in the global marketplace. Joe Clark recently made the comment that Marshall McLuhan's global village has become a tough neighbourhood. You don't have to go far from Banff to find that out.

This year's conference, organized by Nigel Waters, Vice President Program and Publications and Lloyd Ash, Vice President, Meetings, brings to CTRF members many of the crucial issues facing us in 1992. From the state of Canada's airline industry to the competitiveness of Canada's ports to the impact of the Free Trade Agreement to the skills and techniques that will enable the transportation sector to meet the needs of passengers and shippers, this conference program touches on all of them. There will also be opportunities for less gruelling activities as well after and between the sessions.

On your behalf, I congratulate and thank Vice Presidents Nigel Waters and Lloyd Ash for their time and talent organizing this conference. It is also appropriate to recognize the University of Calgary and Trimac, the respective employers of these people for their contribution. Finally, on behalf of the Board of Directors, thank you to all CTRF members for your continuing support.

Sincerely,

Andrew Elliott
President, CTRF

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MOTOR CARRIER AND RAILWAY COMPETITION BETWEEN CANADA AND THE UNITED STATES

by John Heads*

The objective of this paper is to review the competitive climate faced by motor carriers and railways in Canada and the United States. The paper is based on a study of the transborder competitiveness of Canadian trucking carried out by the University of Manitoba Transport Institute in mid-1991[1] and work undertaken by the present author into the relative taxation burdens of transport carriers in Canada and the United States.[2]

The paper starts with a section on taxation burdens facing the motor carrier and railway transport modes in Canada and the United States. The problem of input costs and operating environments is addressed in the second section. The scope of the paper is ambitious and, with apologies to T.S. Eliot, "between the idea and the reality . . . falls the shadow." The documentation of the taxation issue is reasonably comprehensive, but the data in other areas are less complete. Consequently, in places the paper is more a pointer towards the additional research which is needed rather than a definitive assessment of the "fairness" of current competition.

A. THE TAXATION ISSUE

The approach in this section is to establish a cost component structure for a typical Class I motor carrier, with a somewhat different approach for the railway industry, where payments under each taxation head are expressed as percentages of operating revenues. The relative tax burdens in Canada and the United States under each component are then established.

1. Cost/Tax Components

The cost components of a typical Class I Canadian motor carrier are given below.[3] The sources used to compile the table showed an operating income component of 6% for 1988, giving a return on capital of 7.6% before tax. Although even lower rates of return have been recorded during the present recession, nevertheless this component is raised to 8% in Table 1, which allows a pre-tax return on capital of 11.0%.

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* Director, University of Manitoba Transport Institute

Table 1: Cost Components of a Canadian Motor Carrier

	%
Salaries and wages	34.0
Employee benefits	7.0
Fuel	13.0
Materials	12.0
Depreciation - equipment	11.0
Depreciation - buildings, etc.	1.5
Other	13.5
Operating income	8.0
	100.0

In the case of railway transport, it was arithmetically easier to adopt a different approach. Table 2 shows tax payments by CP Rail as percentages of CP Rail operating revenues.[4] The pre-tax return on the net assets of CP Rail was only 5.7% in 1990 and this reduces the income tax component in Table 2. The accounts of CN Rail were not included in Table 2, primarily because CN Rail did not pay corporate taxes in 1990 as a result of losses on land sales; the tax burden for CN Rail under other tax categories would be comparable to the figures shown in Table 2.

Table 2: Tax Payments by CP Rail as % of CP Rail Operating Revenues

	%
Payroll taxes	2.4
Fuel taxes	2.5
Sales/excise taxes	0.9
Income taxes	3.4
Property taxes	1.8
	11.0

2. Payroll Taxes

Salaries and wages are equivalent to 34% of operating revenues for both Canadian motor carriers and Canadian railways. Payroll taxes are higher in the United States than in Canada. A greater proportion of social welfare costs in Canada is paid by the various levels of government from taxation sources not linked to employment, while in the U.S. more of these costs are funded by specific taxes on employment.

In the motor carrier industry, a comparison was made of payroll taxes on a $30,000 wage in Canada and the equivalent wage in the United States. In Canada, the comparisons covered the Canada Pension Plan, unemployment insurance and the payroll tax for health purposes prorated, as this is levied in only three Canadian provinces. In the U.S., the comparison covered payments under

the Federal Insurance Contribution Act (FICA) and federal and state unemployment taxes. The excess burden in the U.S. was equivalent to 1.7% of the basic wage. When applied to a salaries and wages bill equivalent to 34% of operating revenues, this gives the Canadian carrier an advantage of 0.6% in the payroll tax burden expressed as a percentage of net operating revenues.[5]

The burden of payroll taxes carried by U.S. railroads is much greater than that of U.S. motor carriers. In addition to the social security taxes paid by the motor carrier industry, the U.S. railroads are also faced with payments in respect of the Railroad Retirement Fund and Supplemental Annuities. Full information on the extent of these payments is not available in the public domain. CP Rail's Tax Issues implies that the excess burden on U.S. railroads from social security taxes and the Railroad Retirement Fund and Supplemental Annuities is equivalent to some 6.8% of the salaries and wages bill. Clearly, CP Rail has no reason to wish to exaggerate this heavier U.S. railroad burden, but rather the reverse. Nevertheless, the difference seemed high to the present author and correspondence with CN Rail suggested a figure roughly half this. In view of subsequent confirmation of the CN Rail estimate,[6] the excess burden is taken as equivalent to 3.4% of the salaries and wages bill. These lower payroll taxes therefore give the Canadian carrier an advantage of 1.2% in the tax burden expressed as a percentage of operating revenues.

3. Fuel Taxes

Diesel fuel in Canada is subject to a federal excise tax of 4¢/litre and this applies to fuel used by motor carriers[7] and by railways. As an input to the transportation industries, GST paid on diesel fuel is offset by an equivalent tax credit and this is therefore not considered further in this tax comparison. In the United States, the federal excise tax on diesel fuel was raised to U.S. 20¢/gallon effective January 1, 1991, for the motor carrier industry. At the current exchange rate (March, 1992) of U.S. $83.7 to one Canadian dollar, this excise tax converts to Canadian 6.3¢/litre. The U.S. federal government does not impose any sales/excise taxes on fuel used to propel railway rolling stock.

The 1991 provincial rates of tax on diesel fuel used by motor carriers were 12.6¢/litre in Ontario and Quebec and 9.3¢/litre in British Columbia, for a three province average of 11.5¢. In the U.S., state and local taxes averaged about U.S. 20¢/gallon, the same as the federal tax, and again equivalent to Canadian 6.3¢/litre.[8] Most provinces in Canada levy a tax on locomotive fuel and, although this is often relatively low, it reaches 15¢/litre in Saskatchewan and 12.6¢/litre in Manitoba, with the Manitoba figure reflecting a 1¢/litre reduction in the March 1992 budget. From an examination of published CP Rail data, we estimate that the provincial tax burden on railway diesel fuel averaged 5.9¢/litre in 1990. A Peat Marwick study, provided by CP Rail, examined 21 U.S. states, of which twelve states imposed sales/use or excise taxes on diesel fuel used by railways and

nine states were without such a tax. Averaging jurisdictions with and without a railroad diesel fuel tax, U.S. railroads were faced with an average state tax of about 0.8¢/litre.

Summarizing these findings, the Canadian motor carrier pays some 15.5¢/litre in federal and provincial taxes on diesel fuel, compared with the U.S. motor carrier's burden of 12.6¢/litre. The tax disadvantage of 2.9¢/litre in Canada is equivalent to 8.3% of the Canadian fuel price of approximately 35¢/litre including taxes. Fuel accounts for some 13% of motor carrier operating revenues. A Canadian operator would therefore save (8.3% of 13%) = 1.1% of total costs if U.S. fuel taxes were charged.

This calculation holds for a Canadian motor carrier operating within Canada and for a U.S. motor carrier operating within the U.S. However, virtually all the penalty to the Canadian motor carrier disappears on international traffic. This is because motor carriers are required to pay fuel tax on the basis of fuel used/prorated mileage travelled in each jurisdiction. For example, an Ontario carrier pays New York fuel taxes in respect of operations in that state and a New York carrier pays Ontario fuel taxes in respect of operations in that province. Although there is no prorating of federal taxes in accordance with mileage travelled in the U.S. and Canada, nevertheless both Canadian and U.S. carriers are free on international operations to buy fuel where they can minimize the federal tax bite. Thus, the burden of higher fuel taxes on operations within Canada, as against operations within the United States, virtually disappears on transborder trucking.

In railway operations, the Canadian carrier pays a total diesel fuel tax of 9.9¢/litre, against only 0.8¢/litre in the U.S. Fuel taxes represented 2.5% of CP Rail's operating revenues in 1990, with this figure excluding the manufacturer's sales tax on fuel. The major part of these taxes (92%) represents an excess tax burden over U.S. railroads, equivalent to 2.3% of total CP Rail operating revenues. Unlike the motor carrier industry, there is no redress for transborder operations. The railways pay provincial locomotive fuel taxes on the basis of estimated use in the various provinces. On transcontinental traffic, Canadian railways are therefore competing in Canada subject to Canadian tax requirements against U.S. railroads operating south of the border under U.S. tax regulations.

4. Sales Taxes on Materials and Equipment

Motor carrier and railway purchases of materials and equipment do not incur taxation at the federal level in Canada. GST levied on purchases is refunded against subsequent transactions. There is no federal taxation on railroad purchases of material and equipment in the United States. There is no general federal sales tax on the motor carrier industry in the U.S., but there is a 12% excise tax on trucks and trailers, a graduated excise tax on heavy tires and a

highway user tax on heavy trucks. We estimate that the federal tax rate must average about 6% over the whole spectrum of purchases of materials and equipment.

Provincial retail sales taxes in Canada, weighted according to population, are at an average rate of 6.5% for both motor carriers and railways. A comparable figure for U.S. state and local retail sales taxes would be 5.5%[9] However, in several states sales and use taxes do not apply to heavy tractors and trailers used in highway transport. International and interstate carriers ensure that their purchases of such equipment are made in states where there are no taxes and this effectively reduces the average rate of tax to 2.8% for motor carrier operations. Similarly, the majority of U.S. states do not charge sales/use tax on railway rolling stock, U.S. railroads therefore very rarely pay this tax, and their effective rate of sales tax is also 2.8%.

The net effect of this examination of retail sales and excise taxes for motor carriers is that Canadian operators have an advantage of 6% at the federal level, a disadvantage of 3.7% at the provincial-state level, and a net advantage of 2.3%. This advantage has to be applied to purchases of materials and to depreciation of equipment and buildings (with this depreciation figure used as a surrogate for equipment purchases), i.e. to a total of 24.5% of operating income. Canadian operators therefore have an advantage equivalent to 0.6% of operating revenues.

In railway transport, there is no difference between tax provisions at the federal level between Canada and the U.S., but the Canadian carrier pays 6.5% in provincial taxes against 2.8% in the U.S. Total CP Rail payments for sales/excise taxes were equivalent to 0.9% of railway revenues. Of this, some 0.5% is attributable to higher tax rates in Canada than in the U.S.

5. Corporate Taxes and Depreciation

Although corporate tax rates are lower at the federal level in Canada than in the U.S., the provincial tax rates are appreciably higher than the rates levied by U.S. states. In 1990, the combined corporate tax rate was approximately 43% in Canada, against a comparable rate of 40% in the United States.[10]

However, the U.S. advantage in corporate tax rates is secondary to the effects of much more generous depreciation allowances in the U.S. than in Canada. In the U.S., highway tractors can be fully depreciated in four years and highway trailers in six years. Canadian capital cost recovery allowances on equipment purchased before December 6, 1991, were at the rate of 30% on a diminishing balance basis ad infinitum, but this rate was increased on tractors to 40% for equipment purchased after December 6, 1991. The same problem arises in railway investment. The U.S. railroad is allowed to write off the complete value of any rail-related asset within eight years. In Canada, only 55% of the

railway investment is recovered through capital cost allowances after eight years and the provisions were even less generous than this for railway cars and track investment made before December 6, 1991.

In assessing the effects of higher tax rates and less generous capital cost recovery allowances, the approach was to consider the tax burden facing a motor carrier with a specified cash flow before depreciation and taxes in Canada, as compared with the U.S., and the corporate tax burden borne by CP Rail in Canada, as against what would be imposed in the U.S. These simulations produced corporate tax burdens which were higher in Canada than in the U.S. - to the extent of 0.7% of motor carrier operating revenues and 1.8% of CP Rail's railway revenues. The larger differential for CP Rail reflects low capital cost recovery rates on long-lasting railway investments. These comparisons incorporate the improved capital cost recovery allowances introduced in Canada effective December 6, 1991, but the carriers would point out quite justifiably that this understates their present burden, as the bulk of their investments were obviously made before this date.[11]

6. Property Taxes

The property tax issue has not been raised in a motor carrier context, but it is a source of contention in railway operations. The Canadian railways complain that property taxes are not assessed on highways, which are the right-of-way of the motor carrier industry, and they also fear that their property may be subject to higher property taxes than comparable commercial and industrial property. Since the Railroad Revitalization and Regulatory Reform Act was passed in 1976, the problem of discriminatory municipal taxes on railroad property no longer exists in the United States. This Act prevents a state or local authority from any tax discrimination against railroads in comparison with commercial property within its taxing jurisdiction. The Canadian railways have argued that similar requirements in Canada would reduce property taxes from 1.8% of railway revenues to approximately 1.1%.

7. Total Taxes

The following table brings together the relative tax burdens discussed in this section. The figures are all expressed as percentages of operating revenues, with Canadian advantages shown as positive figures and Canadian disadvantages as negative.

Table 3: Summary of Relative Tax Burdens on Canadian Carriers
Expressed as % of operating revenues

	Motor Carrier	Railway
Payroll	+ 0.6	+ 1.2
Fuel	- 1.1	2.3
Material and equipment	+ 0.6	- 0.5
Income	- 0.7	- 1.8
Property	-	- 0.7
(a) Total	- 0.6	- 4.1
(b) Total excluding payroll	- 1.2	- 5.3

Canadian railway carriers are at a considerable tax disadvantage - equivalent to 4.1% of operating revenues - compared to U.S. railroads, but the Canadian disadvantage is much smaller for motor carriers. This difference between the modes is explained by heavier federal taxation of motor carriers in the United States; fuel taxes imposed on the railways at both the federal and provincial levels in Canada; and inferior Canadian capital cost recovery allowances, which affect railways to a greater extent than motor carriers.

The examination so far has included payroll taxes. It is customary to include payroll taxes in studies of this type and to exclude differences in personal income tax and other taxation facing individual taxpayers, but the present author is not convinced that this approach is appropriate. Payroll taxes are higher in the U.S. than in Canada, because more social security benefits are funded from general taxation in Canada than in the U.S. If the comparison excludes differences in personal income tax, then perhaps payroll taxes should also be excluded from the equation. This has been the approach in the last line of Table 3 and hence the total Canadian disadvantage on the tax bite is increased.

As already mentioned, the Canadian tax disadvantage on fuel does not apply on transborder trucking, as truckers from both sides of the border are assessed fuel taxes in accordance with mileage performed in the respective jurisdictions. Excluding fuel from the calculation, the Canadian motor carrier industry does not have any disadvantage in transborder trucking. Unfortunately, this advantage does not extend to the railways. Transborder traffic is interchanged between U.S. and Canadian railways at the border, or at relatively short distances from the border, and not transported long distances in the foreign jurisdiction as in the trucking mode.

B. INPUT COSTS AND OPERATING ENVIRONMENTS

The second part of this paper discusses input costs and operating environments relating to the motor carrier and railway modes in Canada and the United States.

1. Input Costs

It has been claimed that the input costs faced by Canadian motor carriers in transborder traffic are appreciably higher than those incurred by U.S. carriers. This was examined by Trimac Consulting Services in a study carried out for Transport Canada in late 1990 and entitled Comparison of Canadian and U.S. Trucking Costs in Transborder Markets (referenced in the quotation below as Study 5). This summary is taken from the University of Manitoba Transport Institute report referenced in endnote 1 (pp. 96-98):

> Study 5 conducted an extensive costing of 100 representative traffic lanes between Canada and the United States, addressing each traffic lane for Canada and U.S. domiciled carriers and for unionized and non-unionized fleets giving a total of 400 observations. Taking the 1990/91 exchange rate of 85 U.S. cents to the Canadian dollar, the overall conclusion was that average operating cost was 6% higher for a Canadian domiciled trucker. The difference was much less for the larger unionized companies at 3% than for the smaller firms at 9%, primarily because the smaller U.S. firms often avoided the heavy cost of medical benefits incurred by larger firms.
>
> The following table shows the components which determined the cost disadvantage to the Canadian trucking company.

Cost Comparisons by Major Expense Component

Component	% of Total Costs	Canadian Costs as % of U.S. Costs
Drivers	27.8	90
Fuel	13.4	100
Repairs/tires	19.9	149
Miscellaneous	3.9	132
Equipment depreciation	6.3	108
Administration, terminal, pick-up and delivery	28.7	97
Total	100.0	106

Source: Study 5, pp. 21-2, data implicitly for end 1990/beginning 1991. It is assumed that transborder truckers purchase fuel at similar prices in cheapest locations.

The price indices in Table 5.4 include all indirect taxes in input prices, but not the effects of differences in tax rates and capital cost recovery allowances between the two jurisdictions. The major cost problem in Table 5.4 relates to repairs/tires as the miscellaneous category has too small a share of total cost to be of great concern. Obviously, there should be some comment about the reason for the extremely high cost of repairs and tires in Canada, but this is outside the terms of reference of Study 5.

The reader is left to speculate on the probable causes of the higher costs for repairs and tires in Canada. One possible reason is that longer distribution channels in Canada lead to higher marketing margins than is the case in the United States. Certainly, this argument has been applied to explain differences in the costs of consumer goods in Canada and the United States. Another argument pertains to the remaining customs duties that still apply to truck parts and tires. The impact of these duties also gets magnified as marketing intermediaries apply percentage mark ups to their supply prices. Consequently, customs duties could explain a significant part of the difference. A third suggestion relates to the differences in the depreciation schedules for truck equipment in Canada and the United States. The longer period of depreciation in Canada may encourage Canadian truckers to repair and overhaul older equipment that their U.S. counterparts would replace.

As of March, 1992, the exchange rate has fallen to 83.7 U.S. cents to the Canadian dollar and, according to the Trimac analysis, this would reduce the Canadian disadvantage to about 4.5%. However, the causes and explanations for these cost differences are not well documented. In particular, it is very difficult to understand why repairs/tires should be so much more expensive in Canada. It is also questionable as to whether these excess input costs would be borne by Canadian transborder truckers, since they have opportunities to purchase U.S. services in the normal course of their business. Many also have U.S. affiliates well able to take advantage of lower prices. It would seem that considerable more work is needed for a complete assessment of the relative level of input costs facing Canadian and U.S. motor carriers.

Turning to railway transport, there have been few complaints other than in the tax area of higher input prices for Canadian railways in comparison with U.S. railroads. However, the Canadian railways have claimed that their productivity gains have been less impressive than those of U.S. railroads in the 1980s. Specifically, Canadian labour productivity measured in gross ton miles per employee, increased by 62% in Canada in the period 1980-89, while labour productivity in U.S. railroads doubled.[12] However, without detailed examination, this alarming comparison need not be taken at face value. First, labour productivity is a very imperfect measure, which does not allow for changes in the capital investment used in the industry, and a total factor productivity measure would be more appropriate. Second, 1980 was the year when the

Staggers Act was passed to deregulate U.S. railroads, which had previously been controlled to a much greater extent than the Canadian railways. A comparison for the 1980-89 period would therefore be expected to show remarkable improvement in the U.S.

Nevertheless, Canadian railways do face high operating costs due to low traffic densities. The density of traffic per mile of track is significantly lower for both CN Rail and CP Rail than figures achieved by major U.S. railroads.[13] In addition, CN and CP each handle fewer tonne-miles than the major U.S. railroads, although the implications of this should not be pushed too far.[14] In part, these differences between Canada and the U.S. are the unavoidable result of geography and low population densities in Canada. However, the railways would argue that matters have been made worse by the limitation on line abandonment to 4% of total route mileage in any one year prior to 1993, together with the mandatory operation of the majority of prairie grain branchlines until the year 2000. CP Rail generates only 3% of its traffic from 50% of its mileage and CN Rail carries only 10% of its traffic on 67% of its rail mileage. The operation of low density track in Canada is considerable and this inevitably imposes costs on the system.

2. Operating Environments

Although the Canadian motor carrier industry is no longer alleging tax discrimination in comparison with U.S. motor carriers, there are considerable complaints as to the level of government expenditure on the roads in Canada. In the U.S., taxes on road users are dedicated to road expenditures and, in November 1991, the U.S. Congress approved a six-year $151 billion highway and mass transit package, welcomed by the trucking industry as rehabilitation of interstate highways and other primary roads. The American Trucking Association calculates that this expenditure and associated administrative streamlining will save the industry almost $1 billion per annum in administrative costs, quite apart from the additional savings attributable to better infrastructure.[15]

The Canadian Trucking Association has argued that similar expenditures are necessary in Canada. Over the decade 1975-76 to 1984-85, the Roads and Transportation Association of Canada (RTAC) found that expenditures on roads in Canada, excluding new construction, fell some 10% short of the maintenance figure required to keep the roads in adequate condition and that this shortfall had averaged as much as 20% in the last three years of this time period.[16] RTAC estimated a gap of $3.0 billion between needs and expenditures on road maintenance in 1988/89, equivalent to a shortfall of 26%.[17] Over the years 1983 to 1987, RTAC estimates show that road expenditures by all governments were equivalent to only 74% of road-related revenues and the Coalition to Renew Canada's Infrastructure has urged the need for greater federal government

expenditure on roads, especially as federal motor fuel taxes generate nearly $5 billion a year, while federal road expenditures remain at about $200 million.[18]

The present paper has not examined these statistical estimates in detail and it is generally accepted that there is a degree of subjectivity in determining exactly what constitute road-related revenues. The Canadian motor carrier industry seems to be recognizing that it is not carrying any heavier tax burden, at least in transborder trucking, than its U.S. competitors, but it is complaining that it is receiving less for its tax payments than its competitors south of the border. This is clearly a very real issue.

It is not the intention in this paper to review the complex issue of user charges as they affect the motor carrier and the railway industries. Nevertheless, at risk of stating the obvious, the railways also have strong views on this issue. Firstly, there is the problem of taxation on diesel fuel used in railway operations in Canada, a burden which is virtually non-existent in the United States. The railways complain that they receive no return from this taxation, while at least the motor carriers receive their infrastructure. Secondly, the railways claim that they have to use after-tax revenues for additions to railway infrastructure, while governments do not charge themselves tax when funding infrastructure improvements on the highways. They argue that this could be rectified if they were given an infrastructure investment tax credit for all capital expenditure on the right-of-way, since comparable assets for the motor carrier industry are provided by the various levels of government. Thirdly, there is the complaint about property tax assessments on the railway right-of-way, while no property tax is assessed on the publicly funded highway right-of-way.

In terms of operating environment, there is the issue of highway vehicle weight limits, which are more generous in Canada than in the United States. This is not, of course, relevant to competition in transborder trucking between Canada and the U.S., as Canadian motor carriers have to abide by U.S. limits south of the border and U.S. carriers have to respect Canadian limits in Canada. However, differences in weight limits can affect the cost of doing business within Canada, as against the cost of doing business within the U.S.

To quote from a non-confidential document prepared by CN Rail in October 1990 and provided to the author on an informal basis:

> The effect of vehicle weight on unit cost is quite dramatic. In Canada, a tractor/single-trailer combination can operate from coast to coast at a gross weight of 102,500 lb, carrying a payload of about 68,200 lb. A comparable vehicle in the U.S. would generally be subject to the federal weight limit of 80,000 lb gross weight, limiting its payload to about 47,200 lb. Thus the Canadian truck can carry some 44 percent more payload, while its operating cost per mile is only about 3 percent higher.

However, as the Canadian Trucking Association has pointed out, in correspondence with the author, the federal weight limit of 80,000 lb. gross weight does not apply to all jurisdictions in the United States. Of the 48 continental states, higher weights are permitted on interstate highways in 11 states, mainly as a result of grandfather rights, and on state highways in 17 states. Semi-trailers of 53 ft. or more are allowed on all but four states, while 20 states allow some operations of longer combination vehicles - triple-trailer units, twin 48s and Rocky Mountain doubles. Finally, the more generous weight limits in Canada certainly play a role in the short to medium haul movement of commodities such as gravel, crushed stone, logs and the distribution of gasoline to retail outlets, but this has very little to do with the relative competitive position of the general freight industry operating across Canada, sometimes in competition with U.S. carriers operating across the U.S. The limit on truck capacity in this type of freight is more often volume than weight.

C. CONCLUSION

In transborder competition, the Canadian and the U.S. trucking industries are generally operating with similar tax burdens, but this is not true in respect of rail carriers. The problem for the rail mode relates mainly to fuel taxation in Canada and to capital cost recovery rates, even although these have been improved effective December 6, 1991.

The motor carrier industry appears to be afflicted with higher input costs in Canada than in the U.S., but more research is needed in this area. The Canadian railways suffer from low density traffic, which increases the overall costs of operation.

The Canadian trucking industry considers that it receives far less for its tax payments than the U.S. trucking industry, with this relating primarily to inadequate expenditures on road maintenance in Canada. The Canadian railway industry is unsympathetic to the motor carrier case and claims that railway transport is unfairly penalized in Canada by government taxes on diesel fuel, not accompanied by the provision of any infrastructure. This debate has been going on far too long and there is a great need in Canada for a comprehensive and objective study of user charges in the surface transport modes - and indeed in other transport modes. Highway weight limits are more generous in Canada than in the United States, but the motor carriers argue that the benefits from this affect mainly domestic movements of bulk products like gravel rather than general freight traffic.

Finally, the present paper should have reviewed the regulatory climate in respect of both economic and safety regulation in the two countries. This has been omitted because of space limitations and possible conflicts of interest for the author in view of other commitments at the present time.

Endnotes

1. John Heads, Barry E. Prentice and Mahlon Harvey, University of Manitoba Transport Institute, The Transborder Competitiveness of Canadian Trucking, Transport Canada, June 1991.

2. This work was initially carried out for the Canada Ports Corporation in 1990 and has subsequently been updated several times.

3. This table is calculated using data from Trucking in Canada 1988, S.C. 53-222, p. 34 and Ontario Trucking Association, Submission to the Premier's Trucking Industry Adjustment Strategy Committee, May 31, 1990. Both sets of data exclude from expenses and revenues the very substantial sums paid by trucking companies to owner/operators and the smaller sums paid for interline and piggy-back operations. These expenses flow through motor carrier accounts for the purchase of other transportation services and, to avoid unnecessary arithmetical complications, they are best removed for purposes of the present analysis.

4. The data in this table are compiled from the 1990 Annual Report of Canadian Pacific Limited and the May 1991 issue of the CP Rail document Tax Issues, which CP Rail has been publishing and updating for some time. Manufacturer's sales tax was paid in 1990 on fuel and other items; these payments have been excluded from the table, as this tax was abolished effective January 1, 1991 and replaced by the GST.

5. See University of Manitoba Transport Institute referenced in endnote 1, p. 69.

6. The Round Table on Transportation Through the Greater Vancouver Gateway, Why Canada's Rail Taxes Need to be Overhauled, 900-200 Granville Street, Vancouver, December 1991, p. 1.

7. On December 6, 1991, the federal government introduced a temporary loss offset program for the trucking industry applicable to the 1991 and 1992 calendar years. Trucking companies are eligible for a 3¢/litre rebate on diesel excise tax in return for a reduction in income tax loss carry-forward of $10 for every $1 rebated. While this provides an immediate cash flow for trucking companies in difficulties, it does not affect the long-term position of a viable motor carrier.

8. Calculations were made of U.S. state and local sales taxes for seven states - California, Illinois, Michigan, New Jersey, New York, Ohio and Tennessee - based on data provided by Manitoba motor carriers. This produced an average figure of U.S. 21.3¢/gallon. Transport Topics of November 25, 1991, p. 6, gives an average estimate for U.S. states of 19¢/gallon. An approximate mean of these figures is used in the present paper.

9. Calculated for the seven states listed in endnote 8. See Peat Marwick Thorne, The Effect of Taxation on Canada-U.S. Trucking Competitiveness, Transport

Canada, Ottawa, February 1991, pp. 37-9, supplemented with data for Illinois and New Jersey.

10. These figures are taken from CP Rail's Tax Issues, p.4 and are confirmed by estimates for the motor carrier industry contained in the sources referenced in endnotes 1 and 9.

11. The data summarized in this section is taken from a variety of sources including CP Rail's Tax Issues and the report referenced in endnote 1. Unfortunately, there is not sufficient space to develop the explanation at greater length, but full details of all calculations are available from the author.

12. op. cit., endnote 6, p. 3.

13. In January/June 1991, CN and CP averaged 2.61 million ton-miles of revenue freight per mile of road operated. (The CP figure was only slightly higher than CN.) This would imply roughly 5.2 million ton-miles of revenue freight per mile of road operated for a full year. In 1989, the comparable figure for Class I U.S. railroads was 7.4 million.

14. In 1988, CN performed 88.4 billion revenue ton-miles and CP 66.2 billion, for an average of 77.3 billion. The seven Class I U.S. railroads averaged 124.7 billion revenue ton-miles. However, only four railroads were bigger than CN - Burlington Northern, Union Pacific, CSX and Norfolk-Southern. Conrail and the Santa Fe performed fewer revenue ton-miles than CN, but more than CP. The seventh railroad, Southern Pacific, had the same revenue ton-miles as CP.

15. Transport Topics, December 2, 1991, p. 1.

16. Brian E. Hicks, "RTAC Roadway Infrastructure Study", Proceedings of the Canadian Transportation Research Forum, 1988, pp. 526-36.

17. Estimated from figures quoted in Coalition to Renew Canada's Infrastructure, Submission to the Honourable Jean Corbeil, Minister of Transport, January 1992, p. 3.

18. ibid., pp. 12-13.

Management of Niagara Frontier Border Bridges In The Era of Free Trade

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I. Introduction

The globalization of trade, the Canada-U.S. Free Trade Act and the issue of cross border shopping all impact upon border crossings between the U.S. and Canada. Using data from the four Niagara Frontier bridges between Western New York State and Southern Ontario, this paper comprehensively examines the rise in border traffic and issues related to managing border traffic. Our findings indicate that the Free Trade Act (FTA) inaugurated in 1989 is of particular interest from a commercial point of view, but the more dramatic and problematic impact on border management has clearly been the large increase in auto traffic.

In this paper, the Free Trade Act and its expected impact are first briefly reviewed. This will lead to an examination of actual bridge traffic between 1978 and 1991 to gauge the actual change in activity levels. After documenting a large increase in traffic in recent years, the authors speculate as to the causes of this rise, and propose a predictive model to estimate border activity levels. Finally, from a bridge and border management point of view, the capacity problem is discussed and current planned changes at the Niagara Frontier Bridges are outlined.

II. Review of the Free Trade Act and Expected Impact

Trade between the U.S and Canada has been growing steadily for at least the last ten years; it increased from $77 billion U.S Dollars in 1980 to over $175 billion in 1990.[1] Even before the FTA began in January of 1989, over 65% of this merchandise trade moved free of tariffs.[2] The FTA eliminates virtually all remaining tariffs on a gradual schedule by the year 1999, and more importantly formalizes the desire of both governments to encourage trading efficiencies. The FTA has only a minor impact on easing restrictions on cross-border shopping for individuals, and it was never the intention to create "open borders" of the European Common Market variety.

The FTA should produce benefits from allocative efficiency (comparative advantage of trade) and productive efficiency (economies of scale) between the U.S. and Canada. Theoretically, this should increase trade and thus the amount of merchandise transportation between the two countries. However, the benefits of FTA may not be allocated evenly between the U.S and Canada, between industries, or between different border regions. Furthermore, as all production factors are variable in the long term, the FTA's impact should be much more significant in the long run than in the short run due to the existence of fixed investments. Nonetheless, one area of commerce that is likely to be effected by the FTA and the free trade atmosphere is the border crossing points.

III. Traffic on Niagara Frontier Bridges, 1978-1991

As mentioned earlier, the commencement of the FTA is an integral part of a long historical trend of increased trade between the U.S. and Canada. The evidence of this trend is found not only in aggregate trade statistics but also in a steady rise in bridge traffic between the two nations. In this section of the paper bridge traffic is provided for all vehicle border traffic on the Niagara Frontier between Western New York State and Southern Ontario. The traffic on this border is substantial, last year this border region accounted for more than 20 million one-way trips. To better understand the impact of the FTA in recent years it is desirable to have a historical perspective; In Table I total traffic data are presented for the years 1978-1991.

The data covers all four highway bridges over the Niagara River--the Peace Bridge between Buffalo, N.Y and Fort Erie, Ontario, the Rainbow and Whirlpool Bridges at Niagara Falls, and the Queenston/Lewiston Bridge. The data has been provided by the international bridge authorities which oversee the operation of these four bridges. The bridge commissions identify three vehicle classes: 1) Autos, 2) Buses, and 3) Trucks. Commercial vehicles are not accommodated at the Rainbow and Whirlpool bridges, and unfortunately the truck category at the Queenston/Lewiston Bridge has historically included personal light trucks. However, commercial traffic trends can be gauged at the Peace Bridge. As can be observed in Table 1 and Figure 1 there has been a prolonged and significant increase in total bridge traffic over the last fourteen years, averaging a 6.5% annual increase. Underlying this trend there appear to be different patterns for truck and auto traffic which can be examined separately.

Truck Traffic

It was anticipated that the Free Trade Act of 1989 would rationalize production and lead to greater transportation of products across the border. Interestingly, at the Peace Bridge, 1989 commercial traffic was up just .5% over 1988 to 847,165 trucks. Since that peak, traffic has dropped 2.7% to 824,399 trucks in 1991.[3]

This recent trend interrupts a long term pattern of annual increases in truck traffic. The only other annual decreases occurred in 1980 and 1982. The conclusion is that the decline in commercial truck traffic is due primarily to recessionary forces.

TABLE I

NUMBER OF VEHICLES CROSSING ALL FOUR BRIDGES SPANNING THE NIAGARA RIVER: 1978-1991

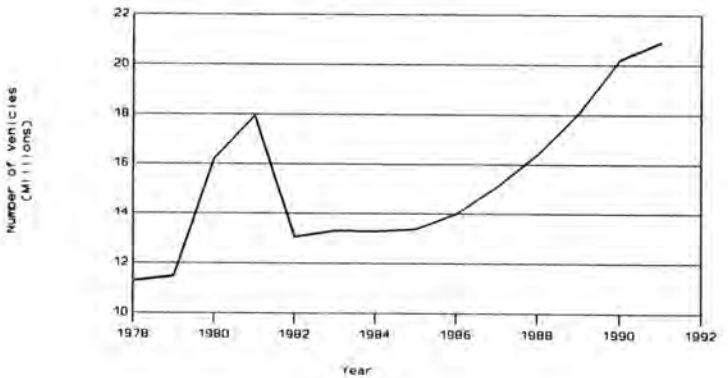
Year	Number of Vehicles	Percent Change from Previous Year
1978	11,291,926	
1979	11,471,183	1.59%
1980	16,203,008	41.25
1981	17,927,745	10.64
1982	13,048,519	-27.22
1983	13,303,453	1.95
1984	13,272,544	-0.23
1985	13,363,567	10.27
1986	13,994,640	4.72
1987	15,065,149	7.65
1988	16,406,772	8.91
1989	18,056,726	10.06
1990	20,225,107	12.01
1991	20,916,787	3.42

SOURCES: Data are provided by the Niagara Falls Bridge Commission and the Buffalo & Fort Erie Public Bridge Authority.

FIGURE I

NUMBER OF VEHICLES CROSSING THE

THE FOUR BRIDGES 1978 - 1991



Auto Traffic

Although "Free Trade" was never intended to produce open borders for individual consumers, there has been a very substantial increase in international auto traffic since 1988. This recent escalation in traffic, along with the spike that occurred in 1980-1981 requires further investigation and explanation.

An interesting statistical blip occurs in 1980-81 indicating a dramatic but temporary rise in auto traffic. During this time retail gasoline prices in Canada were significantly less than in the U.S. apparently causing U.S. drivers to cross the border for lower prices. This idea is supported by the fact that most of the traffic increases occurred at the Peace and Whirlpool Bridges which are used more by "local" travelers. The Queenston/Lewiston Bridge has poor access to gas stations on the Canadian side, and no pronounced increase occurred at this bridge during 1981-82. The implication for bridge managers is that the large cluster of population on the U.S. side of the border has the potential to significantly increase bridge traffic again if an economic incentive arises for Americans to cross into Canada.

Of more recent interest is the accelerating rate of increase in total traffic since 1985, and especially since 1988. This increase is the result of a widespread and well documented movement of Canadian shoppers entering the U.S. for gasoline, cigarettes, liquor, and other consumer goods. The reason for this increase appears to be Canadian fiscal and tax policies which gives a comparative advantage to goods sold in the U.S. First of all, the Canadian Dollar rose from 71 cents U.S in December of 1985 to 87 cents in January 1992.[4] Second, during the 1980's the Canadian and Ontario governments increased substantially so-called "sin taxes" on beer, cigarettes, and liquor, and raised taxes on gasoline as well. For example, in 1992, a case of beer sells for between $8 US and $13 US in stores in Niagara Falls U.S., compared to about $25 US in Ontario. Additionally, the Goods and Services Tax applied beginning in January 1991 in Canada provides consumers the appearance of lower taxes in the U.S. (7% vs. 15%). The authors speculate the recession may actually contribute to the increase in border shopping as unemployed workers have greater free time and more incentive to shop for lower prices.

IV. A Proposed model of Bridge Traffic.

In the section above, suspected causes of the recent large increase in border traffic were provided. Many of these factors can be quantified and it would be desirable to build a predictive model of border traffic. An accurate model would be useful for customs and border officials and also for policy makers in both the U.S. and Canada who may be considering changes in tax policies or interest rates. The authors are currently in the process of gathering data and building a working predictive model of total bridge traffic. This model is somewhat specific to the Ontario region of Canada, but it could easily be modified for other border crossing points. Also, this model is designed to work in the current environment where there is essentially a one way economic incentive (Canada to the U.S.).

TTD = F(EX, TRAV, TXDF, GDP, FTA)

where,

TTD	=	Total traffic demand measured in # of total crossings
EX	=	Exchange Rate CDN/US
TRAV	=	Auto Miles Traveled per Capita
TXDF	=	Difference between Taxes Charged on basket of Gas, Cigarettes, Beer, Food: (Ontario - N.Y.)
GDP	=	Gross Domestic Product (Ontario + N.Y. State)
FTA	=	Free Trade Act (Dummy Variable)

V. Bridge Management Issues.

The long term increase in bridge traffic is likely to continue into the next century. Already, delays are common at the crossing points, with back-ups extending across bridges and disrupting traffic patterns in the country drivers are leaving. As evidence, the New York State Thruway Authority is in the process of erecting an electronic signing system to warn drivers when exits in the last mile of I-190 are blocked with Canada bound traffic (One exit serves a hospital). The delays are significant, and this raises a number of management issues for insuring the smooth flow of traffic across the Canadian/U.S. border crossings.

Bridge Capacity

From a pure traffic capacity standpoint, traffic congestion can occur if there is too much traffic for the number of highway lanes available to carry that traffic. On the four Niagara Frontier bridges, there exists a total combined capacity of seven lanes in each direction, or fourteen lanes to carry the approximately 20 million vehicles per year. According to the U.S. Department of Transportation, this amount of lane capacity has the ability to handle a potential of approximately 119 million vehicles per year at 50 MPH without any congestion occurring.[5] This analysis does not take into consideration the seasonal and daily peaking of border crossing, but consider that an average day's traffic can be handled by the bridge itself with just four hours of capacity.

The analysis just concluded supports what is obvious to the observer--border delays do not occur on the Niagara Frontier bridges due to highway capacity constraints, they occur due to the processing required at the border itself. However, this has not prevented a discussion of new bridge possibilities. A group of Canadian investors has proposed a private toll-financed bridge for a site between Buffalo and Niagara Falls.[6] The Niagara Falls Bridge Commission itself is also considering adding a bridge after the year 2000.

It should be noted that the efficient management of customs could be aided

by greater lane capacity. The limited number of lanes restricts the potential for sorting traffic to ease the flow of certain groups of vehicles, such as commercial trucks. Furthermore, none of the bridges in this study have shoulder lanes to permit emergency vehicles access in case of car fires and medical emergencies which can and have occurred during these frequent back-ups.

Toll Collection Capacity

A second potential area for delays is at the toll collection facilities at each border crossing. Here the Commissions operating the bridges have made several management changes. First, at the Niagara Falls Bridges the toll charge system was changed for autos from one based on the number of passengers to a flat fee (currently $1 Canadian).[7] This allowed much faster processing and also permitted the use of automated exact change collection baskets. Additionally, the commissions are considering charging tolls only one-way, a practice that is common at many toll bridges.

Customs Capacity

To the border traveller the cause of delays is obvious--inadequate customs inspection capacity. In the Niagara Region, the more severe problem occurs at Canadian Customs because returning Canadian residents frequently have goods purchased in the U.S., and require more time consuming processing. In its report "Customs 2000-Blueprint for the Future," Canada Customs recognizes the challenge; over the last several years its work load has increased 30% while its "operational resources" have declined 10%.[8]

Despite this constraint, Canada Customs in its "Customs 2000" report is pursuing timeliness at border crossings and will make "improvements to reduce waiting times."[9] For commercial truck traffic, a number of steps are planned to speed up movement through customs. Administrative requirements and paperwork will be reduced, and EDI (Electronic Data Interchange) will be used extensively to speed processing of commercial traffic manifests. It is expected that most commercial traffic should be able to proceed without delay, subject only to periodic random physical inspections. For public auto travellers, customs hopes to separate "low-risk" travelers and allow these travellers to pass customs without stopping as long as they have nothing to declare. These low-risk travellers are essentially on an honor system, but are subject to selective inspection with steep fines and penalties for violations. A variation of this process is a "No Goods to Declare" manned express customs booth. These systems have been experimented with at some of the Niagara Frontier Bridges with mixed results.

The Management Challenge

In reality, it is a combination of capacity constraints and changeable demand

that makes managing border traffic on Niagara Frontier Bridges a challenge. Bridge lane capacities do not permit the sorting of traffic required to segregate traffic into three categories: 1) Commercial, 2) Low-Risk/No Declarations Autos, and 3) Autos requiring traditional inspection. As a result, all three classes of vehicles become tied up together in traffic jams leading to the bridges. As long as this is the case, truck lanes or express auto lanes are of limited usefulness.

The capacity question is a difficult one to address as long as demand for bridge crossing is so unpredictable in the long run. Dramatic jumps in traffic can subside just as quickly, as evidenced by the 1980-81 spike in traffic. Short term capacity constraints could become a non-issue if an often discussed 50 cents/gallon U.S. gasoline tax were enacted and the value of the Canadian dollar fell significantly. A worst case scenario for Bridge managers would be one where an economic incentive exists for consumers on both sides of the border to cross. This could occur if U.S. taxes on gas and liquor stay low, but the U.S. dollar strengthens enough to make basic food items a bargain for U.S. shoppers in Canada.

VI. Conclusions

The Free Trade Act between the U.S. and Canada has reinforced the ongoing trend of increased trade and travel between these two countries. Perhaps the greatest impact of the FTA was an unforeseen one, it may have created a psychological impression among individual travellers that restrictions on cross border shopping were being eased. Unfortunately, the time period since FTA has been one of frequent traffic congestion. Far from being "free," and clear, residents of border cities feel restricted by bridge time delays and short visits to favorite restaurants and tourist attractions on the opposite side of the river are often infeasible.

In summary our findings and observations include the following:

1. Total Bridge traffic has risen considerably (27.5%) between 1988 and 1991.

2. Auto traffic is responsible for this rise, probably due to the strength of the Canadian Dollar and high Canadian sales and excise taxes.

3. Customs processing is the major bottleneck at border bridges, with limited lane capacity also restricting the flexibility of customs.

4. Bridge traffic volume is volatile, and subject to macroeconomic trends beyond bridge manager's control.

5. A predictive model of bridge traffic based on macroeconomic variables would be helpful to bridge managers and is under development by the authors.

Endnotes

1. U.S Department of Commerce. Survey of Current Business, USDC, Various Years.

2. Stephen T. Easton. "Free Trade, Nationalism, and The Common Man: The Free Trade Agreement Between Canada and the United State, " Contemporary Policy Issues, July, 1989, pp. 61-76.

3. Buffalo and Fort Erie Public Bridge Authority.

4. Revenue Canada, "Currency Exchange Rates, 1972-91."

5. "Program UROAD Writeup," Urban Transportation Planning System. Washington D.C., USDOT, May 1984, Capacity Matrix.

6. Robert McCarthy, "Canadian Group Mulls Building Private Toll Span," The Buffalo News. November 24, 1991.

7. Richard Baldwin, "Tolls to Change on Three Bridges to Canada." The Buffalo News. April 18, 1991.

8. "Customs 2000: A Blueprint for Change" Revenue Canada, Customs and Excise. 1990. p.9.

9. "Customs 2000." p. 11

The Role of Transportation in Free Trade Competition

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1. Importance of Transportation in a Free Trade Environment.

The United States is Canada's largest trading partner and its most important market (the United States is the largest market for every Canadian province, except for Yukon/Northwest Territories). Three-quarters of all Canadian exports cross the U.S. border. The geographic proximity and the cultural similarities of the two nations have helped establish Canada and the United States as important and mutually dependent partners in trade. The Canada-U.S. Free Trade Agreement has linked the two partners in trade even more closely. For Canada, the pact's primary purpose is to gain easier access to the United States market and to provide increased opportunities there.

2. Effect of Transportation on Price of Commodities.

The study by Nicholas Skoulas (1981)showed that transport costs contribute significantly to the production and distribution costs of goods. Based on Canadian data, the proportion of transport costs to total production costs can reach 13 per cent in primary industries and 11 per cent in manufacturing. Average transport costs incurred in the production of goods exceed those related to utilities, advertising and promotion, and retail and wholesale margins.

When transport costs embodied in the production process are considered together with those associated with the distribution of output, total transport costs constitute a significant portion of purchaser's price for both domestic sales and exports.

For domestic sales, more than 22 per cent of goods-producing industries, in terms of value, have transport cost ratios exceeding 10 per cent of producers' price. Over 54 per cent of the value of exported commodities of Canadian goods-producing industries is characterized by having 10 per cent or more of their value at the Canadian border made up of transportation charges. Exports are more "transport cost sensitive" than domestic sales. The strength of many Canadian industries depends on export sales, and high and rising transportation costs dampen the price competitiveness of Canadian goods in foreign markets.

3. Relationship between Transportation Costs and Rates.

Large proportion of railroad costs are fixed costs, because of the huge investment railroads have made in their right of ways, track, and equipment. The result is that railroad marginal costs, or "variable costs" as rate makers call it, are thought to be considerably lower than the average, or "fully distributed" costs. Since any shipment charged a rate greater than the marginal costs of handling will contribute to the railroad's overhead and profits, the railroads may find it profitable to give very low rates on some types of shipments which, otherwise, would not be shipped at higher rates. While some rates were set below fully allocated cost, many other rates have been set well above it. Competition has cut severely into the traffic with the highest rates, leaving railroads with mostly low-rated traffic. The railroads' perceived low marginal costs, high average costs, and historical monopoly pricing power led to a highly discriminatory rate structure. This structure continues today despite the loss by the railroads of much of their monopoly power.

Rates in the transportation industry tend to increase as a value of the commodity transported increases. Transportation costs constitute smaller percentage of the total cost for most high priced goods than for most low priced goods. The market for high priced goods will be less reduced by high transportation charges than the market for low priced goods. Commodities having higher elasticities of supply or demand should tend to have lower rates for transportation. The competitive structure of the market for the commodity transported will have an impact on the rates for that commodity.

The cost of carrying a shipment will usually increase with the distance hauled, but less than proportionately because significant proportion of the transport cost is a terminal cost. Cost also increases with shipment weight, but less than proportionately due to the economics of handling larger shipment sizes.

Cost of shipping of a particular product varies according to the attributes of the commodity. Density of the commodity will affect the volume a shipment consumes in a transport vehicle, that affects the cost of carriage. Special handling requirements, such as refrigeration, shock protection, and livestock feeding, add to the cost of a shipment. Level of service provided will clearly influence carrier cost. Fast, dependable service may cost more to provide than slow, unreliable service. The level of rates may also vary between regions of the country because both competitive factors and carrier costs may vary among them.

4. The Profit Maximization Model for Commodities.

Freight transportation is a derived demand based on economic activities the purpose of which is to make a profit. Each unit of product manufactured in a region and shipped to a market is subject to a unit production cost and a unit transportation cost. Producers will be willing to manufacture and ship products to a certain market, only if marginal sales revenues at that market are greater than or equal to the sum of marginal production cost and the average unit transportation cost. The classical economic behaviour of every producer of any commodity is to seek maximum overall profit. The amount of product a producer can sell in a market is limited, because the production cost, transportation cost, and selling price are not constant. They are functions of

quantity produced, shipped, and sold.

For n production areas and m markets, profit P of all producers is represented by the following formula:

$$P = \sum_{j=1}^{n} [c_j(x_{j,}) \cdot x_{j,}] - \sum_{k=1}^{m} [p_k(x_{,k}) \cdot x_{,k}] + \sum_{j=1}^{n} \sum_{k=1}^{m} t_{j,k} \cdot x_{j,k}$$

where:

$x_{j,k}$ — flow between origin j and destination k

$x_{j,} = \sum_{k=1}^{m} x_{j,k}$ — quantity produced at origin j

$x_{,k} = \sum_{j=1}^{n} x_{j,k}$ — quantity sold at market k

$c_j(x_{j,})$ — unit production cost function at origin j

$p_k(x_{,k})$ — price at market j

$t_{j,k}$ — average unit transportation cost between j and k.

A general formula for unit production cost at origin j, as a function of quantity produced is

$$c_j(x_{j,}) = C_{j2} \cdot x_{j,}^2 + C_{j1} \cdot x_{j,} + C_{j0},$$

where C_{j2}, C_{j1}, and C_{j0} are origin dependent constants. The shape of such a curve is shown in Figure 1.

A general formula for the selling price at market k, as a function of quantity produced is

$$p_k(x_{,k}) = K_k \cdot (1 + x_{,k})^{-0.1}$$

where K_k is a market dependent constants. The shape of such a curve is shown in Figure 2. Derivation of the above formulae can be found in Yu (1981).

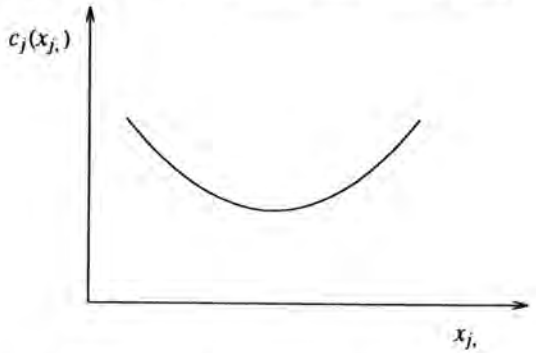


Figure 1. A General Shape of a Unit Production Cost Function at Origin j.

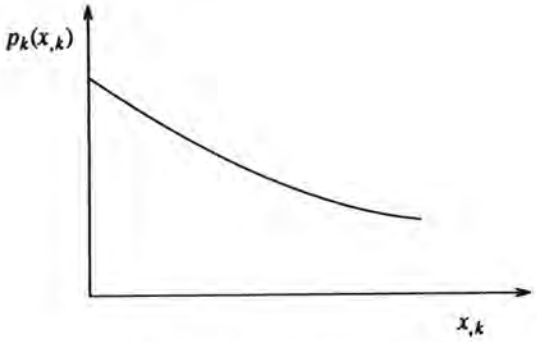


Figure 2. A General Shape of a Selling Price Function at Market k

5. Data Used in the Model.

Flow data are taken from a Commodity Transportation Survey conducted by the U.S. Bureau of Census (*CTS*, 1977). It is the best available data for our study. It provides statistics on the volume and characteristics of commodity shipments by manufacturing establishments in the United States.

Data include the type, weight, value of commodities, shipping mode, zones of origin and destination, distance, and estimated total tonnage represented by each record. The data contains two files. The first one shows origin-destination data for state-to-state commodity flow; the second one shows origin-destination commodity flow data from and to forty nine production zones. Information on origin and destination of each shipment is provided for fifty states and the District of Columbia. For our study the first file was chosen, as it contains more records (1,501,549 compared to 566,475).

Network data are taken from Report No. DOT-OS-60512-8 (Jones, 1977). There are 120 nodes and 343 links for truck and 120 nodes and 278 links for rail.

Economic data are taken from a PhD Thesis by David Yu (1981). Unit production cost curves and selling prices in the markets are given as functions of respectively quantity produced and quantity sold.

6. Application to Wood Products.

In this research, the model is tested for the SIC 249 commodity group covering the majority of wood products. For illustrative purposes, the study is limited to 4 production zones and 6 markets located mainly in the eastern part of the United States. This commodity group was moved mainly by rail and truck (only 1% by water and less than 1% by air). Therefore, this study considers only truck and rail modes.

From the flow data, unit transportation costs are calculated for each origin — destination pair within the states containing these production zones and markets. The procedure used for this purpose is as follows:

First, a multiple regression analysis is used to determine the modal share for rail and truck as a function of distance. It is used as weighting factor in calculating expected unit transportation cost, when knowing transportation costs by truck and rail.

The unit transportation cost for rail was found using multiple regression analysis.

Calculation of transportation cost by trucks is more elaborate. Using the procedure suggested by Samuelson (1977), truck data are separated into two groups:
— less than truck load shipments (LTL);
— truck load shipments (TL),
Unit transportation costs for each group are then calculated separately. The expected unit transportation cost for trucks as a whole is calculated from the percentage of tonnage moved by LTL and TL. In the study, no clear relationship was found between distance and the percentages moved by LTL and TL.

7. Results and Their Analysis.

The formulae used for calculating expected unit transportation cost by truck and rail as function of distance x are listed below (an adjusted R^2 value is shown for each equation in parenthesis).

The function representing modal share by truck and rail is

$$\text{percentage of weight moved by truck} = -3.153 \cdot 10^{-6} \cdot x^2 - 0.06805 \cdot x + 98.93$$

This relationship is shown in Figure 3.

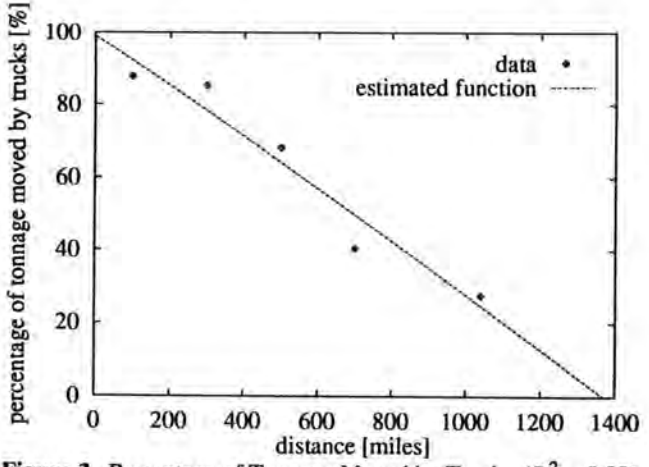


Figure 3. Percentage of Tonnage Moved by Truck. ($R^2 = 0.88$)

The formula for unit transportation cost by rail (uc_R) is

$$uc_R = -0.01697 \cdot x + 273.9 - 117.5 \cdot \log(x) + 13.69 \cdot \log^2(x) \quad (R^2 = 0.91)$$

The unit transportation cost function by rail is presented in Figure 4.

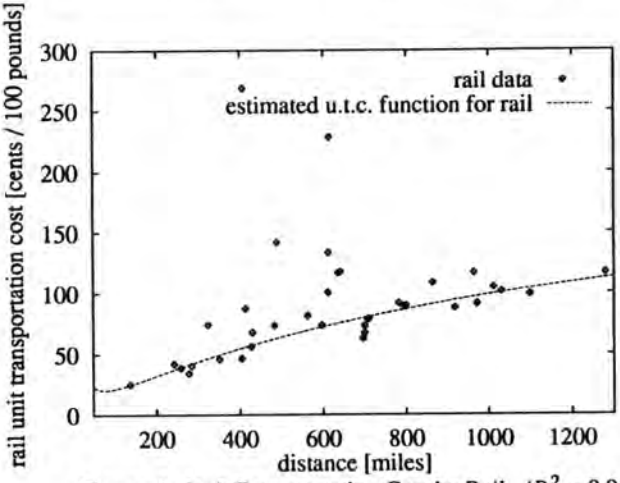


Figure 4. Unit Transportation Cost by Rail. ($R^2 = 0.91$)

The formula for unit transportation cost by TL (uc_{TL}) is (c.f. Figure 5)

$$uc_{TL} = -6.888 \cdot 10^{-5} \cdot x^2 + 0.2170 \cdot x + 39.91 \quad (R^2 = 0.97)$$

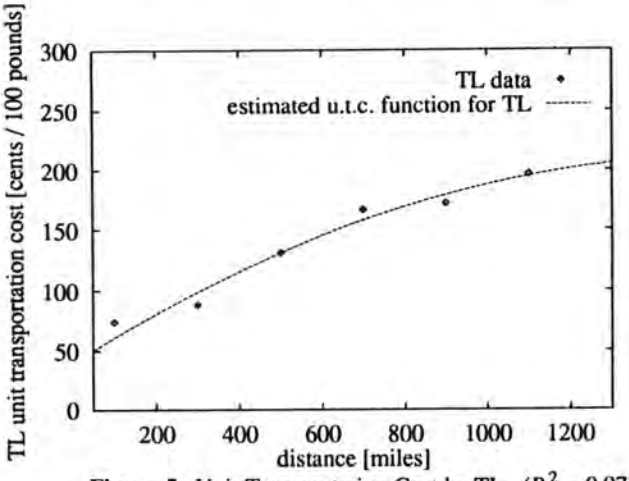


Figure 5. Unit Transportation Cost by TL. ($R^2 = 0.97$)

The unit transportation cost by LTL (uc_{LTL}) function has a following functional form

$$uc_{LTL} = -3.742 \cdot 10^{-4} \cdot x^2 + 365.6 \qquad (R^2 = 0.97)$$

and its graphical image is shown in Figure 6.

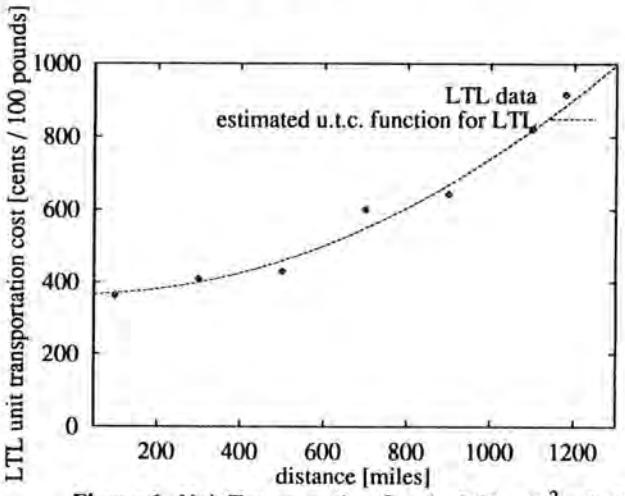


Figure 6. Unit Transportation Cost by LTL. ($R^2 = 0.97$)

The percentage moved by LTL, independent of distance, was found to be 4.5%.

The four origins chosen for the final analysis are: Atlanta GA, Evansville IN, St. Louis MO, and Charlotte NC. Also, the following six destinations were selected: Sikeston MO, Kansas City MO, Chattanooga TN, Cape Girardeau MO, Quincy IL, and Des Moines IN.

The unit transportation costs (in cents per one hundred pounds) between these origins and destinations are presented in the Table 1.

The flows between production zones and markets for transportation costs given in Table 1 are presented in Table 2.

New predicted flows for lower transportation cost (80% of that in Table 1) are presented in Table 3. It can be seen that there is 12.7% increase in the total flow profits to producers increase by 13.8%.

New predicted flows for lower transportation cost (50% of that in Table 1) are presented in Table 4. It can be seen that there is 35% increase in the total flow and 38.2% increase in profits to producers.

Table 1. Unit Transportation Cost [cents / 100 pounds]

	Sikeston	Kansas City	Chattanooga	Cape Girardeau	Quincy	Des Moines
Atlanta	101.79	121.82	60.06	100.14	118.16	123.65
Evansville	77.15	99.31	84.83	81.84	84.86	110.65
St. Louis	70.75	78.79	102.58	65.33	60.39	95.64
Charlotte	115.90	124.18	89.48	114.97	123.24	122.93

Table 2. Flows in thousands of tons for transportation cost = 100%
profit = $37{,}635 \cdot 10^3$ dollars, total flow = $1{,}597 \cdot 10^3$ tons]

	Sikeston	Kansas City	Chattanooga	Cape Girardeau	Quincy	Des Moines
Atlanta	0	0	192	0	0	0
Evansville	0	0	0	0	0	0
St. Louis	86	345	0	340	143	492
Charlotte	0	0	0	0	0	0

Table 3. Flows in thousands of tons for transportation cost = 80%
profit = $42{,}838 \cdot 10^3$ dollars, total flow = $1{,}800 \cdot 10^3$ tons

	Sikeston	Kansas City	Chattanooga	Cape Girardeau	Quincy	Des Moines
Atlanta	0	0	217	0	0	0
Evansville	77	0	0	0	0	0
St. Louis	18	389	0	373	155	571
Charlotte	0	0	0	0	0	0

Table 4. Flows in thousands of tons for transportation cost = 50%
profit = $52{,}017 \cdot 10^3$ dollars, total flow = $2{,}160 \cdot 10^3$ tons

	Sikeston	Kansas City	Chattanooga	Cape Girardeau	Quincy	Des Moines
Atlanta	0	0	259	0	0	0
Evansville	116	0	0	0	0	0
St. Louis	0	464	0	429	176	574
Charlotte	0	0	0	0	0	0

8. Methods of Lowering Transportation Costs.

There are many ways of increasing modal efficiency. Some are presented here.

A. Through advanced traffic management for truck and rail of the type shown below:

- Strategic Transportation Analysis (STAN) is an interactive graphic multimode multi product system for national or regional strategic planning of freight transportation (Crainic, 1990). The primary role of STAN is the comparison and evaluation of alternatives (major changes to the transportation infrastructure or important modifications to the operating policies and

cost structures). Flows, link costs, delays and congestion, intermodal shipments may be compared among different scenarios.

- Knowledge Based Expert System (KBES) for Intelligent Vehicle-Roadway System projects are advanced systems for surveillance control and management of integrated freeway and arterial network. Their goal is to reduce congestion and reduce the travel time, higher level of service (Ritchie, 1990).

- KBES technology can also provide route guidance (selection) information (Taylor, 1990).

B. Through improving fuel economy as listed below:

- General improvements like further use of front-wheel drive and use of four speed automatic transmissions.

- Improvements in engine economy, for example: four valve designs, lean-burn fast-burn combustion, electronic ignition control.

- Lowering the drag coefficient. (For example, the drag resistance for a 38-tonne tractor semitrailer on a level road constitutes 40% of the total movement resistance. Hence 40% of fuel consumption is used to overcome this resistance).

C. Through introduction of new alternative transportation fuels: ethanol, hydrogen, methane, methanol, natural gas, and propane (Difiglio, 1989).

D. Through the use of "longer combination vehicles" (LCVs) which would produce:

- Higher productivity, as fleet could be reduced in size and fewer trips need to be made. As a result the number of vehicle-miles per tonne moved could be decreased.

- Considerable fuel savings; tests shown 23%-27% of savings on the fuel consumption for triple CVs over twin trailers (Geuy, 1989).

- A decrease in side effects as the pavement effects rating of LCVs is better than conventional equipment per ton hauled in a comparable service. Also extended life and reduced maintenance costs of bridges could be expected.

9. Conclusions and Need for Further Research.

A profit maximizing model was formulated and applied to a group of wood products. The results show clearly that lowering transportation cost between production zones and markets would increase flows and profits for producers. The model may also be applied to other commodity groups, to show the benefits of lowering transportation costs.

The availability of detailed disaggregate data is a major problem in this type of study. This indicates the need for a coordinated effort among the various organizations involved in goods movement to have a complete set of data that could be used in analyses of this type. Having such a bank of data on goods movement is an expensive endeavour and requires adequate funding.

References.

Crainic1990.
T. G. Crainic, M. Florian, and J-E. Léal, "A Model for the Strategic Planning of National Freight Transportation by Rail," *Transportation Science*, vol. 24, no. 1, pp. 1-23, 1990.

***CTS*1981.**
"Census of Transportation, 1977: Commodity Transportation Survey," conducted by the Bureau of the Census, Washington, DC, 1981.

Difiglio1989.
C. Difiglio, "Timing of Methanol Supply and Demand: Implications for Alternative Transportation Fuel Policies," *Transportation Research*, vol. 23A, no. 3, pp. 229-241, 1989.

Geuy1989.
B. L. Geuy, "An Industry Perspective on Longer Combination Vehicle Operations in the Western USA," *Transportation Planning and Technology*, vol. 14, pp. 101-115, 1989.

***Jones*1977.**
Georgia Institute of Technology, "Procedures for Multi-State Multi-Mode Analysis: First Year's Research," (DOT-OS-60512-8), U.S. Department of Transportation, Washington, DC, December 1977.

Ritchie1990.
S. G. Ritchie, "A Knowledge-Based Decision Support Architecture for Advanced Traffic Management," *Transportation Research*, vol. 24A, no. 1, pp. 27-37, 1990.

Samuelson1977.
R. D. Samuelson, "Modeling the Freight Rate Structure," CTS Report 77-7, Massachusetts Institute of Technology, Center for Transportation Studies, February, 1977.

Skoulas1981.
N. Skoulas, "Transport Costs and Their Implications for Price Competitiveness in Canadian Goods-Producing Industries," in *Monograph Series of the Research Branch, Bureau of Competition Policy*, vol. 9, Consumer and Corporate Affairs Canada, Ottawa, ON, 1981.

Taylor1990.
M. A. P. Taylor, "A Knowledge-Based Systems for Transport Network Analysis: A Fifth Generation Perspective on Transport Network Problems," *Transportation Research*, vol. 24A, no. 1, pp. 3-14, 1990.

Yu1981.
H.-C. D. Yu, *A Unified Freight Transportation Planning Model*, 1981. PhD thesis, Georgia Institute of Technology.

PROJECTED COST REDUCTIONS AND EFFICIENCIES THROUGH ABANDONMENT OF SELECTED RAIL SEGMENTS

This paper summarizes the research conducted by the Senior Grain Transportation Committee (SGTC) Subcommittee on the Implications of Subsidy to Truck Transport. The savings and costs of abandonment of selected low density grain dependent branch lines have been estimated. This includes the projected savings in line-related variable costs of the railways; the projected net savings in volume-related costs; the projected net savings in elevator operating costs; and the estimated additional truck costs.[1]

A transitional off-track elevator option was reviewed as well as a direct trucking option which involved closure of the originating elevators. The emphasis was on the changes in savings or costs that would occur under either option.

1. PROJECTED LINE-RELATED VARIABLE COST SAVINGS

A list of 20 grain dependent branch line segments for each of Canadian National (CN) and CP Rail was presented to the Subcommittee by the railways for consideration. The lines have a low density of grain traffic and largely represent the high-cost grain lines identified in the SGTC brochure, *Straight Talk About Grain Transportation.* The original list of 40 lines was reduced to the 34 lines listed in Table 1.1 as one line was withdrawn by CN and five lines have been abandoned following the establishment of Alternate Service Agreements under the System Improvement Reserve (SIR) fund.

The line-related variable cost savings were projected in current 1990/91 dollars. The 1988 line-related variable costs[2] of the associated grain dependent branch lines, as determined by the National Transportation Agency (NTA) in its 1988 costing review, were indexed to 1990/91 dollars using the NTA line-related price index adopted for the Western Grain Transportation Act (WGTA) rate scale for 1990/91. These costs were converted to cost per mile figures and then applied to the specific miles of the segments identified.

In total, some 1366.2 miles of rail line were identified by the railways for consideration at a saving in line-related variable costs of some $18.05 million. The segments involved had an average line-related variable cost of $13,213 per mile compared to an average line-related variable cost of $14,258 per mile for all 6630.9 miles in the grain dependent branch line network. While multi-year maintenance programs by the railways may render individual figures on an annual basis either too high or slightly on the low side, this effect is likely smoothed out when line costs are averaged over 34 lines and 1366.2 miles. As indicated by the relative costs, these lines are of interest to the industry because of low density rather than high line-related

TABLE 1.1: CP RAIL AND CN RAIL LOW DENSITY, HIGH COST BRANCH LINE SEGMENTS

SUBDIVISION		FROM/TO	RAILWAY MILES
CP Rail Line Segments:			
1.	Stirling	Orion - Etzikom	14.7
2.	Dunelm	Player - Simmie	25.2
3.	Burstall	Schuler Spur	6.8
4.	Gretna	Altona - Gretna	6.7
5.	Amulet	Ormiston - Crane Valley	7.7
6.	Hatton	Hatton - Golden Prairie	17.8
7.	Neudorf	Esterhazy - Neudorf	43.6
8.	Russell	Binscarth - Inglis	23.9
9.	MacLeod	Aldersyde - Fort MacLeod	73.8
10.	Cardston	Stirling - Cardston	46.8
11.	Coronation	Kerrobert - Major	21.4
12.	Dodsland	Dodsland - Smiley	28.4
13.	Pennant	Wickett - Hazlet	19.4
14.	Turin	Lethbridge - Turin	27.0
15.	Notukeu	Notukeu - Val Marie	96.9
16.	Lyleton	Deloraine - Waskada	17.6
17.	Lomond	Eltham - Hays	112.3
18.	Bassano	Empress - Bassano	118.4
19.	Shamrock	Tyson - Hak	33.1
20.	Altawan	Notukeu - Shaunavon	65.7
	Subtotal		807.2
CN Line Segments:			
1.	Big River N	CP Jct. - Big River	24.5
2.	Cowan S	North Jct. - Swan River	96.8
3.	Tisdale E	Hudson Bay - Crane	57.0
4.	Winnipegosis	Sifton Jct. - Fork River	10.9
5.	Erwood	Swan River - Birch River	23.0
6.	Lewvan S	Lampman - Talmage	49.0
7.	Cudworth-Meacham	Meacham - Totzke	14.8
8.	Bonnyville	Abilene Jct. - Grand Centre	61.1
9.	Carlton	Dalmeny - Laird	28.2
10.	Bengough	Weyburn Jct. - Willowbunch	71.5
11.	Chelan	Reserve - Crooked River	60.1
12.	Bodo S	Salvador - Catcus Lake	14.3
13.	Rossburn W	Rossburn - Russell	25.6
14.	Paddockwood	Whitestar - Paddockwood	22.2
	Subtotal		559.0
	Total		1366.2
	All Grain Dependent Lines, 1988		6630.9

Note: Bengough owned by CN but operated by CP Rail. CP Rail indicates that rationalization would also include the Weyburn to Radville section to bring the mileage to 98.0 miles.

variable costs. The savings in line-related variable costs would occur under either the off-track or the direct trucking options as the railway segments would be removed.

2. PROJECTED ELEVATOR OPERATING COST SAVINGS

It was identified that 92 active originating stations or delivery points were associated with the 34 line segments under consideration (another 13 stations were identified as recent closures) and those 92 originating stations involved 131 elevators. Table 2.1 provides a summary of selected information which characterizes the originating elevators. There was also one siding for producer loading of grain cars.

Under the off-track option the originating elevators would continue to operate; however, in the direct trucking option these elevators were assumed to close. In reality a combination of the two options would occur depending on the size and age of the facilities as well as other factors.

A model developed by the Canadian Grain Commission (CGC)[3] was used to estimate the savings in elevator operating costs from closure of the 131 elevators. The model partitioned elevators into five classes depending upon tonnage capacity and estimated a functional relationship between average operating cost, y, and annual turnover, x, as follows:

$$y = a + b/x$$

where coefficients, a and b, were separately estimated for each capacity class:

Tonnage Capacity	a	b
0-2000	2.206	20.185
2001-3000	2.475	15.405
3001-4000	2.475	13.892
4001-6000	2.086	12.541
>6000	3.176	6.541

The elevator operating cost savings were projected in current 1990/91 dollars. The following simplifying assumptions were made:

i) the tonnage from one station which was closed within the last two years was assigned to the closest station on the same line;

ii) for stations with more than one elevator, the 10 year average of deliveries to the station was apportioned to the individual elevators in proportion to the capacity of the individual elevators. This has the effect of assigning the same annual turnover rate to each elevator at a station; and

TABLE 2.1: SUMMARY OF INFORMATION FROM ORIGINATING ELEVATORS

Transfer tonnage (10 year average to 1987/88)	2 054 200
Total Western Canada tonnage (10 year average delivery to 1987/88)	29 249 800
% of Western Canada tonnage	7%
Permit book holders on originating lines (1989/90)	10,408
Total number of regular permit book holders (1989/90)	138,564
% of Western Canada permit book holders	8%
Number of originating primary elevators (1990/91)	131
Total number of primary elevators (1990/91)	1,578
% of total primary elevators	8%
Storage capacity of originating primary elevators (1990/91)	537 420
Total storage capacity of primary elevators (1990/91)	7 205 370
% of total storage capacity	7%

(Note: 10 year average deliveries could be greater than individual annual deliveries)

Number of Originating Primary Elevator Companies

Saskatchewan Wheat Pool	42
Alberta Wheat Pool	27
Pioneer Grain	19
United Grain Growers	18
Manitoba Pool Elevators	11
Parrish and Heimbecker Ltd.	6
Paterson and Sons Ltd.	5
Cargill	2
Alberta Terminals Ltd. (Cargill)	1
Total	131

Summary of Number of Originating Elevator Companies By Delivery Station (Point)

	Single	Two Co.	Three Co.	Total
Manitoba	11	5	0	16
Saskatchewan	29	15	1	45
Alberta	19	10	2	31
Total	59	30	3	92

Number of Originating Elevators Based on Capacity (000 Tonnes)

	0-2	2-3	3-4	4-6	6+	Total
Manitoba	0	8	5	7	1	21
Saskatchewan	8	23	16	15	1	63
Alberta	2	6	13	10	16	47
Total	10	37	34	32	18	131

Note: ATL facility at Picture Butte has since been closed.

Source: Grain Elevators in Canada and Grain Deliveries at Prairie Points, CGC; Seeded and Quota Acreage Statistics, Canadian Wheat Board (CWB).

iii) average elevator costs from the model in respect of 1983/84-1985/86 were indexed to 1990/91 using an assumed inflationary factor of 10% for the entire period.

In total the closure of 92 stations with 131 elevators involved savings in elevator operating costs of some $12.66 million. It is worth noting that elevator operating costs as defined in the CGC model did not include head office cost allocations, property taxes or depreciation.[4] Moreover, no closing cost or salvage value was assumed for the elevators involved. The additional operating costs of alternate stations are presented in Section 5.

3. PROJECTED NET VOLUME-RELATED COST SAVINGS

The grain was transferred from the originating station to the nearest alternative station which could be on a different rail line or railway. Because of confidentiality concerns, the railways provided the net volume-related cost differentials (D) between the originating and alternative rail segments based on the 1988 NTA approved cost base.

The net savings in volume-related costs[5] (NVRC) were projected in the following manner:

$$NVRC = (D_e \times T_e \times I) + (D_w \times T_w \times I)$$

where the cost of transferred tonnage moving east (T_e) or west (T_w) to port positions was indexed (I). The following simplifying assumptions were made:

i) the cost differentials assumed that the same operating practices in place in 1988 would be in place in 1990/91. For example, no additional crews or equipment would be needed to handle the additional tonnage on the alternate line. In the one case where the transferred tonnage would have significantly affected operating practices, a revised volume-related cost was estimated by the railway;

ii) the relative split of the transferred grain moving east or west was assumed to be the same in 1990/91 as occurred in 1988 for the subdivision containing the alternate point. This resulted in a percentage east/west split for the total transferred tonnage of 44/56% compared to 40/60% for the six principal grains and oilseeds transported in 1989/90 under the WGTA[6]; and

iii) cost differentials were indexed to 1990/91 dollars by the NTA approved volume-related price index adopted for the WGTA rate scale for 1990/91. The cost differentials include a contribution to fixed costs of 20% of volume-related variable costs.

In total the discontinuance of moving 2 054 200 tonnes of grain from 34 line segments and 131 originating elevators would result in volume-related cost savings of $7.46 million; this is an average volume-related cost savings of $3.63 per tonne. This cost saving would occur in both the off-track and direct trucking options as the grain is transported to port destinations by railway from the alternate station in either case.

4. ESTIMATED ADDITIONAL TRUCK CHARGES

In order to assess the impact of rationalization of the branch line segments, the grain traffic was diverted to the nearest alternative station which had the capacity to handle the total tonnage from the originating station. No attempt was made to redirect the grain to the same elevator company or railway and only primary elevators were considered as alternatives. Once the alternative stations were identified, trucking costs were projected in 1990/91 dollars.

It should be noted that this approach is not consistent with the criterion used to administer alternative service agreements under the SIR fund where compensation is paid for grain traffic diverted to the nearest alternative station only and is based on a commercially tendered trucking rate.

All truck moves had a fixed cost (FC) component and a variable cost (VC) component that varied as the distance (D) changed:

$$TC = FC + VC \times D$$

Fixed costs were costs that must be paid regardless of the distance driven and include items such as depreciation, interest on investment, licence fees, insurance, and administration. Variable costs were relative to the distance driven and include items such as repairs and parts, tires and batteries, fuel and driving labour.

Trimac Consulting Services Ltd. provided a computer model used to project the truck cost functions in this study. The costs were derived with assistance from the Alberta Agriculture Transportation Branch, and both producer and truck representatives on the Subcommittee. The respective costs are indicated in Table 3.1. Road routes, weight allowances and elevator-to-elevator mileages were provided by provincial government highways and transportation departments at the request of the Subcommittee representative from the Manitoba Trucking Association. In either the off-track or direct trucking option, only the incremental cost of moving to these options was relevant to the study.

1) OFF-TRACK OPTION

The incremental cost under this option would be the commercial cost of trucking grain the distance between the originating and alternative stations. Producers would continue to truck to the originating elevator as was the case when the rail line was still in place. The total cost per tonne was estimated as follows:

total cost per tonne: $1.75 + $0.09 x distance

TABLE 3.1: PROJECTED GRAIN TRUCK COSTS PER TONNE

Distance (Mile)	Commercial B-Train Elevator Pickup (40T)	Commercial Semi, Farm Pickup (23T)	Farm Truck (9T)
5	$2.22	$3.62	$3.85
10	$2.69	$4.26	$4.60
15	$3.16	$4.91	$5.35
20	$3.62	$5.55	$6.10
25	$4.09	$6.20	$6.85
30	$4.56	$6.84	$7.60
35	$5.02	$7.49	
40	$5.49	$8.13	
45	$5.96	$8.77	
50	$6.43	$9.42	
55	$6.89	$10.06	
60	$7.36	$10.71	
65	$7.83	$11.35	
70	$8.29	$12.00	
75	$8.76	$12.64	
80	$9.23	$13.28	
85	$9.70	$13.93	

Note: Equations in the text are rounded therefore costs per tonne in the table will differ slightly.

The following simplifying assumptions were made to cost the moves using a B-train capable of hauling 40 tonnes at a time:

i) an average travelling speed of 45 miles per hour;
ii) a total load and unload time of 1.75 hours;
iii) an operator wage of $16 per hour;
iv) a diesel fuel cost of $0.50 per litre;
v) a contribution to overhead costs of 10% of revenue;
vi) administration and interest costs of 14% of revenue;
vii) dedication of the truck to grain movement for long periods of time; and
viii) no back haul.

The distance between the elevators was from 7 to 85 miles for the 92 originating stations with a weighted average distance of 32 miles. The transferred tonnage was as low as 5 100 tonnes and as high as 57 600 tonnes with an average transfer of 21 850 tonnes.

In total the 2 054 200 tonnes of traffic was hauled an average of 32 miles for a projected truck cost of $9.80 million. This represents an average cost of $4.77 per tonne or $0.15 per tonne/mile.

2) DIRECT TRUCKING

Under the direct trucking option, the grain was trucked from the farm to the alternate station. The additional cost would be the commercial cost of transporting the grain to the alternate station less the cost of producer trucking to the originating station. The distance from farm to alternate elevator was estimated by the distance between the originating and alternate station. This distance would likely be the maximum increase in distance as some producers may deliver to stations which are closer than the designated station or may deliver by an alternate route because of the farm location.

Commercial truckers indicate there is an additional loading time required when hauling from a farm because of factors such as ease of access to bins and amount of grain contracted per haul (due to quotas). They also indicate that they would likely use a smaller truck than under the off-track option because of considerations such as ease of use in farm yards. As a result the estimated total cost per tonne of using a semi-trailer hauling 23 tonnes a trip would be as follows:

total cost per tonne: $2.98 + $0.13 x distance

based on the following simplifying assumptions:

i) an average travelling speed of 40 miles per hour;
ii) a total load and unload time of 2 hours;
iii) an operator wage of $14 per hour; and
iv) fuel costs, contribution to overhead costs, administration and interest charges, and back haul were assumed to be the same as under the off-track option.

In total the 2 054 200 tonnes of traffic was hauled a weighted average of 32 miles for a projected truck cost of $14.65 million or an average cost per tonne of $7.13 ($0.22 per tonne/mile).

Based on the discussions with producer representatives and the Alberta government, the farm to originating elevator move was costed as a farmer owned 9 tonne truck. The resulting total costs per tonne were as follows:

total cost per tonne: $3.10 + $0.15 x distance

The following assumptions were used in developing the above farm truck cost functions:

i) an assignment of one-third of the fixed costs to grain transport for delivery to elevators;
ii) an average travelling speed of 35 miles per hour;
iii) a total load and unload time of 0.75 hours;
iii) a wage of $10 per hour; and
iv) fuel costs of $0.50 per litre.

Producers were projected to truck an average of 11 miles and deliver an average of 197 tonnes. Individual moves were projected to be between 5 and 30 miles with a weighted average haul of 11 miles and average deliveries ranging between 56 and 592 tonnes. The relatively low average delivery suggests that permit holders are likely to be delivering grains to other lines not under consideration in this study. The projected cost of hauling 2 054 200 tonnes was $9.91 million or an average of $4.82 on a per tonne basis ($0.44 per tonne/mile).

In total the diversion of 2 054 200 tonnes of traffic under the direct trucking option was projected to have incremental net truck costs of $4.74 million (semi less farm truck costs). This represents an average incremental cost of $2.31 per tonne or $0.11 per tonne/mile. The incremental hauling distance was projected to be 21 miles. Although the farm-to-elevator move was costed using a commercial truck, some producers may choose to truck themselves.

5. PROJECTED ADDITIONAL ELEVATOR OPERATING COSTS

It was projected that the diverted grain traffic would move to 46 alternative stations involving 99 elevators. Table 5.1 provides a summary of selected information which characterizes the alternative elevators.

The grain delivery for each originating station was shifted to the closest alternate station unless grain was more likely to move to a different alternative because of shipping patterns, road routings or incentive rates. In any cases where the projected turnover rate at the closest alternate exceeded 12 times[7] deliveries were moved to the next closest alternate station.

The CGC model from Section 2 was again used but this time to project the additional elevator operating costs that would be incurred in handling the diverted grain traffic. The additional elevator operating costs were projected in current 1990/91 dollars using the following assumptions:

i) multiple-elevator stations had current deliveries apportioned by the capacities of individual elevators and current elevator operating costs were determined accordingly;

ii) projected deliveries were the sum of current deliveries and diverted or transferred tonnage, and were again apportioned by individual elevator capacity;

iii) current elevator operating costs were subtracted from projected elevator operating costs to determine projected additional elevator operating costs.

In total the 46 alternative stations involving 99 elevators currently handling 2 319 700 tonnes were projected to handle 4 373 900 tonnes with the diverted grain traffic. This would raise the current operating costs from $13.76 million to

TABLE 5.1: SUMMARY OF INFORMATION FOR ALTERNATIVE PRIMARY ELEVATORS, 1990/91

Number of alternate primary elevators	101
Total number of primary elevators	1,578
% of total primary elevators	5%
Storage capacity of alternate primary elevators	692 390
Total storage capacity of primary elevators	7 205 370
% of total storage capacity	9%

Number of Alternate Primary Elevator Companies

Saskatchewan Wheat Pool	25
United Grain Growers	21
Pioneer Grain	14
Alberta Wheat Pool	14
Manitoba Pool Elevators	9
Cargill	7
Parrish & Heimbecker Ltd.	4
Alberta Terminals Ltd. (Cargill)	2
Paterson and Sons Ltd.	1
Canbra	1
Weyburn Inland Terminal Ltd.	1
Total	99

Summary of Number of Alternate Elevator Companies By Delivery Point (Station)

	Single	Two Co.	Three Co.	Total
Manitoba	0	6	2	8
Saskatchewan	6	12	6	24
Alberta	2	8	4	14
Total	8	26	12	46

Number of Alternate Elevators Based on Capacity (000 Tonnes)

	0-2	2-3	3-4	4-6	6-10	10-30	30+	Total
Manitoba	0	2	6	7	3	0	0	18
Saskatchewan	3	4	8	14	13	6	1	49
Alberta	1	1	3	12	10	3	2	32
Total	4	7	17	33	26	9	3	99

Source: Grain Elevators in Canada and Grain Deliveries at Prairie Points, CGC; Seeded and Quota Acreage Statistics, CWB.

$20.00 million for projected additional elevator operating costs of $6.24 million. The alternative elevators were assumed to incur these operating costs under both off-track and direct trucking options.

Three further points are worth noting. First, any capital improvements that may be required at the alternative elevators to handle the additional grain have not been included in the additional costs[8]. Second and relating to the first point, the study allows the turnover rate at the alternate station to increase up to 12 times. If a turnover rate changes substantially from current levels additional capital investment would likely be required. Third, in practice grain could move to stations other than the designated station. The designation of alternates is only a projection of likely grain movement.

6. SUMMARY OF PROJECTED NET SAVINGS

Overall, closure of less than a quarter of the grain dependent network was projected to result in net system savings of $9.48 million under the off-track option and to result in $27.18 million under the direct trucking option as summarized in Table 6.1. This represents net savings from redirecting seven per cent of the total Western Canada tonnage delivered by eight per cent of permit book holders to alternate stations.

TABLE 6.1: SUMMARY OF THE TOTAL PROJECTED NET SYSTEM SAVINGS FROM OFF-TRACK AND DIRECT TRUCKING OPTIONS

A. OFF-TRACK OPTION

	Projected Savings	Projected Costs	Projected Net Savings
Line-Related Variable Costs	$18,051,378		$18,051,378
Elevator Operating Costs		$6,238,386	-$6,238,386
Volume-Related Costs			$7,464,838
Truck Costs		$9,796,061	-$9,796,061
Totals			$9,481,769

B. DIRECT TRUCKING OPTION

	Projected Savings	Projected Costs	Projected Net Savings
Line-Related Variable Costs	$18,051,378		$18,051,378
Elevator Operating Costs	$12,662,975	$6,238,386	$6,424,589
Volume-Related Costs			$7,464,838
Truck Costs	$9,910,190	$14,647,024	-$4,736,834
Totals			$27,175,967

The following points are worth noting for the aggregate figures:

i) the savings in line-related variable costs were projected to be high enough to cover the additional net costs of either option; and

ii) the highest savings to the system were projected to occur under the direct trucking option mainly because of the savings occurring from closure of the originating elevators as well as lower net truck costs.

When the net savings were developed by alternate station the following points were noted:

i) the net volume-related cost savings were negative in four cases. In two of the cases the additional cost (rather than savings) was due to a more circuitous route to the port position. In another case the sizable volume of transferred grain would require additional crews to facilitate switching. In the remaining case grain was shifted to a higher cost railway.

ii) The net savings were negative at 8 of the 46 alternate stations under the off-track option, meaning that, in these instances, there would be a cost, not a saving in moving to a transitional off-track elevator.

iii) In all cases under the direct trucking option, the net savings were positive indicating that system costs were reduced by implementing this option.

Both railways indicated that car and cycle savings were being captured in the projected volume-related cost savings. CP Rail noted that the car-related savings arose from a transfer of grain from light lines to 263 000 lb. lines, and from car day savings from switching from boxcars to hopper cars as a result of patterns of use and frequency of service. Car ownership savings would be produced if government-owned cars were used to move the transferred grain. CP Rail projected that boxcar requirements would be reduced by 488 cars and hopper car requirements would be increased by 77 cars. CN projected a reduction of approximately 100 cars, which for system efficiencies would be government-supplied aluminum hopper cars.

It maybe noted that the results of this paper have excluded any explicit allowance for highway impacts. The SGTC did give careful consideration to the issue of highway impact but concluded that there does not appear to be a consensus on the magnitude of any such impact. Moreover the truck costs identified in this paper include fuel taxes and licence fees which are a source of revenue to the provinces who have jurisdiction over highways. To the extent that additional road haul implies the payment of additional fuel taxes and licence fees then the analysis in this paper provides an implicit allowance for any highway impact. However, this remains a matter of some controversy and is in large measure a matter of policy between the federal and provincial governments.

ENDNOTES

[1] The detailed data were not presented with the study because of confidentiality requirements.

[2] Includes depreciation, cost of capital, material and labour associated with railway physical infrastructure necessary to keep the line operational.

[3] *Potential Cost Reductions From Primary Elevator Closures*, CGC for the Efficiency Subcommittee of the SGTC, December, 1990.

[4] AWP has suggested that the treatment of elevator capital assets associated with branch line abandonment has not been resolved.

[5] Includes depreciation, cost of capital, material, fuel and labour associated with the movement of grain and includes a 20 per cent contribution to fixed costs.

[6] As reported by the NTA.

[7] Highest turnover rate achieved by an elevator based on 10 year average deliveries to 1987/88.

[8] *Potential Cost Reductions from Primary Elevator Closures*, CGC for the Efficiency Subcommittee of the SGTC, December, 1990.

EXAMEN COMPLET DE 1992 CONCERNANT LA LOI DE 1987 SUR LES TRANSPORTS NATIONAUX : LA DIMENSION FERROVIAIRE

Introduction

Le gouvernement fédéral a mis sur pied récemment un comité d'étude pour mener un examen complet de la *Loi de 1987 sur les transports nationaux* (LTN) en 1992, processus prévu en vertu de ce même texte législatif. En effet, l'article 266 de la LTN précise le but d'un tel exercice, soit celui d'évaluer l'impact de la loi sur les expéditeurs, les voyageurs et les transporteurs de même que sur le commerce et sur les régions et leur développement économique. Le rapport de cet examen complet doit être remis au ministre fédéral des Transports le 31 janvier 1993.

Dans le cadre de cet examen global de la LTN, il serait intéressant de souligner les modifications qui, à notre sens, devraient y être apportées en matière ferroviaire.

Mécanisme d'abandon

La politique nationale des transports contenue dans l'article 3 de la LTN préconise que «les transports soient reconnus comme un facteur primordial de développement économique régional et que soit maintenu un équilibre entre les objectifs de rentabilité des liaisons de transport et ceux de développement économique régional en vue de la réalisation du potentiel économique de chaque région».

Il existe à nos yeux une incohérence manifeste dans la loi entre, d'une part, la recherche d'un équilibre entre les objectifs de rentabilité des liaisons de transport et ceux du développement économique régional prévus à l'article 3 et, d'autre part, les dispositions spécifiques (articles 157 à 181) sur le mécanisme d'abandon ferroviaire mettant l'accent sur le seul critère strict de rentabilité.

Nous estimons que la loi devrait donc être modifiée pour que, dans le cadre de cette recherche d'équilibre, le développement économique régional soit un critère retenu aux fins des abandons ferroviaires, au même titre que le critère strict de la rentabilité.

La LTN, entrée en vigueur le 1er janvier 1988, modifie en profondeur les règles du jeu en matière d'abandon ferroviaire, un tel mécanisme facilitant le processus d'abandon d'embranchements ferroviaires par leur exploitant.

Ainsi, la longueur des voies ferrées abandonnées au Québec se chiffre pour les quatre premières années d'application de la LTN à 827 milles. À titre de comparaison avec les provinces voisines, l'Ontario a perdu 621 milles alors que le Nouveau-Brunswick et la Nouvelle-Écosse perdaient 219 milles chacun.

Le nouveau mécanisme d'abandon découlant des articles 159 à 177 de la loi peut se résumer ainsi. En cas de non-opposition à une demande d'abandon, l'Office national des transports (ONT) doit ordonner l'abandon. S'il y a opposition à la demande d'abandon, l'ONT doit déterminer si le tronçon est rentable ou non, s'il y a motif ou non de croire qu'il puisse le devenir dans un avenir prévisible et s'il est d'intérêt public de le conserver.

Nous devons souligner le cadre très rigide de ce mécanisme législatif d'abandon. En effet, il est facile de constater que ces règles du jeu restrictives ne permettent pas d'invoquer les arguments de l'impact sur les expéditeurs et des conséquences socio-économiques de l'abandon sur la région concernée. Seul le critère strict de la rentabilité est déterminant. Ainsi, sur 26 décisions de l'ONT relatives à des requêtes en abandon provenant du Québec pour les années 1988 à 1991, sept seulement ont ordonné le maintien en exploitation, soit 28 %.

Dans un tel contexte, nous croyons que le gouvernement fédéral devrait procéder à des modifications en profondeur du mécanisme d'abandon prévu par la LTN. En particulier, l'intérêt public devrait être privilégié et constituer un critère déterminant dans la décision de l'ONT du maintien ou de l'abandon d'une voie ferrée, et non un critère accessoire comme c'est le cas actuellement.

À ce sujet, voici ce que le *Rapport intérimaire de la Commission royale sur le transport des voyageurs au Canada* souligne en avril 1991 en matière d'aliénation des emprises ferroviaires :

> «C'est pourquoi, nous ne pouvons nous permettre d'attendre jusqu'à notre rapport final de 1992 pour inciter ardemment le gouvernement fédéral à revoir sans plus tarder sa politique sur l'abandon des lignes de chemin de fer et l'aliénation des emprises afin d'éviter la perte irrévocable d'emprises ferroviaires pour d'éventuels services voyageurs à l'avenir[1].»

La gravité de la situation explique une telle initiative, tout à fait exceptionnelle dans le cadre d'un rapport intérimaire.

Impacts sur les chemins de fer d'intérêt local

Le concept de chemin de fer d'intérêt local est relativement nouveau au Canada. En effet, la constitution du premier chemin de fer d'intérêt local, le Central Western, date de l'automne 1986.

Rappelons que la création de ce premier chemin de fer d'intérêt local situé en Alberta pose le problème de la compétence provinciale ou fédérale de ses activités :

> «La question dans la cause opposant Central Western aux Travailleurs unis des transports devant la Cour suprême du Canada est de savoir lequel du gouvernement provincial ou du gouvernement fédéral a compétence, pour les fins de relations de travail, sur une voie ferrée de 105 milles située entièrement dans la province d'Alberta[2].»

Après un débat judiciaire de trois ans, la Cour suprême du Canada décide que le chemin de fer d'intérêt local Central Western n'est pas soumis aux dispositions du Code canadien du travail et n'est donc pas un ouvrage ou une entreprise fédérale au sens de l'alinéa 92 (10) a) de la *Loi constitutionnelle de 1867*. En d'autres mots, ce chemin de fer d'intérêt local relève de la compétence provinciale en raison de la nature distincte de ses activités par rapport à celles du CN.

Cette décision fondamentale constitue un élément déterminant pour l'émergence de chemins de fer d'intérêt local en ce sens que ceux-ci ne sont pas soumis aux conventions collectives très onéreuses des syndicats canadiens. À ce sujet, les auteurs Richard Lande et Michael Loughman écrivaient ceci :

> «If, on the other hand, the Supreme Court rules in favour of the C.W.R., then there may very well be a steady growth in the number of shortline railways in Canada, as these railways will be able to more effectively utilize their labour[3].»

La *Loi nationale de 1987 sur les transports nationaux* par le truchement des trois dispositions (droits de circulation, clause «à l'avantage général du Canada» et aide d'autres moyens de transport) a des impacts déterminants sur l'existence des chemins de fer d'intérêt local.

- Droits de circulation

L'article 148 de la LTN prévoit l'octroi de droits de circulation à une compagnie ferroviaire par une autre entreprise de chemin de fer.

Ainsi, deux compagnies ontariennes de chemin de fer d'intérêt local (Ontario Midwestern[4] et Victoria County[5]) demandent à l'ONT de déterminer les droits de circulation et ce, en vertu de l'article 148 de la LTN.

En mai 1991, l'ONT refuse d'octroyer des droits de circulation sur les lignes du CN aux deux requérantes ontariennes en raison du fait que l'article 148 de la LTN ne vise pas spécifiquement les chemins de fer d'intérêt local relevant de l'autorité provinciale. La rigidité de cette disposition nous semble paradoxale avec l'esprit de déréglementation qui a présidé à la réforme législative de 1987.

Nous estimons que dans un tel contexte, il est fondamental que le gouvernement fédéral apporte des amendements majeurs à l'article 148 de la LTN de façon à permettre spécifiquement aux chemins de fer d'intérêt local relevant de l'autorité provinciale d'obtenir des droits de circulation d'une compagnie ferroviaire à charte fédérale.

- La clause «à l'avantage général du Canada»

L'article 174 de la LTN prévoit expressément que la cession de toutes les lignes ferroviaires, faisant l'objet d'un accord avec Via Rail, ne peut s'effectuer qu'en faveur d'entreprises de juridiction fédérale.

Cette clause dite «à l'avantage général du Canada» couvrant les lignes ferroviaires assujetties à un service de voyageurs, constitue un obstacle majeur à la création de chemins de fer d'intérêt local sur ces tronçons. En effet, les chemins de fer d'intérêt local ne voulant pas être soumis à l'autorité fédérale en raison notamment des conventions collectives très coûteuses des syndicats canadiens, ne peuvent prétendre acquérir certaines catégories de lignes.

Nous sommes donc d'avis que le gouvernement fédéral devrait amender l'article 174 pour faire disparaître la clause dite «à l'avantage général du Canada».

- Aide financière à d'autres moyens de transport

L'article 175 de la LTN permet le financement d'autres moyens de transport pour les expéditeurs touchés par l'abandon d'un tronçon ferroviaire.

De nombreux intervenants ont déploré le fait qu'une seule demande de financement ait été acceptée par le ministère fédéral des Transports. Rappelons que le recours à ce programme d'aide financière, prévu expressément par la loi, devrait représenter un outil essentiel pour les expéditeurs aux prises avec des abandons ferroviaires dans leurs régions. Cette disposition législative est malheureusement restée inopérante.

Lors de l'examen complet de la LTN, il nous apparaît essentiel que le gouvernement fédéral modifie l'article 175 de la LTN de façon à prévoir en faveur des expéditeurs touchés un financement statutaire d'une part, et à étendre ce dernier aux chemins de fer d'intérêt local pour contribuer à leur émergence.

Le contexte québécois

Au Québec, il n'existe actuellement aucun chemin de fer d'intérêt local. Nous croyons fermement que l'une des raisons fondamentales de l'absence de chemins de fer d'intérêt local est le coût élevé

d'acquisition de tronçons ferroviaires évalués dans certains cas, à plusieurs millions de dollars.

À cet égard, nous estimons que, en l'absence de subventions étatiques, seule une approche s'inspirant de l'exemple de la compagnie de chemin de fer américaine Norfolk Southern peut résoudre le problème du coût trop élevé de l'acquisition de tronçons par un exploitant de chemin de fer d'intérêt local.

En effet, cette compagnie de chemin de fer américaine, par son programme de filiation directe («thoroughbred») loue, au lieu de vendre à un exploitant le chemin de fer d'intérêt local les tronçons dont celle-là veut se départir, et ce avec une entente conjointe de marketing. Juridiquement, ce sujet est élaboré de façon plus explicite dans le texte intitulé «L'enjeu de l'acquisition des voies ferrées abandonnées»[6].

En première partie de notre exposé, nous avons souligné la nécessité pour le gouvernement fédéral, dans le cadre de l'examen complet de la loi, d'apporter des modifications pour favoriser l'émergence de chemins de fer d'intérêt local. Cependant, les provinces ont, elles aussi, un rôle à jouer pour favoriser une telle émergence. Ainsi, le ministère des Transports du Québec entend favoriser la création de chemins de fer d'intérêt local par la réalisation d'études de faisabilité de certains tronçons ferroviaires ainsi que par la mise sur pied en juin 1992 d'un colloque sur le financement des chemins de fer d'intérêt local. En outre, il procède actuellement à une révision complète de la *Loi sur les chemins de fer* (L.R.Q., chapitre C-14). La révision de cette loi du Québec a pour but de permettre la constitution de compagnies de chemin de fer par lettres-patentes au lieu du mode actuel, long et coûteux, d'une loi ou «charte» et d'introduire, comme au niveau fédéral, la notion de certificat d'aptitude. Cette nouvelle procédure devrait favoriser la création de chemins de fer d'intérêt local.

En dernier lieu, soulignons la prochaine mise en service d'un premier chemin de fer local à vocation touristique au Québec. Ce service ferroviaire touristique ayant pour nom le *Petit Train à vapeur Hull-Wakefield* devrait être inauguré le 27 juin 1992.

Problématique de Via Rail

Bien que l'avenir de Via Rail ne soit pas l'objet spécifique du mandat confié au comité d'étude chargé de procéder à l'examen complet de la LTN, il nous apparaît utile de proposer quelques modifications concernant la société Via Rail.

Ces modifications s'inscrivent aussi dans le contexte du rapport final de la Commission royale sur le transport des voyageurs du Canada, devant être déposé à l'automne 1992.

Nous croyons qu'il est impératif de doter Via Rail de l'encadrement législatif qui lui fait grandement défaut. En effet, le gouvernement fédéral devrait adopter une loi qui précise le cadre, les

objectifs généraux des services ferroviaires pour passagers de même que le statut, les responsabilités et les droits de Via Rail, notamment en matière de relations contractuelles avec CN et CP.

Rappelons que le gouvernement fédéral a déjà présenté en février 1986 le projet de loi C-97 portant sur le transport ferroviaire des voyageurs qui est mort au feuilleton. Nous estimons que Via Rail, à l'instar d'AMTRAK, de par un statut législatif propre, pourrait bénéficier d'une plus large autonomie de gestion et détenir notamment un pouvoir d'emprunt. Dans ce nouveau contexte, Via Rail pourrait acquérir certains tronçons ferroviaires achalandés tout comme AMTRAK et ainsi diminuer de façon substantielle ses coûts d'opération.

En dernier lieu, nous croyons que Via Rail devrait être exempté de l'obligation d'assumer le coût de certains services ferroviaires en régions éloignées qui était en 1988, de 58 700 000 $. Selon nous, il appartient au gouvernement fédéral, et non à Via Rail, d'assumer le coût de tels services ferroviaires de voyageurs en régions éloignées en tant que service public.

Conclusion

Nous avons essayé de souligner la nécessité de modifier certaines dispositions législatives de caractère ferroviaire. Cependant, il faut noter que, dans certains mécanismes de réglementation, (par expemle, les contrats confidentiels et à un degré moindre, les prix de ligne concurrentiels) il n'y a pas lieu à modifications immédiates car les effets marquants de ceux-là pourraient être revus adéquatement à plus long terme.

En ce qui concerne les contrats confidentiels, l'examen annuel de 1990 de l'ONT nous révèle que leur nombre a doublé en comparaison avec l'année 1989, soit 3 900. Le succès des contrats confidentiels est lié au fait que les expéditeurs et les transporteurs ont des intérêts communs. Pour les expéditeurs, le fait de contracter avec un transporteur ferroviaire limite l'augmentation annuelle des coûts de transport. Pour les transporteurs ferroviaires, les contrats confidentiels sont une source substantielle de revenus. En effet, CN et CP estiment que pour l'année 1990, 70 % de leurs revenus, sauf ceux reliés au transport du grain, proviennent des contrats confidentiels. Il s'agit donc là d'un effet positif de la LTN qu'il faut signaler.

Relativement aux prix de ligne concurrentiels, le recours à cette disposition n'est guère connu et utilisé par les expéditeurs. D'ailleurs, l'ONT ne s'est prononcé en la matière que dans deux cas seulement. Le premier cas concerne la requête d'Alberta Gas Chemicals en 1988 d'obtenir du CP un prix de ligne concurrentiel pour transporter du méthanol de Medecine Hat à Coutts, Alberta; le 27 septembre 1991, l'ONT a fixé pour l'année 1991 le prix de ligne concurrentiel à 8,80 $ la tonne. Pour le second cas, l'ONT a déterminé un prix de ligne concurrentiel pour la firme CSP Foods

pour le transport de l'huile de Canola de trois points d'origine à un point d'expédition situé aux États-Unis.

Soulignons que CN et CP sont opposés aux prix de ligne concurrentiels en raison du fait qu'ils doivent partager avec leurs compétiteurs les bénéfices de leurs investissements. Cependant, pour les expéditeurs, les prix de ligne concurrentiels sont considérés comme des outils de négociation facilitant la signature d'une entente avec la compagnie ferroviaire concernée.

En conclusion, dans le cadre de l'examen complet devant être réalisé cette année, il nous apparaît essentiel de procéder à des modifications majeures à certaines dispositions de la LTN touchant le transport ferroviaire pour répondre aux besoins des expéditeurs et des exploitants de chemins de fer d'intérêt local ainsi que des voyageurs.

À cet égard, nous formulons d'ailleurs le souhait que soit créée une association canadienne des chemins de fer d'intérêt local pour promouvoir les intérêts de ses membres particulièrement vis-à-vis des gouvernements fédéral et provinciaux.

NOTE : Les opinions émises dans cette étude sont celles de l'auteur et ne reflètent pas nécessairement les vues du ministère des Transports du Québec.

NOTES

1. Le *Rapport intérimaire de la Commission royale sur le transport des voyageurs au Canada*, avril 1991, p. 242

2. Central Western Railway Corporation c. Travailleurs unis des transports, etc. Cour suprême du Canada, 20 décembre 1990, p. 1

3. Richard LANDE et Michael LOUGHMAN, «Shortline Railway Industry in Canada», *Concordia Transportation Management Centre*, September 1990, p. 24

4. Décision de l'ONT sur la demande de droits de circulation par le chemin de fer d'intérêt local Ontario Midwestern, 10 mai 1991

5. Décision de l'ONT sur la demande de droits de circulation par le chemin de fer d'intérêt local Victoria County, 22 mai 1991

6. Louis DOYLE, «Les enjeux de l'acquisition des voies ferrées abandonnées», *Congrès du Groupe de recherches sur les transports au Canada*, mai 1991, Québec (C.T.R.F.) Evolution in Transportation, p. 244-253.

NOUVEAUX CHEMINS DE FER D'INTÉRÊT LOCAL AU CANADA

Acquéreur	Propriété	Situation	Loi constitutive
Nouvelle-Écosse			
3 groupes intéressés : - Anacosti et Pacific Co. Inc. de Chicago - Huron Transportation Group Inc. de la Virginie - Railtex Service Co Inc. du Texas * décision en juin 1992	CN	Entre Sydney et Truro	
Ontario			
Victoria County	CN	Entre Lindsay et d'autres points en Ontario	1990 L.O. chapitre Pr.14
Port Stanley Terminal Rail	CN	Entre St-Thomas et Port Stanley	
Goderich-Exeter (filiale ontarienne de Railtex Service Co. Inc. du Texas)	CN	Entre Stratford et Goderich Entre Centralia et Clinton Junction	1990 L.O. chapitre Pr. 41
* acquisition sujette à une approbation de l'Ontario Municipal Board			
Saskatchewan			
Southern Rail Cooperative	CN et CP	Situé dans le sud de la province	
* projet de démonstration d'une durée de 3 ans			
Alberta			
Central Western	CN et CP	Entre Ferlow-Junction et Dinosaur et additions	1984 L.A. chapitre 71

THE USE OF SPATIAL DECISION SUPPORT SYSTEMS TO LOCATE INLAND GRAIN TERMINALS

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INTRODUCTION

This paper discusses the use of Decision Support Software (DSS) in locating high throughput (htp) grain elevators. The study is divided into two major sections. The first section determines the optimal province-wide spacing for htp terminals in the Province of Saskatchewan. The second section focuses on locating one specific htp terminal in a deficient area which has been identified in part one. The location decision will be made using four different decision support systems. The DSS results will be compared both with each other and with the more traditional approach to location problems which uses mathematical programming methods.

HISTORICAL BACKGROUND

The prairie grain collection system has been undergoing an ongoing rationalization process since the late 1930s. Traditionally this has been accomplished by closing smaller, inefficient elevators and increasing the capacity of others, either by constructing a larger traditional elevator or by adding extra storage facilities i.e. annexes, to existing elevators. In this way the number of elevators, but not the actual amount of storage capacity, was reduced (Hall, 1977; Wilson, 1981).

Since 1976 there has been a change in the approach to rationalization which has been prompted primarily by economic forces. During this period rationalization was occurring at an accelerated pace. This was due in part to the large number of railway branch lines which were being abandoned, effectively shutting down a large number of grain delivery points. Instead of simply replacing the lost capacity with traditional wooden elevators, most companies have opted to construct large concrete htp elevators. These elevators are capable of cleaning and handling a high volume of throughput and can load railway cars at a much greater rate than traditional primary elevators. The savings in loading time are of an extremely large magnitude. Traditional elevators take approximately one week to load 20 grain cars, whereas a htp elevator can load 25 cars in a day (Alberta Wheat Pool, 1991).

The htp elevators are spaced much farther apart than were traditional primary elevators. Primary elevator spacing was originally based on the horse and wagon mode of transportation which existed when the network was established, between 1881 and 1930. As such elevators were built approximately ten miles apart along railway branch lines. This close spacing is no longer necessary under the current truck-based mode of grain transportation.

METHODOLOGY

Spacing

The following section determines the spacing required for the optimal htp elevator distribution. Once this optimal spacing of htp facilities is known, the approximate locations of future facilities can be determined, using existing locations as

starting points. The existing points must be used as starting points in order to maintain an appropriate spacing in a province-wide context.

The optimal htp facility spacing will be determined by establishing the equilibrium between the aggregate cost of trucking grain to elevator and the cost of constructing and operating htp facilities. Trucking costs will favour more facilities, located at a relatively close spacing, since this would result in decreased hauling distances, thus decreased costs. Construction costs on the other hand favours fewer facilities, thus a wider spacing.

Both total elevator and total trucking costs are estimated using five possible htp elevator spacings: 20, 40, 80 160, and 320 kilometres apart. Trucking costs for the five possible spacings have been taken from Meyer and Sparks (1987, p. 332). Meyer and Sparks determined the cost of hauling grain for each of nine different modes of trucking ranging from small, private vehicles to large custom and commercial trucks. The truck types and their associated costs at different elevator spacings are shown in Figure 1. Transportation costs are not perfectly linear over distance and thus a regression is run for each truck type to derive a formula which can be used for finding the equilibrium point between trucking and elevator costs.

Figure 1: Trucking Rates at Different HTP Elevator Spacings ($/tonne)

Spacing (km)	**20**	**40**	**80**	**160**	**320**
Private Trucks					
2 axle	7.9	11.16	15.34	21.75	38.26
3 axle	5.45	8.70	13.21	18.83	27.86
3 axle with pup	5.15	7.39	11.57	15.96	22.19
5 axle	5.25	8.94	14.7	22.45	31.61
A-train	3.69	6.47	11.15	18.15	27.17
Custom Trucks					
3 axle pup	2.96	3.93	5.35	7.79	13.37
5 axle	3.88	5.27	7.58	12.16	20.19
A-train	2.86	4.11	5.58	8.71	15.17
Commercial Trucks					
A-train	1.13	1.72	2.87	5.15	9.66

The number of elevators needed under each spacing scenario is determined by dividing Saskatchewan's grain production area by the given spacing. The grain production area is approximately 340,200 square kilometers (640 kilometers east/west by 560 kilometers north/south). The number of htp facilities at each spacing is shown in Figure 2.

Figure 2: Number of HTP Elevators Required Under Different Spacings

Spacing (km)	20	40	80	160	320
Number of Elevators	896	224	56	14	3.5

Elevator construction costs are based on the current cost of construction experienced for those htp facilities currently in the construction phase. Construction cost per elevator is set at 4.5 million dollars (Western Producer, August 8, 1991). The lifetime of the htp

facility is assumed to be 50 years. Two different operating expense scenarios will be used. The first assumes operating costs to be $100,000 per year and the second $250,000 per year. Elevator companies were not willing to reveal true operating costs and as such, estimates have had to be used. Based on these assumed per facility cost variables, the cost of operating an htp elevator network can be calculated as follows:

$$Ct = Cc + n(50 \times Co)$$

Where: Ct = Total Aggregate Elevator Cost ($)
Cc = Aggregate Elevator Construction Cost ($)
Co = Aggregate Yearly Elevator Operating Cost ($)
n = number of facilities

To determine the total cost of transporting the Saskatchewan grain crop, the above mentioned transportation costs have been applied to the 1979-80 to 1989-90 ten year average for Saskatchewan crop production of 15,641,100 tonnes (Canadian Grain Commission, Economics and Statistics Division a, 1989-90, p. 34). For each spacing and mode scenario the transportation costs for the fifty year period are calculated as follows:

$$CXM = 50 (tXM/2 \times 15,641,100)$$

Where: CXM = Total Transportation Cost ($)
tXM = Per tonne Transportation Cost
X = Maximum haul for spacing(km)
M = Mode

The per tonne cost of transporting grain distance X by mode M (tXM) is divided by 2 as a form of determining the average transportation costs for the given spacing. If, for example, the spacing is 20 kilometres, the farthest any given producer, located on the boundary of elevator service areas, would have to haul would be half the spacing distance, or 10 kilometres. The total per tonne costs used are for this maximum distance. Assuming producers are located at an even spacing, the average hauling distance for a given elevator is half the maximum hauling distance, which in the case of the example is 5 kilometres. Based on the five possible spacings, Figure 3 shows the total cost of constructing and operating the htp elevators for their 50 year life span as well as the cost of the nine different types of trucking.

Figure 3: 50 year Elevator and Trucking Costs at Various Spacings (M$)

Spacing (km)	20	40	80	160	320
Elevators					
@ $100,000/yr operating cost	85.12	21.28	5.32	1.33	0.33
@ $250,000/yr operating cost	152.3	38.08	9.52	2.38	0.59
Private Trucks					
2 axle	15.4	21.8	30.0	42.5	74.8
3 axle	10.7	17.0	25.8	36.8	54.5
3 axle with pup	10.1	14.4	22.6	31.2	43.4
5 axle	10.3	17.5	28.7	43.9	61.8
A-train	7.21	12.6	21.8	35.5	53.1
Custom Trucks					
3 axle pup	5.79	7.68	10.5	15.2	26.1
5 axle	7.59	10.3	14.8	23.8	39.5
A-train	5.59	8.04	10.9	17.0	29.7
Commercial Truck					
A-train	2.21	3.36	5.61	10.1	18.9

Micro Location Study

Initially, TSA88 (Eastern Software, 1984), a warehouse transportation problem software package will be used to optimize the study area identified as htp deficit. This and other linear programming programs optimize solely on the basis of a single criterion, transportation costs. The solution produced by TSA88 will be compared with that determined by the four decision support systems listed below. It is hypothesized that the DSS will select a different optimal solution from the linear programming package because the DSS are able to incorporate multiple criteria in the location selection process and are not limited to a single criteria. The DSS which will be used are: DINAS - Dynamic Interactive Network Analysis System (Ogryczak, Studzinski and Zorychta, 1988); DAS - Decision Analysis System (Armada Systems, 1990); MATS - Multi Attribute Trade-off System (Brown, Stinson and Grant, 1986); and AIM - Aspiration-level Interactive Method (Lotfi and Zionts, 1988).

The DSS will optimize the network in terms of the interests of the six major players involved: the producers, elevator companies, railway companies and municipal, provincial, and federal governments. These six players, and their interests have been identified by Meyer and Sparks (1987). It is the sometimes conflicting interests of these players which must be traded off until a suitable compromise is reached. The first interest group is the grain producers themselves. An efficient grain handling and transportation system is desirable for this group because the more economically grain can be shipped, the more competitive it becomes on the world market. Producers are also interested in minimizing their own individual transportation costs to the elevator and, as such, desire a relatively close network of elevators.

The second group of players are the railway companies which operate what they consider to be an overbuilt system of railway branch lines, the product of an overly competitive period at the beginning of the century. The railways are anxious to abandon many of the low traffic volume, grain dependent, branch lines or at least sections of them. The railways would prefer to have grain delivery points located either along main lines and branch lines which generate a relatively large volume of traffic. Most existing prairie branch lines are protected by statute until the year 2000 (Wilson, 1981). After this date many can be abandoned. When constructing a long term facility such as a htp terminal it is important to consider this future situation, rather than the current one.

Elevator companies, like the railway companies, are interested in rationalizing their network of facilities which was also designed in a different era.

The provincial and municipal governments, compromising the fourth and fifth groups, are somewhat interested in maintaining a close network of elevators, or at least an htp location which would minimize aggregate shipping distance. The provincial government is responsible for maintaining and building highways and the municipal government is responsible for secondary roads. The further apart the elevators are located the more trucking must occur. To increase hauling efficiency, larger trucks are used, thus increasing wear on the road network. The governments are thus responsible for greater road expenses with no corresponding increase in revenue.

The final player in the system is the federal government. The federal government's main interest is in delivering grain to buyers at the most competitive price possible since grain is an important foreign exchange earner for the country. In addition, it is interested in reducing the level of subsidization that it now provides to rail companies which are legally required to haul grain on protected branch lines.

For both linear programming and DSS solution methods, the problem will be formulated in a similar fashion. Farms represent the grain supply points. The three ports, Vancouver/Prince Rupert, Churchill, and Armstrong/Thunder Bay, are the demand nodes. The final set of nodes are the ones of interest for this study. They will be the towns in the study region which currently fill the role of grain shipment points. They represent transshipment points and have no intrinsic supply or demand quantities

themselves. The purpose of this study is to determine which one(s) of them should be the site of a new htp facility.

Meyer and Sparks (1987) trucking costs will be used for farm to elevator grain hauling costs. Published railway freight rates for export grain will be used as cost co-efficients from elevator to port. The tariff for export wheat will be used. Although the crops handled through the elevator system are not exclusively export wheat, it does constitute a large proportion of grain shipped in the 1989-90 crop year (Canadian Grain Commission, Economics and Statistics Division a, 1989-90, p. 65).

It is assumed that changes in the primary elevator system must occur within the existing location context, therefore, no new delivery points, i.e., elevator locations may be established. This is a realistic assumption since existing delivery points already have the access roads, railways sidings and other necessary infrastructure.

DSS Variables

Whereas the Warehouse problem uses only a single variable, namely transportation costs, the decision support systems are able to make use of multiple variables in the location analysis. The variables used in the analysis are listed in Figure 4. They have been chosen to reflect the interests of the various major players in the grain handling and transportation system.

Figure 4: Variables used in the DSS Analysis

Variable	Objective	Objective Description
Ship	Minimize	Aggregate transportation costs when using the given delivery point
10M	Maximize	Number of producers within 10 mile radius of the delivery point
20M	Minimize	Number of producers more than 20 miles from the delivery point
Farthest	Minimize	Distance of farthest producer
Main	Minimize	Distance to railway main line
Roadac	Maximize	Speed limit on access road to town
Curcap	Maximize	Current storage capacity

Several of the objectives are directed toward the producer's interests, some are based on efficiency and others on equity. These objectives are: the number of producers within a 10 mile radius of the delivery point (10M), the number of (study area) producers greater than 20 miles from the delivery point (20M), and the distance of the farthest producer from the delivery point (Farthest). The co-efficients for "10M" and "20M" simply represent the number of producers and the co-efficient for "Farthest" is the distance in miles. The co-efficients for these objectives are assigned directly to the town nodes. The other objective of direct interest to the producers is "Ship", that is the transportation cost associated with moving the grain from the farms, through the delivery point and on to port. The cost co-efficients for "Ship" are assigned to the arcs between the nodes and represent the cost of moving one tonne of grain that distance. This objective is the one used on its own in the classical transportation problem (Orden, 1956).

The railway's interests are reflected in by the "Main" objective which represents the number of miles along the branch line the town is from the main railway line. The companies would like to see this objective minimized as it could mean that a portion of

the line could be abandoned. This would result in savings through lowered maintenance costs and decreased time operating on the branch line. They are interested in reducing branch line milage because trains must operate at reduced speeds on them, thus they are more costly to operate than a main line. This objective is tied to the town nodes.

The "Curcap" objective represents the current elevator storage capacity, in tonnes, at each delivery point. It has been included because it is somewhat representative of the current delivery patterns in the area. "Curcap" is tied to the town nodes.

The "Roadac" objective is included because, to accommodate large numbers of large grain trucks, the access road to the htp elevator should be paved and of relatively high quality. For this study, speed limit on the main access road to the town is used as an indicator for road quality.

The delivery points will be evaluated using the criteria in both an unweighted and weighted fashion. The initial evaluation will use unweighted criteria. Under this analysis, both the aspiration (desired) and reservation (minimum acceptable) levels are set to the utopia (best possible) levels for each criteria. The seven criteria are not necessarily all of equal importance. In the second evaluation, criteria are weighted as follows (out of 100):

100 • Aggregate transportation costs when using the given shipping point (Ship)
• Number of producers within a twenty mile radius (20M)
• Distance to the main rail line (Main)
75 • Number of producers within a ten mile radius (10M)
50 • Hauling distance for producer furthest from the delivery point (Farthest)
• Current elevator capacity at the delivery point (Curcap)
25 • Speed limit on main access road to delivery point (Roadac)

Although all variables have been selected because they represent concerns of the major players, this weighting has been selected because it gives priority (greatest weighting) to the some of the greatest concerns of the producers and railways, "20M" and "Main" respectively. In addition, minimizing transportation costs "Ship" is a priority of all groups. "10M" is weighted slightly lower because it is not completely independent of "20M". "Curcap" and "Farthest" have been weighted at half the maximum. In the case of "Farthest" this is because, although it is important that no producer haul exhorbitant distances, the variable measuring the interests of a single producer should have a lesser impact than the variables measureing the interests of a group of producers ("10M" and "20M"). "Curcap" is given a lower rating because, although it is a indicator of current delivery patterns, it will not necessarily be important in terms of new delivery patterns. The lowest weighting is given to "Roadac" because this varies relatively little among most towns.

RESULTS AND ANALYSIS

Optimal HTP Spacing

The best fit regression formula for the nine types of trucking as well as the elevator costs against distance (the independent variable) was a double log model. The common log of each of the dependent variables in turn was regressed against the common log of distance for the 20, 40, 80, 160 and 320 kilometre spacings. The resultant regression formulae are shown in Figure 5. The extremely high R squared values ranging between .982 and 1 demonstrate the extremely good fit of the lines, with virtually no residuals.

It should be noted that the R-squared value of 1 for elevator costs is due to the fact that elevator costs were generated from a distance based model, rather than real costs. As such they create a perfect fit when entered into a mathematical (regression) model.

The equilibrium point between elevator costs on one hand and each of the nine trucking costs on the other are listed in Figure 5. These were determined by setting the elevator costs' regression formula against each of the trucking costs' formulae in turn. This reveals the equilibrium elevator spacing distance (in kilometres). Note that the elevator costs have been generated with both a $100,000/year and $250,000/year operating cost.

Figure 5: Trucking/Elevator Cost Intercept Points

			Equilibrium Points			
			100,000	250,000	100,000	250,000
Y Variable	Regression Formula*	R2**	log(x)	log(x)	km	km
Private						
2 axle	y = .552x + 8.45	0.985	1.699	1.648	50	44
3 axle	y = .581x + 8.289	0.998	1.742	1.692	55	49
3 axle pup	y = .532x + 8.317	0.996	1.765	1.713	58	52
5 axle	y = .650x + 8.193	0.993	1.733	1.684	54	48
A-train	y = .726x + 7.934	0.996	1.780	1.732	60	54
Custom						
3 axle pup	y = .533x + 8.039	0.982	1.874	1.822	75	66
5 axle	y = .597x + 8.072	0.989	1.81	1.765	65	58
A-train	y = .590x + 7.956	0.986	1.864	1.814	73	65
Commercial						
A-train	y = .778x + 7.299	0.994	1.975	1.928	94	85
Elevators						
@ $100,000/yr operating cost	y = -2.0x + 12.655	1.000				
@ $250,000/yr operating cost	y = -2.0x + 12.785	1.000				

* Double log Model, based on the log of the Y Variable regressed against the log of distance (the independent, or X, variable)

** Each of the R2 values has 4 degrees of freedom

Depending on the truck type and operating cost scenario, the equilibrium elevator spacing ranges between 44 and 94 kilometres apart. The ideal spacing should reflect the current trends in trucking which would favour the larger private and custom haulers (Chaudhary, 1985; Chaudhary 1986; Chaudhary 1987ø). As such, a spacing of 65 kilometres apart would be suggested. This favours the more cost effective custom and commercial haulers, while not completely eliminating the more efficient large scale private haulers.

Other Location Criteria

The ideal spacing is only one of the factors necessary in determining elevator location. Elevators cannot simply be located every 65 kilometres in a perfectly symmetrical pattern across the grain production region. In order to make the location problem more realistic the following other conditions must also hold. First, the htp elevator should be located at an existing delivery point. This is not only indicated by the p-median solution to the location problem (Hakimi, 1964) but also because infrastructure such as access roads and railway sidings are already in place. Second, the facility

should be located on either a main railway line or else a branch line in good repair which is capable of handling fully loaded grain cars. In this way the railways are able to abandon some of the less profitable branch lines and concentrate maintenance and capital investment on a network of high quality lines. This would decrease transportation costs in the railway sector and contribute to overall system efficiency. Third, htp sites should be located on a primary or high quality secondary highway. The trend toward increasingly large trucks for grain hauling requires relatively wide, quality surface, high speed roads. Location at or near the intersection of two or more highways is also preferred in order to maximize access. A final factor in locating new htp elevators is the location of existing ones. Existing htp elevator locations must be used as reference points when determining the location for new facilities in order to maintain the recommended spacing.

MICRO STUDY

A region in south-western Saskatchewan will be used as the basis of the micro study. Based on the optimal spacing previously determined, the region should be, but is not, serviced by a htp facility. It includes 228 farms and five existing delivery points, Beechy, Lucky Lake, Birsay, Dunblane and Macrorie. The region has been selected from among other htp deficit ones because it is relatively isolated from the rest of the grain growing region. Travel to the south and east is almost completely restricted by Lake Diefenbaker and the South Saskatchewan River. In addition, the Coteau, a large grassland area which is used primarily for grazing, surrounds the study area to the west and northwest. These natural barriers aid the locational decision making in the region because the catchment area for the potential htp elevator is well defined and the system is closed in a theoretical sense.

The TSA88 linear programming package and the four DSS, mentioned above, are used to evaluate each of the five delivery points within the study area in order to determine the optimal site for the htp facility within the region. Birsay, the delivery point with the lowest aggregate transportation costs, is selected as the optimum location by the TSA88 package. In the first evaluation in which the DSS are used, all seven criteria are given equal weighting. Under this analysis, both the aspiration and reservation levels are set to the utopia levels for each criteria. Under the unweighted scenario, Lucky Lake is selected as the optimal location by all four DSS. The stability of this, and other solutions will be tested in a following section which deals with sensitivity analysis.

The second evaluation, which weights the criteria, does not produced unanimous results. Two of the systems selected Lucky Lake and the other two selected Birsay. The results are listed in Figure 6.

Figure 6: Comparative Results Produced by DSS

System	Unweighted Optimal Location	Weighted Optimal Location
DINAS	Lucky Lake	Birsay
DAS	Lucky Lake	Lucky Lake
MATS	Lucky Lake	Lucky Lake
AIM	Lucky Lake	Birsay

The discrepancy in the weighted results may be a product of differing methods of weighting with the different systems. The weighting for both DAS and MATS is

accomplished directly, by specifying a weight for each objective. The weighting for both DINAS and AIM is performed indirectly by adjusting the aspiration (desired) and reservation (minimum acceptable) levels. These results indicate that the solution is sensitive to the values used in the weighting process. The extent of this sensitivity is discussed in the following section.

Sensitivity Analysis

As with any location process, when using DSS to locate htp facility sites it is important to determine not only the optimal site but also the stability of the solution. That is to say, it is necessary to determine the magnitude of change in the variables which will result in a change in the optimal solution.

When locating a long term facility such as an inland terminal it is important for the site selected to be stable. Ideally, a large change in some or all of the parameters would be needed to shift the optimal site. In this way, if some or all of the coefficients of the criteria change, as they may do over a long term period, the chance of the optimal location changing is reduced.

Not all of the DSS used have a built in capacity for sensitivity analysis, however, by repeatedly adjusting the aspiration/reservation levels for the objectives a type of sensitivity analysis can be performed. Evaluating all possible combinations of objectives with varying aspiration and reservation levels would be an extremely complex process which would produce much unnecessary data. Several objective configurations were used to test the sensitivity of the DSS solutions.

The first sensitivity test involves relaxing the aspiration levels of each of the seven objectives one at a time, while the aspiration levels of the remaining six objectives are set to their utopia (maximum) values. Each time the aspiration level is lowered, the problem is re-optimized. If the selected location does not change, even when the aspiration level is set to the nadir (worst possible) level, it is assumed that the solution is not very sensitive, i.e. that it is stable. This means that the selected location can be used with considerable confidence because, even if the current coefficients for the objectives change, it will remain the optimal location. If the location selected does not change when the aspiration level is set either at the nadir or at the utopia levels the objective can be considered relatively unimportant in terms of the objective tradeoffs.

The results of the sensitivity analysis which involved decreasing the aspiration levels of the objectives one at a time, while the other objectives retain aspiration levels equivalent to the utopia level are shown in Figure 7.

Figure 7: Comparative Results of DSS with the objectives' aspiration levels set equal to the nadir value

Objective	DAS	DINAS	MATS	AIM
Farthest	Lucky L.	Lucky L.	Lucky L.	Lucky L.
10M	Lucky L.	Lucky L.	*	Lucky L.
20M	Lucky L.	Lucky L.	Lucky L.	Lucky L.
Main	Lucky L.	Lucky L.	Lucky L.	Lucky L.
Roadac	Lucky L.	Lucky L.	Lucky L.	Lucky L.
Curcap	Lucky L.	**	***	****
Ship	Lucky L.	Lucky L.	Lucky L.	Lucky L.

* When weighted at less than half of the other objectives Birsay is selected, when weighted at between half and equal to the other objectives Lucky Lake is selected

** When the aspiration level is set between the nadir level and 11.9 tonnes Birsay is chosen, when the aspiration level is set between 12 tonnes and the utopia level, Lucky Lake is chosen
*** When weighted at less than half of the other objectives Birsay is selected, when weighted at between half and equal to the other objectives Lucky Lake is selected
**** When the aspiration level is set between the nadir level and 9.4 tonnes Birsay is chosen, when the aspiration level is set between 9.5 tonnes and the utopia level, Lucky Lake is chosen

Comparison of DSS with Transportation Problem Software

This section briefly compares DSS with traditional transhipment linear programming as well as comparing and contrasting the four DSS software. The merits and disadvantages will be discussed.

In general, all types of DSS are superior to the traditional Transportation Problem of linear programming which seeks a solution based solely on transportation costs. DSS are capable of handling transportation costs, as well as many other criteria in making a location decision. As such, DSS allow for a more balanced approach to location selection. For this particular problem, the locations selected were usually either Lucky Lake or Birsay, which do share the lowest transportation costs. It would however be possible to have another problem in another area and/or with a different set of objectives, which offered solutions where the location selected did not have the lowest transportation costs.

CONCLUSION

With regards to the optimal Saskatchewan-wide spacing of htp elevators, it is concluded that a spacing of 65 kilometers apart would be most appropriate. This spacing represents a compromise between both the hauling costs of different types of trucks and different elevator operating costs. Lower cost custom and commercial truckers would support a htp network with a wider spacing however, by using a 65 kilometer spacing efficient private hauling remains possible.

The results from the micro study suggest that either Lucky Lake or Birsay would be the most satisficing location for a htp facility, based on the trade offs between the various objectives. Although it is somewhat difficult to select between the two, it may be concluded that Lucky Lake would be the most appropriate location for the htp elevator since this is the location selected not only by all DSS in the unweighted analysis but also by both DSS for which weighting could be accomplished directly.

REFERENCES

Alberta Wheat Pool (1991)."Vermilion Now has "High Tech" Elevator" in **Alberta Pool Budget**. October 18, p. 2.

Armada Systems (1990). **DAS - Decision Analysis System, Shareware Edition 2.41 Documentation.** Downsview, Ontario: Armada Systems.

Brown, Curt, David Stinson and Roy W. Grant (1986). **MATS: Multi-Attribute Tradeoff System 2.01 Documentation.** Denver: Public and Social Evaluation Office.

Canadian Grain Commission, Economics and Statistics Division (1970-71 to 1990-91). **Grain Deliveries at Prairie Points, Crop Year Reports.**

Chaudhary, G. Nabi (1985). Trucking in the Changing Grain Industry (phase I). Alberta Agriculture Production and Resource Economics Branch, **Agdex** No. 843-3.

Chaudhary, G. Nabi (1986). Impact of Reforms to the Statutory Rates on Trucking. Alberta Agriculture Production and Resource Economics Branch, Agdex No. 843-5.

Chaudhary, G. Nabi (1987a). Farm Trucking Costs for Transporting Grain and Grain Delivery Patterns. Alberta Agriculture Production and Resource Economics Branch, **Agdex** No. 843-6.

Chaudhary, G. Nabi (1987b). "Problems in the Grain Handling System." **Proceedings, 22nd Annual Meeting, Canadian Transportation Research Forum**, pp. 409-427.

Eastern Software Products Inc. (1984). **TSA88, Transportation Simplex Algorithm for the IBM PC.** Alexandra, Virginia.

Hakimi, S. L. (1964) "Optimum Locations of Switching Centers and the Absolute Centers and Medians of a Graph." **Operations Research**, 12, pp. 450-459.

Hall, Emmett (1977). **Report of the Grain Handling and Transportation Commission, volumes 1-3.** Ottawa: Government of Canada.

Lotfi, Vahid and Stanley Zionts (1988). **Aspiration-Level Interactive Method (AIM) documentation.** Buffalo: School of Management, Department of Management Science, State University of New York at Buffalo.

Meyer, N. and G. Sparks (1987). "The Economic Cost of Transporting Grains from Farm to Market" **Proceedings, 22nd Annual Meeting, Canadian Transportation Research Forum,** pp. 317-338.

Ogryczak, Wlodzimierz, Krzysztof Studzinski and Kryztian Zorychta (1988). **Dynamic Interactive Network Analysis System (DINAS) documentation.** Warsaw: Institute of Informatics, Warsaw University.

Orden, A. (1956). "The Transhipment Problem" **Management Science,** 2, pp. 276-85.

Western Producer (1991). Grain Terminal Promoters Scale Down Their Plans.

Wilson, Barry (1981). **Beyond the Harvest, Canadian Grain at the Crossroads.** Saskatoon: Western Producer Prairie Books.

SUCCESS STRATEGIES FOR TRUCKLOAD CARRIERS

by

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A. Introduction

The past decade has brought tremendous change to the North American trucking industry. Unfortunately, many trucking companies have not adapted their strategies and operating practices to succeed in the new environment.

This paper examines strategic issues faced by truckload motor carriers. It concentrates on three areas: trends affecting the structure of the industry; implications for specific industry segments; and identification of strategies that are likely to be effective. Findings are based on interviews with trucking executives, shippers and owner operators, a review of previous research and industry periodicals, and an empirical analysis of financial results for U.S. trucking firms.

As implied by the title, results of this research only apply to truckload carriers. Less than truckload carriers were excluded because of major structural differences between the truckload and less than truckload segments.

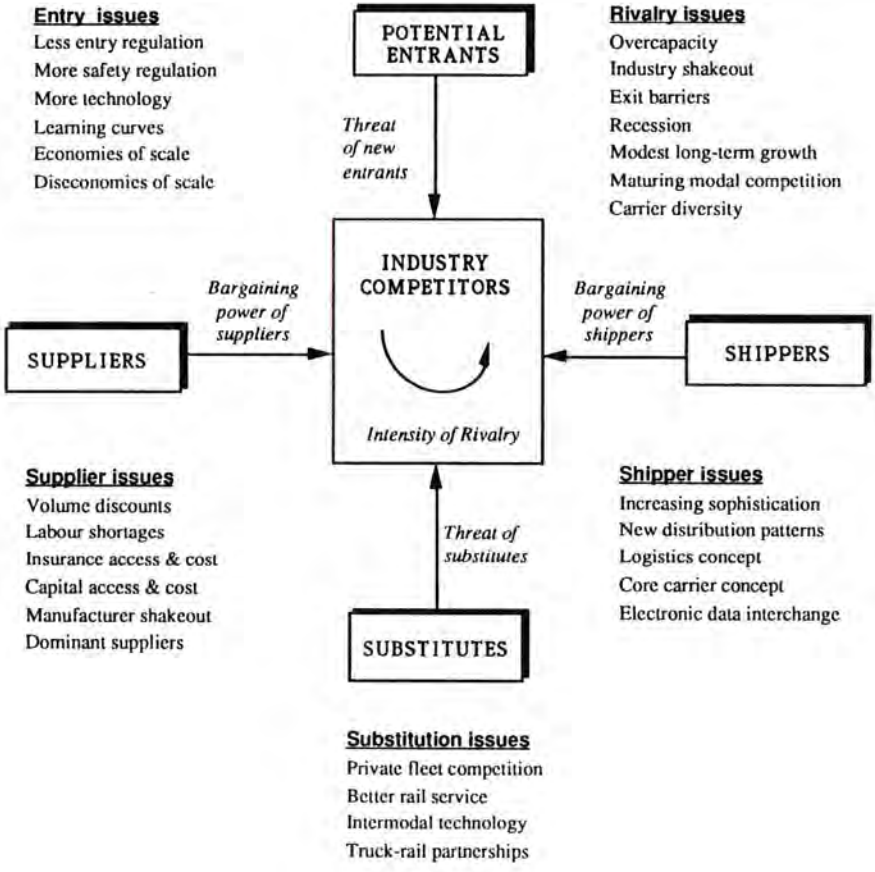
B. Forces shaping the industry

Over the past two years, I have interviewed more than one hundred trucking executives, shippers and owner operators during the course of various consulting assignments. Evidence from these and other sources suggests that important trends are emerging in the industry. Together, these trends have the potential to reshape the truckload business.

The combined effects of industry trends are analyzed in this paper using a generic framework developed by Michael Porter [1]. One of the basic themes of the Porter framework is that the state of competition in a given industry is not an accident. Rather, it reflects the underlying economic structure of the business, which is determined by five competitive forces: threat of new entrants; bargaining power of buyers; bargaining power of suppliers; threat of substitute products or services; and intensity of rivalry among current competitors.

Exhibit 1 applies the Porter framework to the truckload transportation industry. Major developments in each of the five areas are discussed below.

Exhibit 1
Forces shaping the truckload industry



1. Entry issues

The most significant change in this area has been a dramatic decline in the level of entry regulation. The U.S. Motor Carrier Act (1980) and Canadian Motor Vehicle Transport Act (1987) have effectively deregulated entry to interprovincial, interstate, and transborder markets. In addition, several provinces and states have reduced entry controls within their jurisdictions. It seems likely that the deregulation trend will continue [2,3], although Ontario has moved in the opposite direction with a two-year moratorium on new intraprovincial permits [4].

The drop in entry regulation has been accompanied by new safety rules and more emphasis on enforcement. To some extent, this trend could discourage formation of new trucking firms. First, it creates an administrative burden which small carriers may not be equipped to handle. Second, it could eventually force unsafe companies out of business. Analyses conducted by the American Trucking Associations indicate that the percentage of unsatisfactory safety ratings is highest among carriers that have recently received their ICC operating authority [5]. Research by the U.S General Accounting Office found that small carriers had an accident rate twenty percent higher than the industry average [6].

Economies of scale could play a role in preventing successful entry in the truckload business. They are present when unit costs decline with higher per period production volumes. Some analysts have suggested that economies of scale are minimal for truckload carriers [7], but it may be time to reevaluate this assumption. Factors such as volume discounts on equipment and supplies (e.g., bulk fuel purchases), administrative efficiencies (e.g., technology-based information systems), and lower marketing costs (e.g., less dependence on load brokers) could give large carriers an important edge. Taking advantage of these economies is a cornerstone in the strategy of so-called advanced truckload firms [8].

Diseconomies of scale represent the opposite side of the coin. Possible diseconomies of scale include the higher overhead, labour costs, and fringe benefits often associated with large trucking firms.

Learning curves may also be important. They are present when there is a tendency for unit costs to decline as the firm gains more cumulative experience. It is plausible that learning curves exist for several functions, including equipment specifications (e.g., maximizing fuel efficiency), use of technology (e.g., electronic data interchange), and management skills (e.g., contract negotiation).

2. Shipper issues

Shipper trends will have an important effect on the future industry structure. There are several developments of note in this area, including a general increase in the level of shipper sophistication.

Changing distribution patterns will affect demand for truckload services. Canada's traditional east-west distribution patterns are being replaced by north-south trade, and the Canada–U.S. Trade Agreement is expected to encourage this trend [9]. Trucking

companies will have to adjust their networks to conform to new shipment patterns. For Canadian carriers, this will mean more competition with U.S. trucking firms.

Many shippers are reducing the number of trucking companies that they deal with, and moving toward longer-term shipper-carrier relationships. This strategy has been referred to as the core carrier concept. As an example, Reynolds Metal Co. was using 15 carriers in 1991 – down from a one-time high of 750 [10]. From a shipper's perspective, implementing the core carrier concept reduces administrative costs and generates savings through volume discounts. However, it also has implications for trucking companies. Carriers with limited market coverage may not qualify for supplier lists, and multinational shippers could extend the concept to the North American level. As a result, Canadian carriers may lose the business generated by Canadian subsidiaries of multinational firms.

Increasingly, large shippers are demanding technology-based services such as electronic data interchange and satellite tracking [11]. Carriers can use technology to differentiate their services and justify higher rates. However, many small companies lack the resources and management skills required to implement technology-driven systems. As a result, they may be frozen out of important business segments.

The concept of logistics management is reshaping the distribution business. Companies are looking beyond transportation, to consider effects on warehousing, inventory, and customer service. Results of a recent survey suggest that application of the logistics concept is more advanced in the U.S. than in Canada [12], although there is little doubt that it will spread on both sides of the border. Truckload carriers must improve their understanding of logistics issues to differentiate their services and market them effectively [13]. Large carriers may be more adept in this area because they can justify hiring staff specialists.

3. Supplier issues

Volume discounts give large carriers an important edge over small carriers. Discounts can apply to everything from equipment to fuel and tires. In addition to their purchasing power, large companies may have more sophisticated negotiating skills.

Hard times in the trucking industry have hurt equipment and component manufacturers [14]. Furthermore, technological improvements such as engine electronics and emission systems are contributing to shifting market shares [15]. These developments could lead eventually to mergers or bankruptcies among suppliers, or create a dominant supplier situation. In either case, trucking companies would tend to have less relative bargaining power.

Labour supply is becoming a major issue in the trucking industry. Several studies point to emerging shortages and problems with driver quality [16,17]. There are some indications that large carriers may be better equipped to cope with driver shortages than small carriers. Large carriers tend to have better recruiting and training programs. Also, they tend to pay their drivers higher than average wages, which can help reduce turnover [8].

Truck insurance rates have risen dramatically, particularly in the United States [18]. Carrier financial data suggest that small carriers pay higher insurance premiums than large carriers [19]. From an insurer's perspective, large carriers mean lower accident rates, lower administrative costs, and a larger pool of vehicles to spread the risk of a catastrophic accident. Also, self insurance may be a viable option for very large companies.

Trends in financial markets are also affecting truckload carriers. Anecdotal evidence suggests that traditional lenders are growing increasingly wary of dealing with trucking companies – particularly small trucking companies. Furthermore, small and medium-sized carriers can have difficulty gaining access to equity markets. They usually can not absorb the high fixed costs incurred with a public equity issue, and they may lack credibility among investors. As a result, the cost of capital spread between small and large carriers may be growing.

4. Threat of substitutes

Substitute products or services can transform a previously stable environment. Possible substitutes for truckload for-hire carriers include private fleets, rail carriers, and intermodal services.

Low rates resulting from deregulation made it hard for many shippers to justify operating a private fleet. However, a growing emphasis on customer service could bring private fleets back in vogue. This would reduce traffic available to for-hire carriers and introduce new competitors as private fleets obtain operating authorities to compete for backhaul loads. While fewer than 10% of carriers surveyed by the National Transportation Agency (NTA) reported losing traffic to private carriers in 1990, several companies noted that private carrier backhaul pricing affects for-hire rates and payloads – particularly in low density general freight markets [20].

Railways are taking steps to regain traffic lost to truckload carriers. For example, CN has introduced domestic double-stack service in the Moncton-Toronto corridor [21]. CP Rail has introduced bimodal RoadRailer technology to the Southern Ontario market through an agreement with Norfolk Southern [22]. Intermodal technologies are probably the biggest threat to truckload carriers, particularly in long haul traffic lanes. This threat could grow dramatically if there is a sudden change in relative cost structures – such as a long-term increase in the price of diesel fuel.

There have been several innovative partnerships between trucking companies and railways. Examples include the J.B. Hunt – Santa Fe *Quantum* service and a similar offering by Southern Pacific and May trucking [23]. Truck-rail partnerships could become more important if predicted driver shortages materialize. Long-haul carriers that ignore these developments do so at their peril.

5. Rivalry Issues

Several issues are contributing to the current state of rivalry among truckload carriers. First and foremost is the apparent level of overcapacity in the industry. A 1990 NTA survey found that 42% of shippers observed more carriers competing for their inter-provincial truckload shipments. In the transborder sector, this proportion increased to 46% [20]. Competition is particularly strong in major traffic lanes targeted by advanced truckload firms (e.g., J.B. Hunt).

Overcapacity has led to severe price competition and a shakeout in the industry. There were 656 trucking bankruptcies reported in Canada during 1990. However, more than 86% of bankrupt firms had liabilities of less than $200,000 [20]. Most carriers surveyed by the NTA expect the current rate of consolidation to continue for several years.

In some cases, exit barriers are keeping truckload carriers in business. Leaving the industry can be a difficult and emotional decision to make, particularly for family-owned companies that have been operating for two or three generations. Other exit barriers can result from legal requirements. For example, U.S. carriers can not be sold, merged, acquired, or voluntarily liquidated unless their employee pension liabilities are fully funded. Therefore, bankruptcy may be their only way out of the industry [18].

Demand for transportation services is derived from industrial activity. The current recession has reduced traffic volumes and contributed to the capacity surplus. Demographic factors suggest that long term economic growth will be modest and, as shown in Exhibit 2, traffic shifts from rail to truck are starting to level off [24]. In essence, trucking is becoming a mature industry.

New and diverse competitors can encourage rivalry. Deregulation led to an influx of relatively small truckload carriers. Some of these companies adopted irrational pricing policies due to their limited managerial skills and lack of costing knowledge. Furthermore, small owner-managed companies may be willing to accept a subnormal rate of return on invested capital to maintain their independence [1].

B. Implications for structural change

Exhibit 3 summarizes key industry developments, and notes whether these factors tend to favour relatively small or relatively large carriers. Overwhelmingly, large trucking companies appear to benefit more from the emerging changes than small trucking companies.

The role of owner-operators also deserves mention. Exhibit 4 lists factors considered by carriers when deciding whether to use owner-operators, based on a report for the Canadian Council of Motor Transport Administrators [25] and other sources. It also shows whether identified factors have a positive or negative impact on demand, whether they are becoming more or less important, and why. While factor weightings will vary from carrier to carrier, the overall effect on demand appears to be negative. In fact, several large Canadian trucking companies are reducing their use of owner-operators [20].

Exhibit 2
U.S. intercity ton-mile indices, 1980-1990

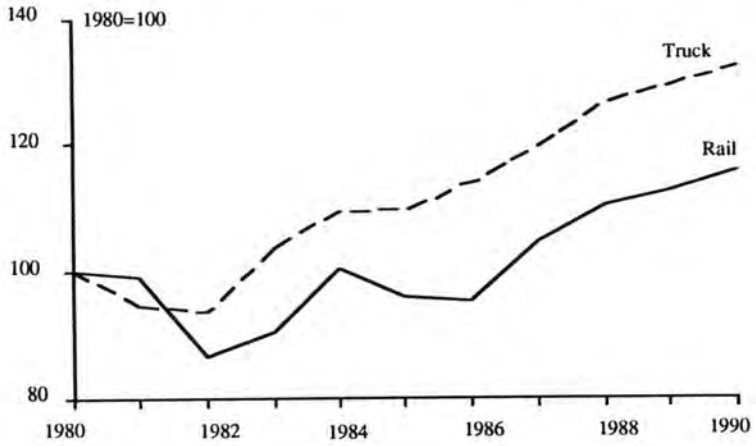


Exhibit 4
Trends affecting demand for owner-operators

Factors considered by carriers	Impact on demand	Importance trend	Reasons
Entrepreneurial spirit (motivation)	+	⬇	Supervision through technology
Less capital risk	+	⬆	Economic uncertainty
Rapid expansion/downsizing	+	⬆	Economic uncertainty
Low cost labour source	+	⬇	Non-union labour; lower real wages
Limited ability to control behavior	–	⬆	Customer service; safety regulations
Overspecified tractors	–	⬆	Low rates require low costs
Low purchasing power	–	⬇	Carrier programs; buying groups
High financing costs	–	⬆	Higher risk premiums
Limits on equipment utilization	–	⬆	Hours of service regulations

Exhibit 3
Summary of industry trends and implications

Issue	Favours Large Carriers	Favours Small Carriers	Neutral
Less entry regulation			●
More safety regulation	●		
More technology	●		
Learning curves	●		
Economies of scale	●		
Diseconomies of scale		●	
Volume discounts	●		
Labour shortages	●		
Insurance access and cost	●		
Capital access and cost	●		
Manufacturer shakeout			●
Dominant suppliers	●		
Private fleet competition			●
Improved rail services			●
Intermodal technology			●
Truck–rail partnerships	●		
More sophisticated shippers			●
New distribution patterns			●
Logistics concept	●		
Core carrier concept	●		
Electronic Data Interchange	●		

C. Empirical evidence

Earlier sections of this paper evaluated changes in the industry environment from a managerial perspective. This section will analyze actual carrier data to identify statistical links between operating strategies and financial performance. Results are based on financial statements for U.S. truckload carriers of general freight. Canadian data could not be analyzed because they are not publicly available at the firm level.

Detailed 1990 financial and operating statistics were obtained from the American Trucking Associations on computer diskette. Truckload carriers of general freight were separated from other carriers using commodity codes on the diskettes, and TL/LTL notations listed in the index of the *1990 Motor Carrier Annual Report* [19]. Certain carriers are required to report truckload and less than truckload revenues separately. When available, this information was used to verify TL notations and make adjustments as appropriate.

To draw conclusions about economies of scale, companies in the sample should provide identical or nearly identical services [7]. Several filters were applied to the data to ensure that the carriers selected are in the same business. Carriers were excluded if they earned less than 95% of their revenue from intercity business, if their average length of haul was less than 250 miles, or if their average load fell outside of a 10-40 ton range. Companies were also excluded if they did not provide data required to calculate the variables listed in Exhibit 5. This produced a sample of 123 companies. Basic characteristics of the sample are outlined in Exhibit 6.

Links between operating practices and financial performance were identified using simple linear regression analysis. Regression determines the equation of the line that best fits observed data. The slope of the regression line indicates the change in the dependent variable (Y) that accompanies a unit change in the independent variable (X). For example, if the dependent variable is cost per mile (cents) and the independent variable is company size (millions of miles travelled), the slope of the regression line measures how much cost per mile is expected to increase or decrease per million miles travelled. However, it does not prove that the change in cost per mile is caused by the increase in miles travelled.

Two profitability measures were applied. Operating income, which is equivalent to one minus the operating ratio, measures profitability before interest and income taxes. Net income measures bottom line profitability. As shown in the hypothetical example below, considering operating costs only can lead to wrong conclusions.

Income Statement Summary	**Company A** (owned trucks)		**Company B** (leased trucks)	
Revenue	10,000,000		10,000,000	
Depreciation	1,000,000		–	
Lease payments	–		2,000,000	
Other operating costs	8,500,000		7,700,000	
Operating Income	500,000	(5.0%)	300,000	(3.0%)
Interest	200,000		–	
Taxes	90,000		90,000	
Net Income	210,000	(2.1%)	210,000	(2.1%)

Exhibit 5
Variable definitions for empirical analysis

Variable name	Definition	Comments
Contract Ratio	Intercity Contract Revenues / Total Intercity Revenues	Measures extent of contract business
Cost per Mile (¢)	(Total Op. Expenses + Interest) x 100 / Total Hwy & Intermodal Miles	Average cost per mile
Cost per Ton-Mile (¢)	(Total Op. Expenses + Interest) x 100 / Total Ton-Miles	Average cost per ton-mile
Fleet Age Index	Accumulated Depreciation / Accounting Cost	Increases with fleet age; maximum index is 1.00
Length of Haul	Total Ton-Miles / Tons of Revenue Freight	Average length of haul
Net Income (%)	Net Income / Total Operating Revenues	Bottom line measure of profitability
Operating Income (%)	Operating Income / Total Operating Revenues	Measure of profitability
Owner-Operator Ratio	Miles Rented With Driver / Total Highway Miles	Increases with use of owner-operators
Power Unit Utilization	Miles With Owned Vehicles / (Number of Owned Trucks + Number of Owned Tractors)	Average utilization of company–owned power units
Revenue (millions)	Total Operating Revenues / 1,000,000	Self-explanatory
Ton-Miles (millions)	Total Ton-Miles / 1,000,000	Measure of company scale
Total Miles (millions)	Total Hwy & Intermodal Miles / 1,000,000	Measure of company scale

An attempt was also made to use return on equity as a profitability measure to account for differences in capital structure. However, a significant number of carriers reported losses on their income statement combined with negative equity on their balance sheet. Mathematically, this combination produces a positive return on equity which is meaningless. Consideration was given to removing these carriers from the sample, but such an approach would have skewed the results in favour of profitable companies.

Results of the empirical analysis are summarized in Exhibit 7, and discussed in more detail below. One-sided t tests were used to evaluate whether the regression coefficients (slopes) are statistically significant. In this case, "statistically significant" means that the corresponding p-value is less than 10%.

1. Economies of scale

Two approaches were used to evaluate economies of scale: cost per mile was compared with the log of total miles travelled, and cost per ton-mile was compared with the log of total ton miles. In both cases, unit costs were found to decrease with higher activity levels. Furthermore, both regression coefficients were statistically significant. These findings suggest that economies of scale exist in the truckload business, which is consistent with results from the qualitative industry analysis.

Based on the above, one would expect large carriers to be more profitable than small carriers. In fact, this seems to be the case. Operating income and net income tended to increase with the log of revenues. Both income coefficients were statistically significant.

2. Fleet age

Older fleets were linked to lower operating income, lower net income, and higher costs per mile. However, only the cost per mile coefficient was statistically significant.

3. Use of owner-operators

Owner-operator use was linked to lower operating income, lower net income, and higher costs per mile. Both the operating income and cost per mile coefficients were statistically significant.

Corsi and Grimm used correlation analysis to examine links between owner operator use and profitability in 1985 and 1986 [8]. Results for 1985 were inconclusive. However, for 1986 they found negative, statistically significant correlations with both operating income and net income.

4. Equipment utilization

Higher utilization of company power units was linked to higher operating income, higher net income, and lower costs per mile. Of these three, only the operating income coefficient was statistically significant.

Exhibit 6
Sample characteristics

	Range	Mean	Std. Deviation
Revenue (millions)	0.25 – 580	24.4	64.6
Average haul (miles)	251 – 1,883	640	352
Average load (tons)	10.2 – 33.1	17.0	4.9
Sample size	123 (96 for utilization analysis)		

Exhibit 7
Results of empirical analysis

Independent variable (X)	Dependent Variable (Y)	Coefficient (slope)	t	Statistical significance
Log (Millions of Miles)	Cost per Mile (¢)	-22.679	4.41	p<.0005
Log (Millions of Ton-Miles)	Cost per Ton-Mile (¢)	-1.336	2.92	p<.0025
Log (Revenues – Millions)	Operating Income (%)	3.001	2.83	p<.005
	Net Income (%)	1.966	2.20	p<.025
Fleet Age Index	Operating Income (%)	-3.292	1.22	–
	Net Income (%)	-.5530	0.24	–
	Cost per Mile (¢)	24.871	1.74	p<.05
Owner-Operator Ratio	Operating Income (%)	-3.590	2.14	p<.025
	Net Income (%)	-1.262	0.89	–
	Cost per Mile (¢)	13.341	1.48	p<.10
Power Unit Utilization (thousands of miles/year)	Operating Income (%)	.0235	1.61	p<.10
	Net Income (%)	.0117	0.97	–
	Cost per Mile (¢)	-.0207	0.26	–
Average Length of Haul (miles)	Operating Income (%)	.0031	1.80	p<.05
	Net Income (%)	.0019	1.33	p<.10
Contract Ratio	Operating Income (%)	2.124	1.11	–
	Net Income (%)	.9248	0.58	–

5. Length of haul

Longer hauls were linked to higher operating income and higher net income. Both coefficients were statistically significant.

6. Contract business

There was a tendency for profitability to increase with more contract business. Regression coefficients were positive for both operating income and net income, although neither coefficient was statistically significant.

D. Conclusions

Results of this research point to important lessons for executives and managers of truckload carriers:

- Major changes occurring in the truckload business environment could reshape the industry. Executives must update their thinking, since traditional assumptions may no longer apply.

- Economies of scale are significant in the truckload business. Small and medium-sized carriers will find it difficult to compete (on price) with large advanced truckload firms operating in major traffic lanes. However, small carriers may find a profitable niche serving shippers outside of major lanes.

- Carriers relying on owner-operators may want to rethink this strategy. At the very least, managers must work with owner-operators to help them reduce their costs (e.g., provide access to bulk fuel prices).

- Focusing on contract business may be a viable strategy for some trucking firms. Contract carriers may be able to avoid severe price competition by emphasizing service. However, if their key customers are large and sophisticated, carriers are unlikely to earn higher than normal returns.

- A modern fleet reduces operating costs but does not always improve bottom line profitability. To be profitable, carriers must achieve high asset utilization.

While large carriers appear to have a cost advantage, trucking companies should not pursue growth for growth's sake. New business must provide sufficient financial return to justify expansion of the fleet.

It would be interesting to apply more sophisticated statistical techniques to the empirical data. Cluster analysis could be used to segment the sample into groups of companies with similar overall strategies, and profitability comparisons could be made between these groups. Similarly, multiple regression could be used to improve the predictive power of the models. However, data limitations and technical issues (e.g., multicollinearity) might limit the usefulness of more complex techniques.

References

[1] Porter, Michael E. *Competitive Strategy: Techniques for Analyzing Industries and Competitors.* New York: The Free Press, 1980.

[2] Schulz, John D. "Motor Deregulation Bill Reintroduced: Two TL Carriers Announce Their Support." *Traffic World.* March 4, 1991: 10-11.

[3] Schulz, John D. "ICC Considering Total Repeal of Its 54-Year-Old Contract Rules." *Traffic World.* July 15, 1991: 11-12.

[4] Foster, Cecil. "Truck Policies on Crash Course." *Financial Post* April 26, 1991: 47.

[5] American Trucking Associations, Inc. *Statement Before the House Subcommittee on Surface Transportation.* March 19, 1986.

[6] Schulz, John D. "GAO Finds Link Between Truck Safety and Company Size and Profitability." *Traffic World.* May 20, 1991: 17.

[7] Sugrue, Paul K, Manfred H. Ledford and Nicholas A. Glaskowsky, Jr. "Operating Economies of Scale in the U.S. Long-Haul Common Carrier, Motor Freight Industry." *Transportation Journal.* Fall 1982: 27-41.

[8] Corsi, Thomas M. and Curtis M. Grimm. "ATLFs: Driving Owner-Operators into the Sunset." *Journal of the Transportation Research Forum.* Volume XXIX, Number 2, 1989: 285-290.

[9] O'Callaghan, Janet and David Hartgen. *Transportation Impacts of the U.S.–Canada Free Trade Agreement.* University of North Carolina at Charlotte March 5, 1990.

[10] MacDonald, Mitchell E. "Partners in Quality." *Traffic Management.* May 1991: 38-43.

[11] MacDonald, Mitchell E. "The Fast Track to Customer Service." *Traffic Management.* April 1991: 54-56.

[12] Jamieson & Radford Consultants Ltd. *Logistics Management Practices in Canada.* Prepared for Transport Canada, 1990.

[13] Davis, Grant M., John Ozment, and William A. Cunningham. "Motor Carrier Marketing/Pricing Strategy – A Logistical Approach." *Journal of the Transportation Research Forum.* Volume XXIX, Number 2, 1989: 277-284.

[14] Schulz, John D. "Manufacturers Suffer Rough Year." *Traffic World.* December 31, 1990: 8.

[15] "Detroit Diesel's Fortunes Looking Good After Jump in Market Share." *Motor Truck.* October, 1991: 16.

[16] Bowland, J.M. and D.B. Toms. "Productivity Improvements in the Trucking Industry." *Proceedings of the 26th Annual Meeting of the Canadian Transportation Research Forum.* May 1991: 126-137.

[17] Price Waterhouse and ADI Ltd. *Human Resource Study of the Canadian Trucking Industry.* prepared for Employment and Immigration Canada, Spring 1990.

[18] Glaskowsky, Nicholas A. *Effects of Deregulation on Motor Carriers, 2nd edition.* Eno Foundation for Transportation, 1990.

[19] American Trucking Associations. *1990 Motor Carrier Annual Report.*

[20] National Transportation Agency of Canada. *1990 Annual Review.*

[21] Foster, Cecil. "Canadian National to Begin Domestic Double-Stack Service." *Traffic World.* August 13, 1990: 20.

[22] "Trailers to hit the Rails." *Materials Management and Distribution.* June 1991: 17.

[23] Rosenfield, Ira. "J.B. Hunt-Santa Fe Honeymoon Has Other Carriers Thinking Marriage." *Traffic World.* June 3, 1991: 9-10.

[24] Smith, Frank A. *Transportation in America, 9th edition.* Eno Transportation Foundation Inc., 1991.

[25] Special Task Force on Owner-Operators. *Report to the Canadian Council of Motor Transport Administrators.* June, 1991.

COMPARATIVE TAXES AND TRUCKING COMPETITION

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Motor Carriers are a vital link in Canada's economy. The transportation and distribution services performed are important and enabling ingredients in Canada's domestic and international trade. With Free Trade and the need to be competitive on both the North American and World markets, greater attention is being paid to motor carrier economics.

Within a motor carriers stream of expenses, as well as in its cost structure, taxes and fees are an importance and significant portion of the total. Both carriers and policy formulators are struggling with a number of related issues. These include: heightened competition, especially in the international trade with the U.S., declining revenues, bankruptcies, and market concentration. As a result, an understanding of the effects, level, and growth of these taxes is necessary[1].

Both carriers and shippers are alarmed at both the rate of growth and also at the growing role of taxes for general revenue purposes. Few would argue at the need for user taxes, for highway maintenance and construction. However, the concern lies with the growing use of these taxes for general revenue purposes.

MOTOR CARRIER MARKET

To reinforce and emphasize the importance of motor carriers, an observation of their overall market presence is necessary. While there are many discrete segments to the real truck market[2], for the limited purpose of this presentation we will display three general segments. These are the domestic flows, and the flows to and from the United States.

Within each portion, the truck market also segments into two general types: truckload shipments and less-than-truckload shipments. Data is generally not available on the same level for both types, so in this paper we will look more generally at the truckload market. This is the larger sector of the truck market, in tonnage terms.

Participation in domestic flows is restricted to Canadian Carriers, while the that in international flows also includes U.S. carriers. Listed below on Table 1 is a dated, 1987, compilation of data[3] that nonetheless gives a conservative[4] indication

that the trucking mode in total has the following market shares and volumes.

TABLE 1

CANADIAN INTERCITY TRUCK MARKET

Canadian Truck Markets	Market Shares %	Volume - Tons
1. Canada's Domestic Trade	60.1	260,173,400
2. Trade to U. S.	30.1	42,752,200
3. Trade from U.S.	43.7	41,418,500

In addition to the above data, we have also provided information on the 1987 Domestic Motor Carrier Market by Province in Exhibits 1 and 2. Exhibit 1 contains data on the total tonnage originated in each province. Exhibit 2 provides data on terminations within each province.

COMPETITION FOR TRAFFIC FLOWS

Competition for traffic has always been intense in all three of these distinct markets. Not only was it generally between motor carriers, including Owner-Operators, but also with intermodal competition with the rail carriers.

The level of competition increased substantially with the economic deregulation of the motor and rail carriers. First, the 1980 deregulation in the US caused sharply competitive effects, some of which spread into Canada. Then deregulation appeared in Canada with The Freedom to Move legislation in 1987.

In the international trade, U.S. carriers moved in very rapidly to gain markets. They priced more aggressively given their freedom and longer experience. In addition, they had the dual advantage of a favorable currency exchange and a lower cost structure. As a result, they gained traffic generally at the expense of the Canadian carriers.

In both country's deregulation, the combined effects of freedom of entry and the pricing freedom had two effects. The first was significantly increased competition for truckload traffic. The second, a corollary to the first, was price erosion, as carriers struggled to buy or protect markets.

With lower yields, carriers were forced to closely examine their expenses and costs, in order to see how they could trim and survive. Some were more successful in these efforts then were others. The next section is indicative of what they typically found in their efforts.

MOTOR CARRIER ECONOMICS

In order to produce a given truckload service, it is easy to see that a motor carrier must typically provide a tractor, a trailer, and a driver. No one would deny that the rate being charged must cover the expenses in providing these, but in addition, there are a great deal of related expenses not quite so evident. This gets us into truckload costing, the spreading or allocation of expenses to related consumption.

The major divisors to convert expenses to costs include distance, time, weight and the fuel used for the shipment. To provide sample reports, we used data from the Operating Costs of Trucks in Canada 1990[5] and The Blue Book of Trucking Companies[6].

The sample reports reflect a truckload shipment of 22.9 Metric Tons, 25 tons, going 800 KM, 500 miles, in a dry van with a 95 percent load factor and the surrogate revenue derived from an operating ratio of 90 percent. These reports are contained as Exhibit 3 for the Canadian sample and Exhibit 4 for the US sample. The results provide the following insight:

Table 2

COMPARATIVE RATES AND COSTS

Shipments from Alberta and Wisconsin

	Alberta	Wisconsin
Total Revenue	$ 919 Cdn	$ 460 US
Carrier Costs	$ 836 Cdn	$ 418 US
Taxes & Fees	$ 26	$ 23
Fuel Taxes	$ 25	$ 23
Taxes & Fees % of Revenue	5.55	10.00
% of Costs	6.10	11.00

While not the topic for this paper, one readily notes the great difference between these derivations of two revenue and cost situations. In reviewing the reports in the exhibits, one will find it apparent that one of the major reasons for

the difference exists in the higher wages for drivers and to a lesser extent, the difference in taxes and fees, including fuel taxes. However, even this is misleading, for one of the forces for higher wages is the higher Federal and Provincial Income Taxes in Canada compared to those in the States.

TAXES AND FEES

As can be seen from the above, the taxes and fees paid by motor carriers include both direct and indirect expenses and costs. Direct taxes might be those that are separately identified in costing. Typically his group includes the following general areas: fuel taxes and the tractor and trailer registration and license fees. Both have two components in that they are assessed by both Federal and Provincial/State agencies.

Fuel Taxes Taxes on fuel have been long established as a revenue generator by governmental agencies. When highway construction programs, or more recently highway and bridge rehabilitation programs, are designed, they are generally paid for from increased fuel taxes. Because these have been broad-based on users with readily identifiable benefits, there has been little opposition and in fact support.

The current average provincial tax on diesel fuel as of January, 1992 was 12.42 cents per liter. In addition, the federal tax was another 11.26 cents for a total burden of 23.68 cents, see Exhibit 5 for details including the provincial details. There are two components to the competitive problems that these taxes have caused:

First, these taxes have escalated 44.9 percent over the last five years. This is almost 20 percent faster than the U. S. taxes have grown.

Second, when measured on an equivalent basis with U.S.taxes including adjustment for the different currencies, the Canadian taxes are 172.5 percent of the US taxes.

These two great differences have not only created but have also exacerbated a significant competitive disadvantage for the Canadian Motor Carriers.

Tractor & Trailer Fees There are a number of taxes and fees assessed against the tractors and trailers. These include the annual registrations of each, the sales taxes on the purchases, taxes on parts for repair and maintenance including tires and batteries. These have been assessed for a number of years for both highway and general fund purposes.

As with the fuel taxes, there are great variations between the provinces and

the states. In addition, there are also federal taxes and fees in both Canada and in the US. In the sample reports for Alberta and Wisconsin based truckload carriers, the following is included:

Table 3

COMPARATIVE TRACTOR/TRAILER FEES

Annual Charges per Vehicle

	Alberta	Wisconsin
Tractor	$ 1,626 Cdn	$ 1,814 US
Trailer	10	Incl
Total	$ 1,627	$ 1,814

While the difference seems to favor the Alberta carrier, the actual results depend upon the currency exchange ratio. At present, with the Canadian Dollar at $ 0.840 US, the higher cost is with the Alberta carrier with an 6.7 percent cost disadvantage.

FINDINGS AND CONCLUSIONS

In the two most direct tax areas, for fuel and for the vehicles, the disadvantage currently lies with the Canadian motor carriers. This has the greatest competitive impact in the international flows between Canada and the US.

While both costs and taxes are dynamic in nature, the taxes thus far appear to have grown faster than the costs. In that regard, the Canadian motor carriers also appear to have the disadvantage. Their costs are growing faster than are those of the competition, the US carriers.

More could be said about other less direct taxes, such as income, and again the conclusion that would be reached is that the Canadian taxes are higher and thus far are growing faster. All of this puts more pressure on the motor carriers to be both cost competitive and in their very survival.

From the public policy point of view, it is clear that it is in the public interest to continue to have the motor carriers. Thus, it appears that the public agencies on both the federal and the provincial levels must do their part in keeping the motor carriers competitive. In those areas where commonality of taxes exists, it appears that the Canadian taxes should be brought into parity with that of the US.

ENDNOTE REFERENCES

1. The National Transportation Agency has reported 656 trucking company bankruptcies in 1990, up 72 percent from 1989, and it expects even more when the 1991 results are produced. This is from Robert Robertson in the February 1992 issue of Materials Management & Distribution - View From the Top. page 19.

2. Market segmentation analysis indicates that discrete markets tend to exist on the basis of the origin and destination geography along with the commodity, shipment size and equipment type.

3. The 1987 Data Base is valuable because it displays the flows and modal splits prior to the deregulation.

4. The domestic traffic flow section of the overall portrayal of the market is conservative in that it includes only the intercity portion of the total. that also be undercounted, due to the nature of the survey which produced it.

5. Transport Canada, Policy and Coordination

6. Transportation Technical Services, Inc. of New York. It provides files the 1990 results on 2,742 major U.S. and Canadian trucking companies.

1987 CANADIAN TRANSEARCH - DOMESTIC FLOWS ONLY

Total Originations in Short Tons - 2000 Lbs

(Excludes International Traffic with the U.S.)

No.	Province	Total Tons	Trucking Services For Hire Motor Carriers Truckload	Trucking Services For Hire Motor Carriers Less than TL	Trucking Services Private Carriers	Railroad Traffic Carload	Railroad Traffic Intermodal
1	NEWFOUNDLAND	1,590,381	951,914	71,835	541,495	17,693	7,444
	Percent Share	100.00%	59.85%	4.52%	34.05%	1.11%	0.47%
2	PRINCE EDWARD ISLAND	585,871	296,717	14,876	268,434	5,616	228
	Percent Share	100.00%	50.65%	2.54%	45.82%	0.96%	0.04%
3	NOVA SCOTIA	15,232,880	4,479,475	357,047	2,310,082	6,840,620	1,245,656
	Percent Share	100.00%	29.41%	2.34%	15.17%	44.91%	8.18%
4	NEW BRUNSWICK	13,687,836	6,768,624	536,401	2,224,719	3,997,365	160,727
	Percent Share	100.00%	49.45%	3.92%	16.25%	29.20%	1.17%
5	QUEBEC	67,477,146	30,060,953	2,224,308	22,793,873	9,429,456	2,968,556
	Percent Share	100.00%	44.55%	3.30%	33.78%	13.97%	4.40%
6	ONTARIO	139,700,529	71,753,637	4,351,544	33,038,855	27,677,935	2,878,558
	Percent Share	100.00%	51.36%	3.11%	23.65%	19.81%	2.06%
7	MANITOBA	19,216,377	6,640,136	495,385	1,739,223	9,769,047	572,586
	Percent Share	100.00%	34.55%	2.58%	9.05%	50.84%	2.98%
8	SASKATCHEWAN	41,938,803	6,360,222	259,510	1,760,521	33,407,342	151,208
	Percent Share	100.00%	15.17%	0.62%	4.20%	79.66%	0.36%
9	ALBERTA	64,635,268	23,058,223	840,085	5,380,623	34,304,042	1,052,295
	Percent Share	100.00%	35.67%	1.30%	8.32%	53.07%	1.63%
10	BRITISH COLUMBIA	68,498,921	25,462,887	926,720	4,081,762	36,382,529	1,645,023
	Percent Share	100.00%	37.17%	1.35%	5.96%	53.11%	2.40%
11	YUKON	106,084	83,803	22,016	265	0	0
	Percent Share	100.00%	79.00%	20.75%	0.25%	0.00%	0.00%
12	NORTH WEST TERR.	272,792	14,744	2,455	0	255,593	0
	Percent Share	100.00%	5.40%	0.90%	0.00%	93.70%	0.00%
	TOTAL	432,942,899	175,931,340	10,102,182	74,139,854	162,087,241	10,682,281
	% Modal Share	100.00%	40.64%	2.33%	17.12%	37.44%	2.47%

Source: Reebie Associates from Transport Canada and the National Transportation Agency

1987 CANADIAN TRANSEARCH - DOMESTIC FLOWS ONLY

Total Destinations in Short Tons - 2000 Lbs

(Excludes International Traffic with the U.S.)

No.	Province	Total Tons	Trucking Services For Hire Motor Carriers Truckload	Trucking Services For Hire Motor Carriers Less than TL	Trucking Services Private Carriers	Railroad Traffic Carload	Railroad Traffic Intermodal
1	NEWFOUNDLAND	2,164,295	1,166,441	139,447	543,820	94,592	219,995
	Percent Share	100.00%	53.89%	6.44%	25.13%	4.37%	10.16%
2	PRINCE EDWARD ISLAND	746,483	264,284	65,025	302,840	88,425	25,909
	Percent Share	100.00%	35.40%	8.71%	40.57%	11.85%	3.47%
3	NOVA SCOTIA	16,441,095	4,797,140	510,272	2,203,997	7,584,235	1,345,451
	Percent Share	100.00%	29.18%	3.10%	13.41%	46.13%	8.18%
4	NEW BRUNSWICK	14,761,509	6,440,814	576,053	2,596,060	4,849,974	298,608
	Percent Share	100.00%	43.63%	3.90%	17.59%	32.86%	2.02%
5	QUEBEC	70,764,834	29,826,899	2,055,307	22,344,364	14,060,473	2,477,791
	Percent Share	100.00%	42.15%	2.90%	31.58%	19.87%	3.50%
6	ONTARIO	163,564,976	72,290,167	3,924,486	33,225,644	50,478,995	3,645,684
	Percent Share	100.00%	44.20%	2.40%	20.31%	30.86%	2.23%
7	MANITOBA	13,843,863	6,480,757	429,771	1,652,179	4,683,731	597,425
	Percent Share	100.00%	46.81%	3.10%	11.93%	33.83%	4.32%
8	SASKATCHEWAN	11,519,611	6,628,907	455,340	1,879,294	2,406,930	149,140
	Percent Share	100.00%	57.54%	3.95%	16.31%	20.89%	1.29%
9	ALBERTA	35,067,601	22,358,683	895,475	5,223,985	5,763,641	825,817
	Percent Share	100.00%	63.76%	2.55%	14.90%	16.44%	2.35%
10	BRITISH COLUMBIA	103,602,266	25,428,143	984,215	4,161,944	71,931,523	1,096,441
	Percent Share	100.00%	24.54%	0.95%	4.02%	69.43%	1.06%
11	YUKON	188,869	146,974	41,630	265	0	0
	Percent Share	100.00%	77.82%	22.04%	0.14%	0.00%	0.00%
12	NORTH WEST TERR.	277,486	102,126	25,161	5,460	144,719	20
	Percent Share	100.00%	36.80%	9.07%	1.97%	52.15%	0.01%
	TOTAL	432,942,899	175,931,340	10,102,183	74,139,854	162,087,241	10,682,281
	% Modal Share	100.00%	40.64%	2.33%	17.12%	37.44%	2.47%

Source: Reebie Associates from Transport Canada and the National Transportation Agency

EXHIBIT 3

*** TEST *** 03-30-1992

********** CTCAM - CANADIAN TRUCK COST ANALYSIS MODEL ********** Page 1

---------- MOVEMENT DESCRIPTION ----------

Commodity	:PAPER ON PALLETS	FROM	: AAA
STCC	: 2621100	TO	: BBB
Truck Type	: 1X48' DRY VAN	Trip KM	: 800.0
Carrier Type	: Non-Union Fleet	Delivery Days	: 1.00
Net MTons	: 22.69	Load Factor	: 95.0%
Equipment	: Average	Driver	: Non-Union
		Cost Basis	: Alberta

---------- SUMMARY MOVEMENT ANALYSIS ----------

Revenue per Truckload : 919.51 Description :
1st Qtr 1991 Cost per Truckload : 835.92 Revenue/Cost Ratio : 110%

---------- DETAILED COST ANALYSIS ----------

	Per Truckload	Per KM	Per MTon
Driver Wages	266.56	0.333	11.75
Fuel	53.30	0.067	2.35
Tractor	188.79	0.236	8.32
Trailer	103.25	0.129	4.55
Insurance	112.08	0.140	4.94
Fees and Taxes	51.20	0.064	2.26
Tolls & Driver Expense	0.00	0.000	0.00
Overhead	60.74	0.076	2.68
Sub Total, Costs	835.92	1.045	36.83
Profit	83.59	0.104	3.68
Total Revenue	919.51	1.149	40.52

---------- TOTAL COST PER TRUCKLOAD FORECAST ----------

2nd Qtr 1991	3rd Qtr 1991	4th Qtr 1991	1st Qtr 1992	2nd Qtr 1992	3rd Qtr 1992	4th Qtr 1992	1st Qtr 1993
837.59	840.10	842.60	866.01	868.52	870.19	872.70	896.10

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EXHIBIT 4

*** TEST *** 03-30-1992
********** TCAM - TRUCK COST ANALYSIS MODEL ********** Page 1

---------- MOVEMENT DESCRIPTION ----------

Commodity	:PAPER ON PALLETS	FROM	: AAA, WI
STCC	: 2621100	TO	: BBB, IL
Truck Type	: 1X48' DRY VAN	Trip Miles	: 500.0
Carrier Type	: LOW 1/4 IRCC	Delivery Days	: 1.00
Net Tons	: 25.00	Load Factor	: 95.0%
Equipment	: Average	Driver	: Single

---------- SUMMARY MOVEMENT ANALYSIS ----------

Revenue per Truckload : 460.16 Description :
2nd Qtr 1991 Cost per Truckload : 418.33 Revenue/Cost Ratio : 110%

---------- DETAILED COST ANALYSIS ----------

	Per Truckload	Per Mile	Per Ton
Driver Wages	133.48	0.267	5.34
Fuel	59.40	0.119	2.38
Tractor	111.53	0.223	4.46
Trailer	26.91	0.054	1.08
Insurance	18.47	0.037	0.74
Fees and Taxes	45.90	0.092	1.84
Tolls & Driver Expense	0.00	0.000	0.00
Overhead	22.63	0.045	0.91
Sub Total, Costs	418.33	0.837	16.73
Profit	41.83	0.084	1.67
Total Revenue	460.16	0.920	18.41

---------- TOTAL COST PER TRUCKLOAD FORECAST ----------

3rd Qtr 1991	4th Qtr 1991	1st Qtr 1992	2nd Qtr 1992	3rd Qtr 1992	4th Qtr 1992	1st Qtr 1993	2nd Qtr 1993
424.61	427.95	431.72	430.46	434.65	437.99	439.67	441.76

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EXHIBIT 5

CANADIAN DIESEL FUEL TAXES

Cents per Liter

Year	NF	PEI	NB	NS	PQ	ON	MB	SK	AB	BC	AVG	FED
1979	6.00	5.50	5.97	5.77	5.50	5.80	4.60	5.82	0.00	4.18	4.91	4.57
1980	6.00	6.31	6.00	6.00	5.50	5.90	4.60	5.91	0.00	4.18	5.04	4.62
1981	7.83	9.01	6.00	6.55	6.96	7.02	4.98	7.88	0.00	5.58	6.18	5.69
1982	10.05	11.04	7.23	8.07	13.43	8.65	6.57	2.97	0.00	6.82	7.48	7.46
1983	11.13	12.13	8.39	9.07	13.95	9.42	8.27	0.00	0.00	7.29	7.97	7.82
1984	11.63	12.76	8.90	9.30	10.87	9.24	8.60	0.00	0.00	8.11	7.94	7.35
1985	12.70	11.52	9.67	8.85	11.25	9.30	9.05	0.00	0.00	8.61	8.10	7.62
1986	12.94	10.94	9.19	9.37	12.35	9.90	9.20	0.00	0.00	8.24	8.21	7.91
1987	12.03	10.57	8.91	8.20	12.45	9.90	9.73	3.50	2.82	7.59	8.57	8.50
1988	11.90	9.41	8.93	8.15	12.45	9.90	9.90	7.00	5.00	8.01	9.07	9.14
1989	11.92	9.02	8.68	11.25	12.45	10.57	9.90	9.50	5.00	8.63	9.69	9.68
1990	12.66	10.63	11.43	12.98	12.45	10.90	9.90	10.00	6.50	10.01	10.75	10.45
1991	15.25	12.33	15.22	13.17	12.03	12.03	10.57	10.00	8.33	10.29	11.92	11.26
1992 Jan	15.60	11.80	14.20	13.70	14.50	14.30	10.90	10.00	9.00	10.20	12.42	11.26

Source: Reebie Associates from Energy, Mines & Resources Canada
Petroleum Monitoring Agency
Canadian Energy Statistics Handbook

EXHIBIT 6

CANADIAN VEHICLE LICENSING FEES

Annual per Vehicle

Year	Prov	Tractor	Trlr	Total	Year	Prov	Tractor	Trlr	Total
1984	BC	$1,379	$10	$1,389	1984	ON	$1,705	$0	$1,705
1986	BC	$1,436	$12	$1,448	1986	ON	$1,962	$0	$1,962
1988	BC	$1,508	$25	$1,533	1988	ON	$2,006	$0	$2,006
1990	BC	$1,662	$25	$1,687	1990	ON	$2,006	$0	$2,006
1984	AB	$1,273	$10	$1,283	1984	PQ	$2,070	$43	$2,113
1986	AB	$1,273	$10	$1,283	1986	PQ	$2,070	$43	$2,113
1988	AB	$1,349	$20	$1,369	1988	PQ	$2,070	$57	$2,127
1990	AB	$1,626	$20	$1,646	1990	PQ	$2,324	$57	$2,381
1984	SK	$2,163	$15	$2,178	1984	NB	$1,050	$9	$1,059
1986	SK	$2,163	$22	$2,185	1986	NB	$1,050	$9	$1,059
1988	SK	$2,163	$32	$2,195	1988	NB	$1,342	$10	$1,352
1990	SK	$2,265	$32	$2,297	1990	NB	$1,562	$10	$1,572
1984	MB	$1,983	$10	$1,993	1984	NS	NA	NA	$0
1986	MB	$1,983	$10	$1,993	1986	NS	NA	NA	$0
1988	MB	$2,202	$10	$2,212	1988	NS	$1,312	$25	$1,337
1990	MB	$2,208	$10	$2,218	1990	NS	$1,435	$25	$1,460

Source: Reebie Associates from Transport Canada
Policy and Coordination
Operating Costs of
Trucks in Canada

BUSINESS SKILLS REQUIREMENTS FOR COMPETITIVE OWNER-OPERATORS

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I. INTRODUCTION

Trucking industry representatives estimate that approximately 30% of owner-operators declare bankruptcy annually. Owner-operators play a significant role in Ontario's trucking industry, constituting roughly 28% of for-hire truck drivers. Financial instability in this sector therefore affects the health of the entire trucking industry; further, it may also pose a safety risk to all highway users if cost cutting measures by financially troubled owner-operators lead to declines in vehicle maintenance and repair standards.

Owner-operators manage small businesses, and therefore require all the managerial skills that any small-business entrepreneur requires, plus technical skills specifically related to trucking. Lack of business skills has been identified by owner-operators, industry and government representatives as one of the critical problems in ensuring a viable owner-operator sector within the trucking industry.

To better understand the business skills needed by the owner-operator trucking sector in Ontario, the Ontario Ministry of Transportation (M.T.O.) conducted a province-wide survey of owner-operators. This paper presents the results of the survey.

II. PURPOSE

The purpose of the owner-operator survey was to:

1. Determine if owner-operators feel they require more training.
2. Determine if owner-operators feel that government should be involved in this area.
3. If training is required, determine the appropriate manner in which training should be done.
4. If training is required, determine if owner-operators would be willing to devote time and/or money to improve their business skills.

III. METHODOLOGY

The Owner-Operator Business Skills Survey (see Appendix A) was developed by M.T.O. after consultation with owner-operator associations, owner-operator support services, and other government agencies. In order to ensure as wide a coverage as possible, the surveys were distributed through several venues; 4200 surveys were distributed through carriers, 2500 through owner-operator associations, and 400 through northwestern M.T.O. truck inspection stations to reach log haulers.

** This report is an abridged version of the Ministry of Transportation Ontario's Freight Distribution Series Volume 4: Owner-Operators' Business Skills Survey, December 1991

Although owner-operators are an important segment of the trucking industry in Ontario, data about their activity is limited. Estimates on the total population range widely, from 12,000 to 18,000. Further, the number of owner-operators working at any one time fluctuates in response to business activity. It was hoped that a distribution of this nature would cover between 25% and 45% of the owner-operators in Ontario.

Despite the broad distribution of surveys, the response rate was somewhat disappointing. In total, 544 surveys were returned, giving a response rate of 7.6%. It is unlikely that there was any overlap in coverage among the surveys issued through carriers and M.T.O. truck inspection stations; however some of the owner-operators reached through the associations may also have received a survey from one of the other groups. Because of this double counting, the actual response rate may be closer to 10%.

It may be that the low response rate indicates a general indifference by the majority of owner-operators to business skills training. However, the experience with other M.T.O. mail-back surveys is that, even when the questionnaire only contains two questions, the response rate is usually less than 25%. More detailed mail-out questionnaires, such as the business skills survey, typically result in a lower response rate.

The distribution of the survey coincided with large scale public demonstrations on the part of truck drivers regarding economic difficulties in the industry, and this timing may have affected the response rate and the nature of the responses.

It must be recognized that the survey only represents those owner-operators who responded, and owner-operators who were not inclined to answer the survey, either because of disenchantment with the government or because of difficulty interpreting the survey, are going to be under-represented in the final results. Nevertheless, the survey provides a good base of data on a segment of the trucking industry which is not well understood.

IV. ANALYSIS OF SURVEY RESULTS

A. OWNER-OPERATOR CHARACTERISTICS

1. Personal Profile

The survey contained several questions which were designed to develop a personal profile of the owner-operators who responded to the survey. Respondents were asked their age, level of education, years of experience as an owner-operator, and home base.

The survey revealed that 72.9% of the respondents have been an owner-operator for ten years or less, with 40% of the respondents having five or less years of experience. These results reflect the relatively high turn-over rate in the owner-operator industry.

Of the respondents who indicated their level of education, 76% have a high school or post secondary education. This may not be an accurate reflection of the owner-operator industry, since the questionnaire may not have been completed by those with less education. In fact, several respondents indicated needing assistance with reading and writing in English.

However, 24% of respondents indicated that they have less than grade 9 education, which corresponds exactly to Statistics Canada's profile of truck drivers in Canada, as discussed in Employment and Immigration Canada's 1990 report Canadian Trucking Industry.[1] It would therefore appear that the majority of owner-operators have at least a basic level of education, and any business skills training for this group should take this into account.

2. Operating Profile

In order to obtain data about the business operation, owner-operators were asked the number of trucks they operate, whether their spouse is involved in the financial affairs of the business, with whom the respondent holds a contract, the industry sector in which they are employed, and the types of trips which they perform.

Over 80% of respondents operate only one vehicle. However, over 10% of owner-operators have two vehicles, and nearly 6% have three or more vehicles. Owner-operators with more than one vehicle may employ another driver, and may therefore require additional business skills compared to a typical one-person operation.

The survey asked owner-operators whether their spouse was involved in the financial affairs of the operation. 70.6% of respondents indicated that this was the case. The high level of spousal involvement indicates that business skills development may be equally important to the spouse as to the owner-operator.

Respondents were asked to indicate if they had a contract with a carrier, a contract with a private company, or were operating independently. The most common type of business relationship among owner-operators surveyed is a contract with a common carrier, which includes nearly three quarters of all respondents. This corresponds closely with the findings of a survey of owner-operators conducted by the National Transportation Agency of Canada, which reported that 73% of respondents operated solely under long-term contracts to trucking companies.

Respondents who declared themselves to be self-employed or who indicated having contracts with both private companies and common carriers were grouped together under the category of "self-employed". These owner-operators made up over 18% of all respondents. Business skill requirements for this group may be significantly different from owner- operators who have a contract with a single common carrier.

Respondents were presented with a list of trucking industry sectors, and were asked to indicate which one(s) they were involved in. Over three quarters of the owner-operators indicated that they were involved in general freight transportation. 18.6% of the respondents indicated that they were involved in transporting specialized freight which did not fall in any of the categories provided. Included among these responses were specialization in transportation of auto parts, produce and steel.

Finally, respondents were asked to indicate the type of trips which they perform. The majority of owner-operators perform trips between Ontario and other jurisdictions. Only 16% of owner-operators are involved solely in trips within Ontario.

1. Other educational categories are not directly comparable due to differences in wording of the questions.

The results of the business profile indicate that owner-operators are not a homogeneous group. A large proportion of respondents conform with the typical profile of an owner-operator with a single truck transporting general freight for a single common carrier. However, a significant sector of owner-operators do not fall within these "typical" business characteristics, and their business skills training requirements may therefore also be different.

B. BUSINESS SKILLS

The owner-operators were presented with twelve business related skills and were asked to indicate which of these they considered critical to the operation of a financially successful business, and which were skills for which the owner-operators felt more training was required. On average, respondents selected 7 of the skills as being critical, 4 of the skills as requiring more training, and 2 of the skills as both critical and requiring more training.

Table 1 presents, for each skill, the percentage of respondents who indicated that the skill is critical to financial success, and the percentage of respondents who indicated that they required more training in each of the business skill areas. The skill which the most respondents felt was financially critical was the ability to select the right equipment, selected by 71.7% of owner-operators. It is interesting to note however that owner-operators were least likely to feel they require more training in this area. The skill which was regarded by the fewest percentage of respondents to be financially critical is the ability to operate a micro-computer, yet this was an area in which the most respondents indicated more training was required.

TABLE 1: Owner-Operator Business Skills Requirements

	Skill is Financially Critical		Respondent Needs Training	
	Rank	Percentage	Rank	Percentage
How to choose equipment	1	71.7%	12	15.8%
How to determine operating costs per mile	2	69.3%	9	35.7%
How to minimize operating costs	3	68.2%	5	42.1%
How to choose best financing	4	67.1%	8	37.3%
How to choose a good accountant	5	66.5%	10	26.3%
How to determine income needs per mile	6	66.2%	7	38.1%
Knowledge of operating laws and regulations	7	62.9%	3	43.4%
How to understand and negotiate a contract	8	58.6%	2	44.1%
How to choose a carrier	9	58.1%	11	21.3%
How to prepare a business plan	10	50.7%	6	41.5%
How to complete a tax return	11	42.8%	4	43.2%
How to operate a micro-computer	12	33.6%	1	55.9%

The results presented in Table 2 are perhaps the most significant of this part of the survey, highlighting those skills which are regarded as being both financially critical areas and ones in which the respondent requires more training. Foremost among the skills in this regard is the ability to minimize operating costs (25.6%), knowledge of trucking laws and regulations (24.1%), the ability to understand and negotiate a contract (23.9%), and the ability to operate a micro-computer (23.7%).

TABLE 2

Respondent Requires Training in in Skill Which is Financially Critical to Success		
1	How to minimize operating costs	25.6%
2	Knowledge of operating laws and regulations	24.1%
3	How to understand and negotiate a contract	23.9%
4	How to operate a micro-computer	23.7%
5	How to choose best financing	21.9%
6	How to determine income needs per mile	20.6%
7	How to complete a tax return	20.4%
8	How to prepare a business plan	19.9%
9	How to determine operating costs per mile	19.5%
10	How to choose a good accountant	13.4%
11	How to choose a carrier	11.0%
12	How to choose equipment	9.2%

1. Business Skills and Personal Characteristics

The responses to the questions on business skills were analyzed for patterns by age, years of experience and level of education.

There is no clear relationship between the respondent's age and their likelihood of identifying skills as being critical to business success. Generally, respondents under the age of 30 or over the age of 49 tended to choose fewer skills as being important. No relationship appears to exist between age and perceived need for training.

The higher the level of education, the more likely the respondent was to feel that each of the skills was important. Surprisingly, no significant differences are apparent by education versus need for training.

There is a general correlation between respondents' years of experience and their perception of the importance of business skills, with the number of skills being identified as important increasing with years of experience. However, as years of experience increases, the number of areas in which the respondents feel they need training declines.

The average number of skill areas identified as being both critical and being an area in which more training was required declines as years of experience increases. As Table 3 indicates, the specific types of skills which were identified also differ by years of experience.

First and second year operators were more likely than more experienced respondents to identify skill areas which are associated with the start up of their operation. These include negotiating a contract, developing a business plan, and determining income requirements and cost per mile.

TABLE 3: Skill is Critical and Training is Required
vs Years of Experience

	1 - 2 YEARS	3 - 5 YEARS	6 YEARS AND OVER
how to understand & negotiate a contract	28.9%	24.1%	23.0%
how to determine income needs per mile	27.6%	22.8%	18.2%
how to complete a tax return	27.6%	20.7%	19.2%
how to prepare a business plan	26.3%	23.4%	17.3%
how to determine operating costs per mile	25.0%	23.4%	16.6%
how to minimize operating costs	25.0%	29.0%	24.9%
how to choose best financing	22.4%	26.9%	19.8%
how to choose a good accountant	14.5%	17.9%	11.5%
how to choose equipment	13.2%	13.8%	6.4%
knowledge of laws & regulations	18.4%	23.4%	26.2%
how to operate a micro-computer	14.5%	25.5%	25.6%
how to choose a carrier	10.5%	11.0%	11.5%

Respondents with three to five years experience were more likely than others to identify skills required to stabilize their business as critical areas in which they require training. They were most likely to identify minimizing operating costs, and were more likely than other respondents to identify how to choose an accountant. The fact that these owner-operators are facing the prospect of replacing their existing equipment in the near future is also reflected in their choices. The second most often selected skill among these respondents was choosing the best financing; further, these respondents were more likely than others to identify choosing equipment as a critical skill in which they need training.

Finally, veteran respondents, having six or more years of experience as owner-operators, were most likely to identify skill areas which changed with time as critical skills in which they required more training. This includes operating a computer, and knowledge of laws and regulations.

2. Business Skills and Business Characteristics

The responses to the questions on business skills were analyzed for patterns by business characteristics. Some significant differences were apparent between respondents who had one truck and respondents who had more than one truck. The skills which are most often perceived to be critical are different among the two groups, as are the areas in which respondents require training.

Differences were also evident between respondents who are self-employed and those who had a contract with a private or for-hire carrier. Self-employed respondents were less likely to regard any of the skill areas as being critical to financial success, or to feel that they need training in any of these areas. Respondents among each of the three types of business relationships selected different skills as being critical. However, among all three groups, the ability to operate a computer was selected most often as an area in which the respondent required more training.

Table 4 presents a comparison by employment type of skill areas which were selected both as being critical and for which the respondent requires additional training. Again self-employed owner-operators were less likely than non-self-employed respondents to identify any of the skills as critical and as an area in which training is required. The only exception to this is developing a business plan, which was chosen more often by self-employed respondents than by non-self-employed respondents. This may be an indication of the importance that these self-employed owner-operators attribute to long range planning.

Among respondents who were not self-employed, the ability to minimize operating costs was most often selected as a critical area in which additional training is required, with the ability to negotiate a contract ranking second. This reflects the nature of the operating environment for owner-operators holding a single source contract, where their ability to minimize their own costs and negotiate a remunerative long term contract are the two most critical factors in their ability to make a profit.

Table 4: Skill is Critical and Training is Required
Versus Employment Type

NON SELF-EMPLOYED RESPONDENTS		SELF-EMPLOYED RESPONDENTS	
how to minimize operating costs	27.4%	how to operate a micro-computer	24.2%
knowledge of laws & regulations	26.2%	how to prepare a business plan	21.2%
how to understand & negotiate a contract	25.5%	how to understand & negotiate a contract	20.2%
how to operate a micro-computer	24.4%	how to minimize operating costs	20.2%
how to choose best financing	23.2%	how to determine income needs per mile	18.2%
how to complete a tax return	21.8%	how to choose best financing	18.2%
how to determine income needs per mile	21.3%	knowledge of laws & regulations	17.2%
how to determine operating costs per mile	20.4%	how to determine operating costs per mile	16.2%
how to prepare a business plan	20.1%	how to complete a tax return	15.2%
how to choose a good accountant	14.1%	how to choose a good accountant	12.1%
how to choose a carrier	11.7%	how to choose a carrier	8.1%
how to choose equipment	10.5%	how to choose equipment	5.1%

Differences are also apparent by the type of trips in which the respondents are involved. Respondents who perform interprovincial trips or a combination of intraprovincial and interprovincial trips were most likely to identify each of the skill areas as being important, and, on average, picked a higher number of critical skill areas than other respondents. In addition, these respondents identified a higher number of skill areas in which they required training, and a greater percentage of those skills were identified as critical.

Respondents involved exclusively in intraprovincial trips, on the other hand, were least likely to identify any of the skill areas as critical, and, on average, picked fewer skill areas in which they required training.

Of the respondents who indicated that their spouse was involved in the financial aspects of the business, 86.5% indicated that the spouse would benefit from increased training in business-related skills.

C. OPPORTUNITY FOR TRAINING

Owner-operators were asked whether they felt they had adequate opportunity to learn the business skills necessary for financial success. As Figure 1 indicates, 43.6% of respondents felt that they had adequate opportunity, and 54.6% felt that they did not.

Figure 1: Adequate Opportunity to Learn Business Skills

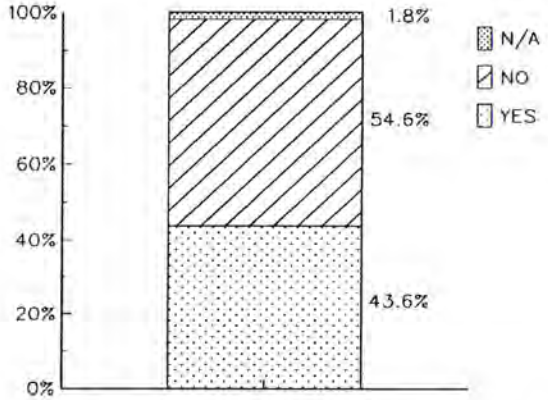


Figure 2 indicates that owner-operator's belief that they have adequate opportunity to learn business skills increases with years of experience. Respondents with three to five years of experience were least likely to feel that they had adequate opportunity to learn business skills.

Figure 2: Opportunity to Learn
Versus Years of Experience

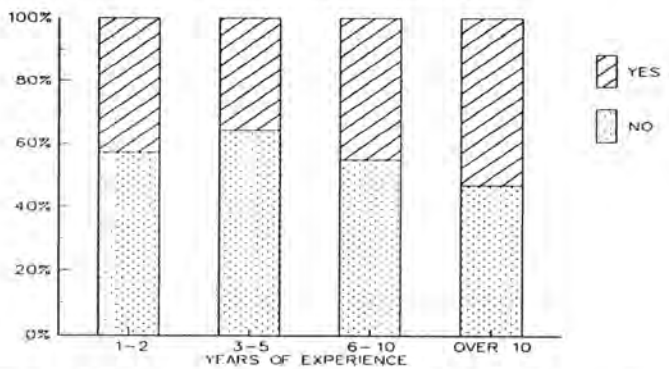
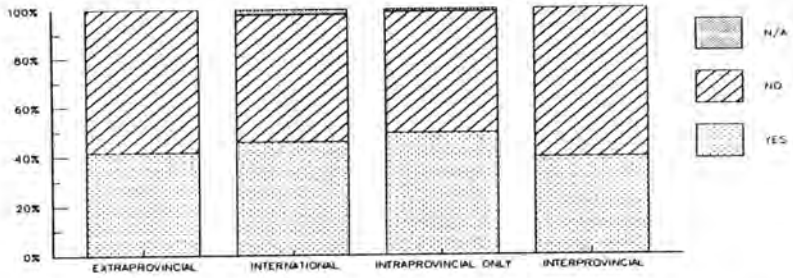


Figure 3 illustrates the perceived opportunity to learn by type of trip performed. Respondents involved exclusively in intraprovincial trips were most likely to feel that they had adequate opportunity to learn, while respondents involved in interprovincial trips, or a combination of interprovincial and intraprovincial trips, are least likely to feel so.

Figure 3: Opportunity to Learn
versus Trip Type



Finally, a comparison of perceived opportunity to learn versus type of business relationship reveals that self-employed respondents most likely to feel that they had adequate opportunity (49.5%), while respondents who hold contracts with a private company were least likely to feel so (27.3%); respondents holding contracts with for-hire companies were in the middle with 43% indicating they have adequate opportunity to learn.

The survey did not ask respondents who reported having adequate opportunity to learn business skills, where and in what form this opportunity occurred. It is probably that in many cases the learning process was on an ad hoc or on-the-job basis and did not involve formal training material or guidance.

D. GOVERNMENT INVOLVEMENT IN PROVIDING TRAINING

1. Should Government Help?

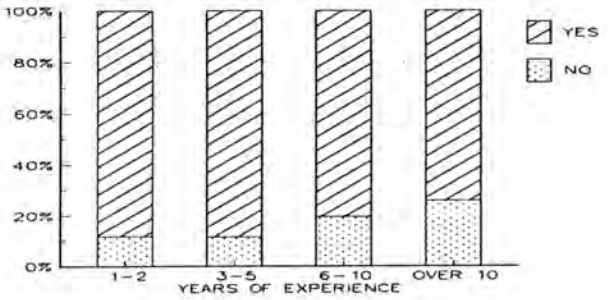
The survey asked owner-operators whether they felt that Government should be involved in helping owner-operators develop their business skills. 81.3% answered yes. Even among those respondents who felt they already had adequate opportunities to learn business skills, 76.1% favoured government involvement in improving owner-operator business skills. A number of respondents commented that, while they did not personally need government assistance in developing business skills, they recognized that other owner-operators in Ontario would benefit from such assistance.

A higher percentage of respondents who had more than one truck preferred government involvement (91.1%) than those with only one truck (80.5%).

A low overall percentage (17.6%) of respondents were opposed to government involvement in helping owner-operators improve their business skills. However some groups were somewhat more likely to oppose government involvement: respondents from Southwestern Region (22.9%); owner-operators who perform international trips between Ontario and the U.S. or a combination of international and intraprovincial trips (23.5%); and owner-operators with college/university education (24.0%).

As Figure 4 illustrates, the desire for government involvement declines as years of experience increases.

Figure 4: Government Involvement
Versus Years of Experience



2. Type of Assistance

Respondents were presented with a list of nine types of assistance which Government could provide to help owner-operators develop their business skills. Table 5 outlines the response rate for each of the options.

Table 5: Form of Assistance

Formal Training	training course	38.5%
	correspondence course	34.4%
Self-help Material	training videos	37.0%
	training cassettes	27.3%
	training books	39.2%
Advisory Service	counselling service	36.4%
	telephone advisory service	37.4%
	newsletter	38.7%
	list of available training	46.1%

76.4% of all respondents selected at least one form of assistance, and typically 3 to 4 options where selected. Although there was no clear preference for type of assistance, the most popular individual choice was that the government provide a list of available training, which was selected by 46.1% of owner-operators, while the least popular choice was a training cassette, selected by 27.3%.

An interesting pattern becomes apparent when analyzing the preferred forms of assistance by years of experience. Respondents with 3 and 5 years of experience were most likely to select at least one form of assistance (86.2%, compared to 79.9% for all other respondents). In addition, respondents with 3 to 5 years of experience were much more likely to choose one of the "Self-help" or "Formal Training" options than other respondents.

Differences in preferred form of assistance were also apparent by variations in the nature of the operation. Respondents with more than one truck were more likely to have advocated a self-help training option (80.0%) than were respondents with one truck (60.4%). Respondents who perform international trips, or a combination or international and intraprovincial trips, were less likely than other respondents to select any of the assistance options, while respondents who perform interprovincial or a combination of interprovincial and intraprovincial trips were more likely than average to select any of the assistance options.

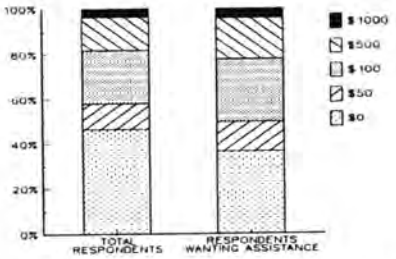
Self-employed respondents were less likely to select any of the options, and among those who selected at least one, were considerably less inclined to favour one of the self-help or formal training options.

3. Commitment to Training

In order to determine the level of commitment which respondents were willing to make to upgrading their business skills, they were asked how much money and time they were willing to spend, and what time of the week they would be available.

Respondents were asked to indicate how much money they would be willing to pay to develop their business skills. The first bar in Figure 5 illustrates the breakdown of responses for all surveys. Nearly half of all respondents were unwilling to spend any money on business skills training. However, this includes respondents who did not feel that they needed training or who did not feel the government should be involved in providing training. The second bar illustrates responses for owner-operators who indicated a preference for a form of training, and thus indicated a need for training and a desire for government assistance. Approximately two-thirds of these respondents were willing to pay to develop their business skills, with the most frequently selected amount being $100. There were no significant differences to this question by the form of assistance preferred.

Figure 5: Amount Willing to Pay

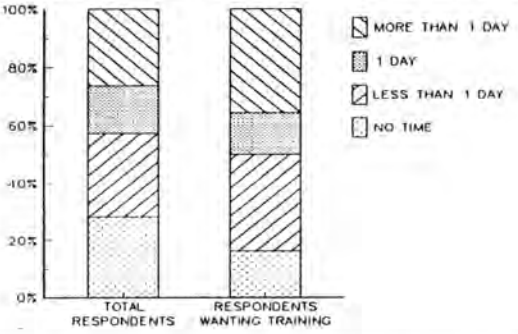


The amount of money respondents were willing to spend was analyzed against the number of trucks operated. This revealed that respondents with more than one truck were more willing to spend money, and were willing to spend more money, than those with one truck.

An analysis of years of experience versus willingness to spend money on training revealed that, as years of experience increases, willingness to spend money on training decreases. This is probably a reflection of the declining relationship between need for training and years of experience. On average, respondents with 3-5 years of experience were willing to spend more money on training than other respondents.

Figure 6 illustrates that the majority of all respondents were willing to commit at least part of a day to upgrading their business skills. Among those who indicated that no time could be committed, a large number of respondents commented that, in today's trucking environment, they had to work long hours seven days a week, and therefore did not have to time to spare.

Figure 6: Time Willing to Spend on Training

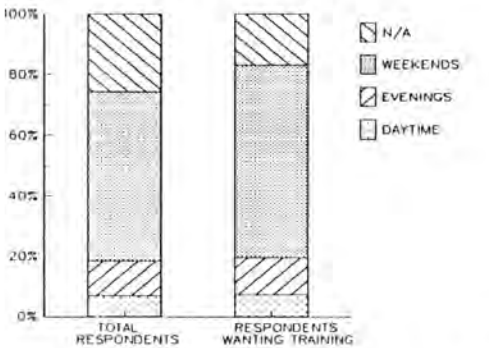


Analysis of willingness to commit time to skills development versus number of trucks operated revealed that respondents with more than one truck were more likely than those with one truck to commit to at least some time for skills development, and were willing to spend more time.

A comparison of willingness to commit time to skills development by years of experience indicated that owner-operators with 1 to 5 years of experience were more willing than more experienced respondents to spend time on training. Among respondents willing to spend time on training, there was no pattern of amount of time by years of experience.

Finally, respondents were asked whether they were available days, evenings or weekends for business skills training. As Figure 7 indicates, the overwhelming preference is for weekends.

Figure 7: Availability



VI. CONCLUSIONS

It appears, based on the survey results, that there is both a need and an expectation for government to help owner-operators develop their business skills. If the government elects to become directly involved in developing owner-operators' business skills - and a large majority of survey respondents advocate that this happen - then it must be recognized that there is no simple solution to identifying which skills are critical and in which areas training is required.

The business skills needs of owner-operators and their spouses appear to change during the life span of the operation, and government may need to target training assistance to different levels of experience.

First and second year owner-operators identified a broad range of skill areas in which they need training, but were less likely than more experienced operators to recognize any of these skills as critical to the success of their business. It might be worth exploring whether general knowledge of a business operation should be an obligatory entry requirement for new entrants into the owner-operator industry.

It appears that a critical point in the life of the owner-operator is reached during the third to fifth year of operation. During this period, owner-operators are likely experiencing an increase in maintenance requirements on their existing equipment, and face the prospect of purchasing new equipment in the near future. This experience range corresponds with the time when survey respondents were most likely to report needing training in skill areas which they regard as critical to business success.

Owner-operators with three to five years experience were least likely to report having adequate opportunity to learn business skills, and were more likely to advocate one of the self-help or formal training options, all of which entail studying training material. Owner-operators in this experience range will probably be the most receptive to taking advantage of available training.

For both the new operators and those with 3-5 years experience, training material which involves a structured curriculum covering a broad range of topics would probably be most suitable. The format in which this material should be provided requires further research.

More experienced owner-operators are less likely to need government assistance in developing their business skills, except in very particular instances, such as when changes occur in trucking-related laws and regulations, or when the owner-operator elects to diversify the nature of the operation, by buying additional equipment, for example, or by becoming self-employed. An advisory service which can answer specific questions would probably be best suited to this group of owner-operators. Again, the best format for the advisory service would require further investigation.

Finally, it must be recognized that business skills development alone will not cure all the problems facing owner-operators. As many of the survey respondents commented, this is just one aspect of a very difficult and complex operating environment, and many other factors will have as big or bigger influence on the financial stability of owner-operators in Ontario.

APPENDIX A

OWNER OPERATORS BUSINESS SKILLS SURVEY

1. How many years have you been an owner operator? _____

2. How many trucks do you operate? _____

3. Where is your home base? _____ (Nearest Town)

4. Do you have a contract with a common carrier _____, private fleet _____ or are you self-employed _____?

5. In what area of the trucking industry are you employed?

(a) Aggregate ____ Other Bulk ____ General Freight ___
Household Moving ____ Log Hauling ____ Courier ___
Other (specify) _____

(b) Between Ontario & the U.S. _____
Within Ontario _____ Between Provinces _____

6. The following is a list of some of the business skills which may be critical to operating a financially successful business. Please _X_ the "important skills" for your operation and then _X_ those skills in which you "require more training".

	Important Business Skills	Require More Training
- how to choose the best equipment	_____	_____
- how to choose the best financing	_____	_____
- how to choose a good accountant	_____	_____
- how to understand & negotiate a contract	_____	_____
- how to prepare a business plan	_____	_____
- how to choose a carrier	_____	_____
- how to determine operating costs per mile	_____	_____
- how to determine income needs per mile	_____	_____
- how to complete a tax return	_____	_____
- how to minimize operating costs	_____	_____
- how to operate a micro-computer	_____	_____
- knowledge of operating laws & regulations	_____	_____

- specify any other business skills you need: _____

7. Do you feel that you have suitable opportunities to learn the business skills necessary for financial success? Yes _____ No _____

8. Do you think anything should be done by Government to help owner operators develop their business skills? Yes _____ No _____

9. If yes, what?
__Develop training books
__Develop training course
__Develop counselling service
__Develop training videos
__Develop phone advisory service
__Newsletter
__Develop training cassettes
__Correspondence Course
__Publish list of available training
Other, please specify _____

10. How much would you be willing to pay to develop your business skills?
$0 ___ $50 ___ $100 ___ $500 ___ $1000 ___

11. How long would you be prepared to spend at any one time on business skills training?
0hrs ___ 1/2hr ___ 1hr ___ 2hrs ___ 3hrs ___
1/2 day ___ 1 day ___ several days ___ 1 week ___

12. What is your availability? __ days __ evenings _ weekend

13. Does your spouse participate in the financial affairs of your business? Yes _____ No _____

14. If yes, would your spouse benefit from business skills training? Yes _____ No _____

15. The following personal information will be useful in designing possible programs.

Your Age: under 30 ___ 30-39 ___ 40-49 ___ over 50 __
Education: elementary school __ high school __
community college or university ___

Thank you for your help. If you have any other comments, please write them on the back.

FREIGHT CAR FLEET PLANNING AS A COMPETITIVE STRATEGY

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ABSTRACT

To appreciate the challenge for freight car fleet planning in providing a competitive edge for the rail industry, it is helpful to survey the economic record of that industry for at least a decade and, more importantly, to review its market outlook for the 1990s and beyond. If we do that, it will become immediately apparent that, in this era of great uncertainty for North American railroads, effective fleet planning is not just an issue of profitability, it is also one of survival.

The railroad industry enters the 1990s with greatly reduced expectations, and ever increasing competitive pressures. It emerged from a decade of almost constant decline in carloadings, market share, and profitability. In the 1980s, rail tonnage among U.S. Class I railroads fell by 6%, from 1.49 billion tons to 1.4 billion.[1] Among Canadian railroads, rail tonnage, for the top ten commodities handled, declined by 5% between 1984 and 1989, despite increasing by 3% during the first 4 years of that period.[2] Yet there are signs that the downward slide might already have abated, thanks to planning initiatives taken in the 1980s. The industry trimmed its bloated labor force by half, abandoned unprofitable tracks, retired surplus equipment, and installed modern networking technology.[3] Thus the challenge for the industry, it can be argued, is to take full advantage of the efficiency of leanness. Nowhere is that challenge more apparent than in freight car fleet planning.

The need to control cost, through effective fleet planning, is made more urgent by the forecasts for flat or marginal growth in bulk carloadings – the dominant area of rail transportation. If markets and, therefore, revenues are not expected to grow significantly, we can grow profits only by curtailing costs, and to control cost, we must plan more effectively.

Moreover, railroads do not, as a whole, earn their cost of capital[4] and, among those which do, only a few car types are really viable for the long term. The clear implication is that replacement by new car construction, or purchase acquisition is not feasible for most car types, hence planning options are somewhat restricted. This points to the issue of market segmentation and survival, and poses yet another important challenge for freight car fleet planning.

One result of uneven market prospects, and declining real revenue is a compelling need to adopt two-tier planning. Planning for stable and growth markets should be compartmentalized, but not separated from planning for temporary and declining

markets. To be effective, freight car fleet planning must recognize the essential uniqueness of those markets. To do otherwise, will make for inefficient resource allocation, waste, and reduced competitiveness.

The planning process must employ modern tools of analysis and technology. Full use must be made of existing computer technology; enabling forecasts should be informed by well-tuned mathematical models; and optimization techniques should be used to inform choices among repair and acquisition strategies. Of equal importance, however, is the need for an integral process to facilitate automatic adjustments to ever changing market conditions.

The effectiveness of freight car fleet planning is enhanced by the development of an "ELOR" subsystem. "ELOR" is an acronym for economic limit of repair. It establishes the economic framework within which the repair eligibility of every freight car is determined and, in that framework, it channels resources from low contributing cars with short remaining lives to high contributing ones with long remaining lives. It is a natural extension of an effective and truly competitive fleet planning strategy.

INTRODUCTION

Fleet planning is designed to maximize actual revenue contribution to earnings, by maintaining the optimum size and distribution of the fleet.[5] In the very short run, or market period, potential revenue is fixed, and the challenge for fleet planning is to minimize the cost of obtaining it. It is precisely this ability to control cost that makes fleet planning indispensable in the long-run effort to improve the competitive position of the industry, viz-a-viz other modes of transportation.

Fleet planning encompasses several levels of decision making. It involves, for example, decisions on fleet size, composition, reserve level, and ownership. These, in turn, trigger other decisions involving such choices as: to sell or purchase, to build or lease, or even to repair or dismantle. Such decisions represent the strategic, as distinct from the operational aspects of fleet planning. Operational aspects include decisions relating to geographic placements of empty cars, backhaul of system and foreign equipment, as well as sizing of customer and free running pools.

Both aspects of fleet planning are essential to the industry's drive to be competitive in the 90s and beyond. They both exert significant influence on cost and, more importantly, they are essentially complementary. However, this paper focuses on the strategic aspects of fleet planning and, consequently, treats operational factors as parameters in the planning process. It is significant, however, that these factors affect the degree of car utilization and, consequently, the level of profitability.

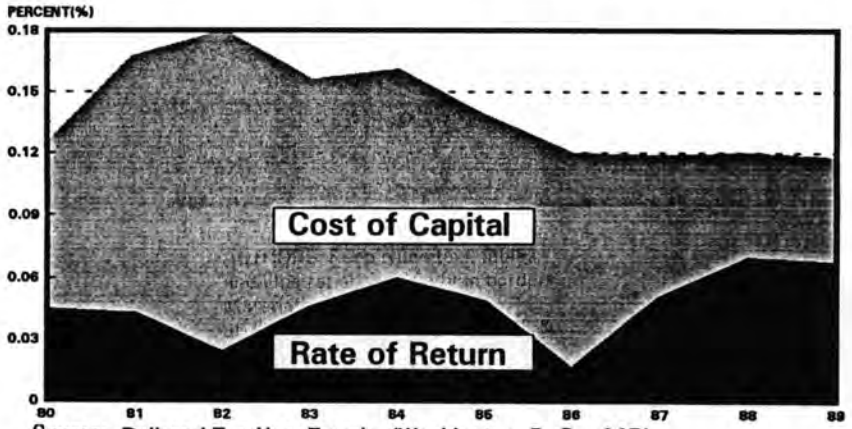
THE URGENT NEED FOR EFFECTIVE FLEET PLANNING

As a group, class I railroads in the United States do not earn their cost of capital.

During the 1980s, the average rate of return on net investment was just 4.4%, or approximately one-third of the ICC's estimated cost of capital for that period.[6] Pertinent data for each year are provided in Exhibit I below:

EXHIBIT I

COST OF CAPITAL vs. RATE OF RETURN ON INVESTMENT

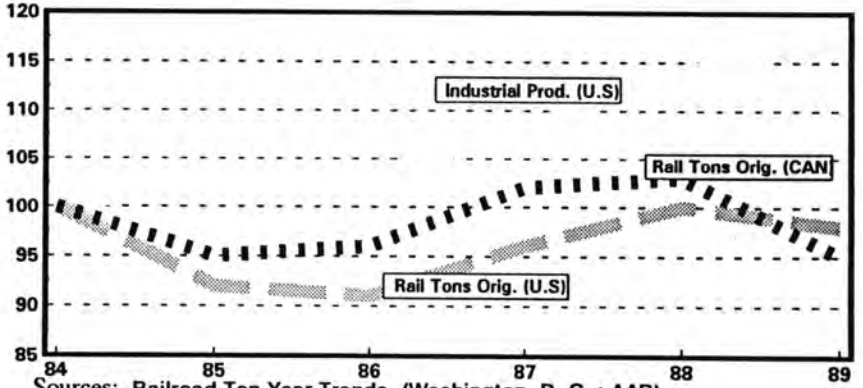


Source: Railroad Ten Year Trends, (Washington, D. C. : AAR)

Moreover, rail tonnage, during that period, did not keep pace with industrial output, clearly indicating a reduced market share for the rail industry in relation to other modes of transportation. From 1980 to 1989, tonnage originated by U.S. Class I railroads fell by 6%, while industrial output increased by 28.5%.[7] The indices of rail tonnage moved by U.S. and Canadian railroads are shown in Exhibit II below:

EXHIBIT II

RAIL TONNAGE AND INDUSTRIAL OUTPUT



Sources: Railroad Ten Year Trends, (Washington, D. C. : AAR)
Railroad in Canada, (Ottawa, Ministry of Industry)

On the basis of solvency indicators, shown below in Exhibit III, Canadian railroads appear to fare no better than their U.S. counterparts.

EXHIBIT III

SOLVENCY INDICATORS

	1983	1984	1985	1986	1987	1988	1989
US CLASS I RAILROADS							
OPERATING INCOME (Constant 1986 C$)	2761	3728	2385	1308	2664	2865	2582
IMPLICIT GROWTH INDEX (re Operating Income)	100	135	86	47	96	104	94
OPERATING RATIO	90%	88%	91%	95%	90%	89%	90%
DEBT TO ASSET RATIO	0.30	0.28	0.27	0.28	0.25	0.24	0.27
CANADIAN RAILROADS							
OPERATING INCOME (Constant 1986 C$)	665	745	850	783	1025	970	330
IMPLICIT GROWTH INDEX (re Operating Income)	100	112	128	118	154	146	50
OPERATING RATIO	92%	91%	89%	90%	87%	87%	95%
DEBT TO ASSET RATIO	0.17	0.35	0.26	0.25	0.28	0.33	0.34

Compiled from data extracted from: Railroad Ten Year Trends, and Rail in Canada, op. cit.

Between 1983 and 1989, the operating ratio, which is the proportion of total operating revenue absorbed by total operating expense, averaged 90% both in Canada and the United States. Moreover, at just under 30%, the average debt to asset ratio was also the same in both countries.

The rather sluggish financial state of the industry promotes a sense of urgency with respect to the need for effective fleet planning. Fleet Planning's potential for cost control, and efficient resource allocation are vital to the industry's effort to improve its competitive position, and guarantee its survival into the 21st century.

FLEET PLANNING PROCESS

The planning process begins with a forecast of the demand for and supply of serviceable car capacity. On the demand side the forecast is initially stated in the form of car loads by commodity groups, and is generally based on macro-economic trends, as well as the business plans of major customers.

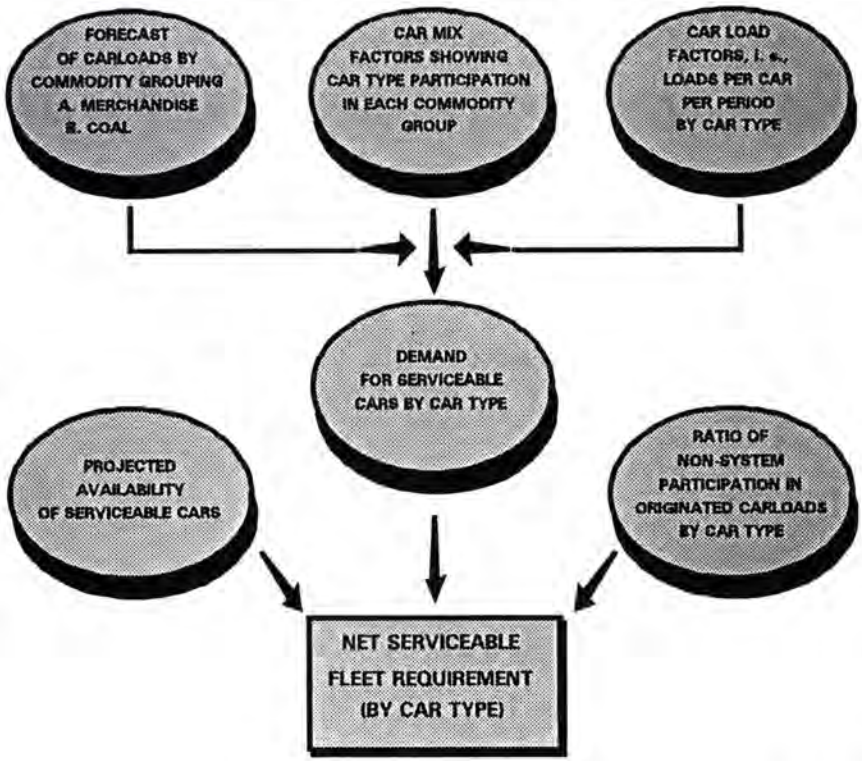
The forecast of carloads by commodity groups is converted to carloads by car type, using car mix factors. These factors are derived from empirical data on the mix of commodities carried by each car type.

Together with load factors, the forecast of carloads by car type enable calculation of gross car requirements. Load factors for any given car type are the number of car-loads that can be moved by that car type during a specific period of time. They are the primary measure of car utilization within the industry.

Simultaneous with the forecast of car requirements, serviceable fleet availability is projected on the basis of estimated fallouts to HBO, and signed commitments for purchases and other acquisitions. Adjustments are made for projected availability of foreign and privately owned cars. With the forecast of available serviceable cars, as well as that of gross car requirements (both developed on a car type basis) it is possible to determine the net serviceable fleet requirement. The process is summarized in Exhibit IV, below:

EXHIBIT IV

DETERMINATION OF NET FLEET REQUIREMENTS



It is at this juncture, that the fleet planning process takes widely divergent courses among North American railroads, although the issues that must be addressed are essentially the same. Should net car requirements be invariably satisfied? If so, what should the supply option or options be? Should requisite equipment be purchased, built, leased, or obtained by repairing heavy bad ordered cars? More importantly, what should the mechanism be by which the optimum course is selected?

It is in the exercise of these choices that fleet planning has the best opportunity to control cost, increase contribution to earnings, and improve the competitive position of the industry. To take full advantage of this opportunity, in the context of limited financial and other resources, it is imperative that the planning process employ traditional tools of financial analysis in combination with the techniques of optimization in a comprehensive computer model. One approach is to construct a model which not only determines the best economic alternatives for meeting projected net fleet requirements, but also calculates those requirements from demand and supply projections, which are shown in Exhibit IV as exogenous inputs to the model.

MARKET SEGMENTATION

Regardless of the approach taken, it is necessary to establish the economic feasibility of each supply option for each car type, as well as the market group it serves. Not all supply options are feasible for all car types. Some do not earn their cost of capital and, therefore, cannot be profitably replaced on a permanent basis. Some may serve markets characterized by temporary or declining demand. Yet earnings from these car types may justify short-term leases, or light repairs, both of which are designed to provide relatively short serviceable life. It is important to the goal of profit maximization that the provision of serviceable capacity for temporary or declining markets be consistent with the time duration of demand. Such exercise in the synchronization of supply and demand is possible only if markets are segmented by car type contribution to earnings.[8]

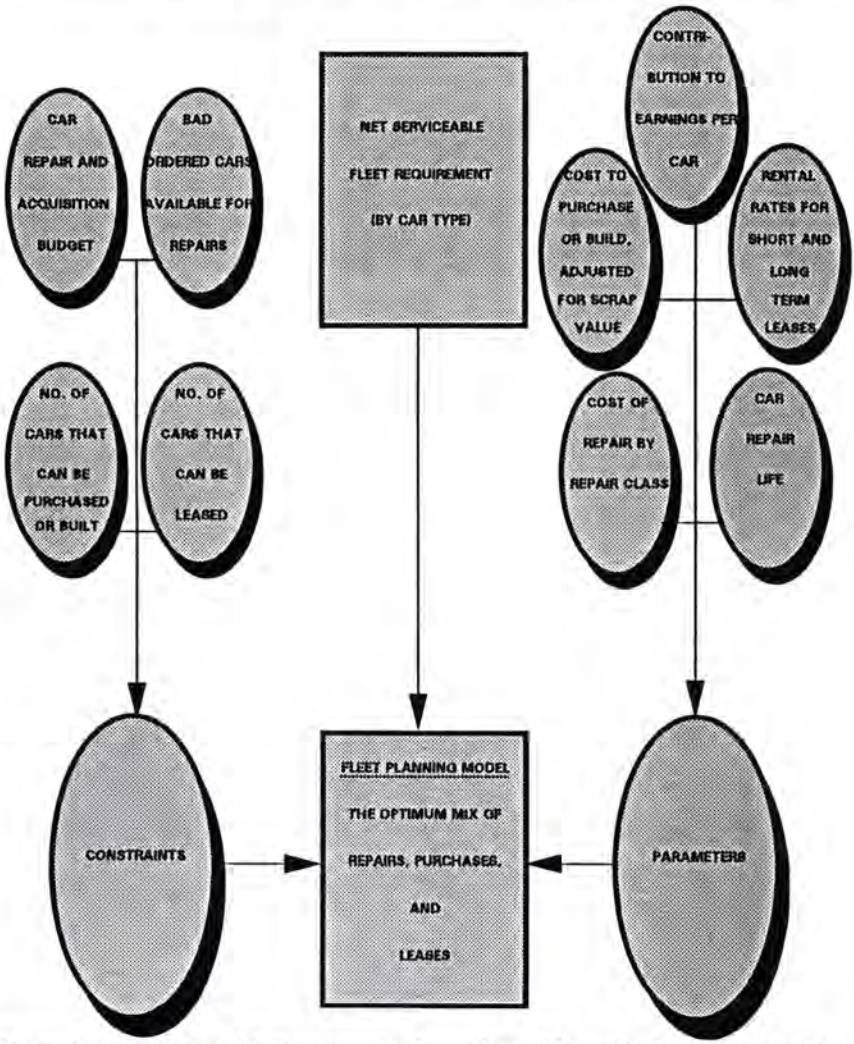
Clearly, not all net serviceable fleet requirements can or should be filled, even if there are feasible supply options. The prerequisite condition, that estimated contribution before car cost be greater than appropriate car cost, is a necessary, but not a sufficient condition for profit maximization. The inadequacy of financial and other resources to satisfy even the feasible component of net fleet requirements makes the goal of profit maximization possible only with the aid of an optimization tool such as linear programming.[9]

THE OPTIMIZATION MODEL

The purpose of the fleet planning model is to maximize potential earnings from the supply of net serviceable fleet requirements. As expected, the model contains several constraints and parameters which define the essential issues of freight car fleet planning, and form the basis for the best feasible solution. These are shown below as basic inputs into the optimization model. (See Exhibit V)

EXHIBIT V

DETERMINATION OF BEST ECONOMIC ALTERNATIVE FOR MEETING PROJECTED NET FLEET REQUIREMENTS



In any optimization model, there must be demand variables, price factors, constraint factors, supply options, parameters, and most importantly, an objective function. In the above diagram, constraints and parameters are shown in buckets to the left and right, respectively, while demand, or net serviceable fleet requirement, is depicted in the center.

Since the purpose of the model, or objective function, is to maximize incremental contribution to earnings, it is instructive to examine the meaning of the term "incremental contribution" and how it is measured. In practice, incremental contribution per move is derived by subtracting the variable costs associated with the transportation of the last carload, from the revenue generated by that carload. Observe that variable costs include car costs, such as per diem and mileage payments, lease payments, and car ownership costs. These costs, along with transportation and switching costs, rise as carload traffic increases.

Consistent with the objective function, both the form and method by which serviceable capacity is added, and the specific car type to which it is added are influenced by the level of incremental contribution. How much is added is a function of the amount of available resources. These resources are represented, in Exhibit V, as constraints which establish feasible solutions within the optimization process.

It is not immediately apparent how car costs incurred through lease payments can be compared with similar costs incurred through purchase acquisitions or heavy repairs. One approach is to reduce such flows to their net present value, after allowing for at least two replacement cycles. Beyond two such cycles (of between 30 and 40 years), net present value approaches zero, and further cycling becomes superfluous.

The basic structure of the model is represented by the matrix in the following tableau:

EXHIBIT VI

THE FLEET PLANNING TABLEAU

	PURc	BLDc	LSEc	REP CL1c	REP CL2c	REP CL3c	... RHS
INCREMENTAL CONTRIBUTION	$	$	$	$	$	$	
EQUIP. ACQUISITION / REP. BUDGET	x11	x12	x13	x14	x15	x16	<q1
MARKET AVAILABILITY OF NEW CARS	x21						<q2
MARKET AVAILABILITY OF LEASED CARS			x33				<q3
SYSTEM AVAILABILITY OF HBO CARS FOR REPAIR				x44	x45	x46	<q4
SHOP CAPACITY		x52		x54			<q5
DEMAND FOR CAR CAPACITY	1	1	1	1	1	1	=dc

where
- c represents car types
- x11 represents the amount of money required to purchase 1 car
- x12 represents the amount of money required to build 1 car
- x13 represents the periodic lease payment per car
- x14 represents the cost of a class1 heavy repair
- x15 represents the cost of a class2 heavy repair
- x16 represents the cost of a class3 heavy repair
- x21..x54 represents the amount of resource 'i' used per unit 'j' supplied, which, is, invariably 1, as each is expressed in units of cars.
- q represents the total availability of each resource
- dc represents total demand, by car type

The explicit tableau may be reduced to a logical one as follows:

	SUPPLY OPTIONS	RHS	
CONTRIBUTION	$cj		(1)
RESOURCE AVAILABILITY	xij	< qi	(2)
DEMAND	1	= dij	(3)

The reduced tableau, or matrix, shows the essential construct of the model. Row 1 contains the car type contribution of each supply option. This contribution may be regarded as the coefficient of the objective function, as it provides the income basis upon which the the optimum solution is derived.

Row 2, which is expressed as an inequality, constitutes the first group of constraints in the model. These include the budget as well as the varied forms in which serviceable capacity may be acquired. The methods of acquisition are collectively referred to as supply options. The third and final row, which represents demand, or incremental fleet requirement (by car type), constitutes the other group of constraints. Here, the expression of demand as an inequality may lead to infeasible solutions, (in light of budgetary and other restrictions), unless the model includes a vector for "unfilled demand". That vector, along with other vectors or columns in the matrix, represents the choices that must be made, consistent with the objective function and the availability of resources required to satisfy it.

THE ELOR SUB-SYSTEM

The repair eligibility of stored heavy bad ordered cars (HBOs) may be predetermined, using the criterion of economic limit of repair, or "ELOR".[10] Under the ELOR system, HBOs that are not eligible for repair are immediately retired and sold. Others are held as potential candidates for future repair programs. However, since the repair option is just one of several supply options available to the Fleet Planning Model, not all repair eligible heavy bad ordered cars would, or should be repaired. From the standpoint of profit maximization or loss minimization (both of which are consistent with the optimum solution to the model), it may be desirable that some repairable HBOs be retired instead.

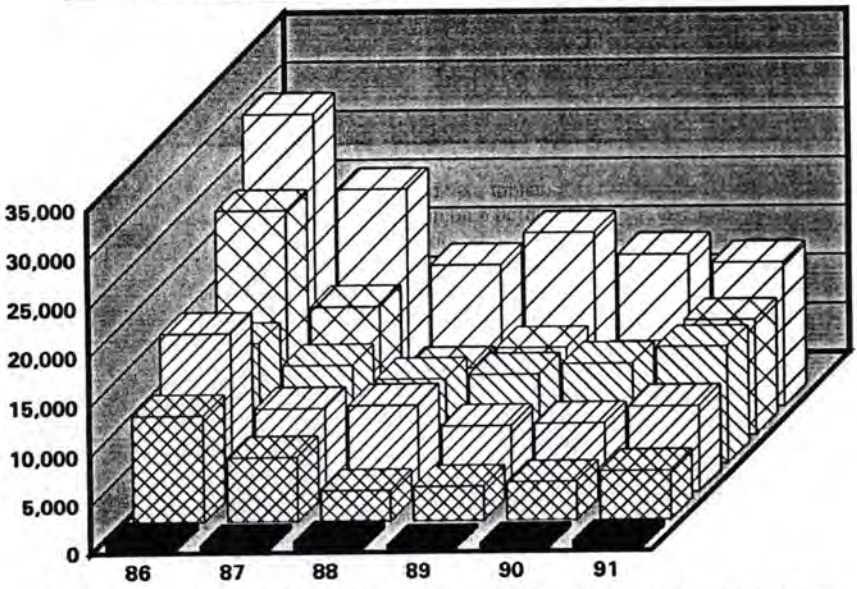
The main value of "ELOR" to the fleet planning process is its role as a clearing mechanism for potential heavy repair candidates. Beyond that, however, it ensures that repairs are never performed unprofitably nor sub-optimally, and HBOs are never retired prematurely. As such, it may be regarded as a natural extension of an effective fleet planning strategy.

SIGNIFICANT BENEFITS

If the industry were to size and distribute its fleet optimally, it will at least avoid the waste associated with investments in idle serviceable capacity. Among class I railroads in the U.S, idle serviceable capacity, computed on average daily basis during the last six years ranged from 42,864 cars in 1988 to 93,358 in 1986.[11] Relevant data are shown in Exhibit VII below:

EXHIBIT VII

FREIGHT CAR SURPLUSES AMONG U.S. CLASS I RAILROADS



Source: AAR, Transport. Dept: "FREIGHT CAR SURPLUSES Class I Railroads"

At a weighted average price of approximately $41,000 per car and a capital cost of 12.5% per annum, the estimated loss to class I railroads, on account of idle serviceable capacity amounted to $355 million per year during that period.

If the only goal of fleet planning were to minimize that loss, the effort would be richly rewarded. Of equal significance, however, is the model's ability to determine the optimum car supply strategy, that is, the mix of repairs, purchases, and leases which minimizes the long-term cost of protecting profitable traffic. It is this potential for cost control that makes fleet planning an essential tool in the industry's drive to compete more effectively in the 1990s and beyond.

ENDNOTES

[1] Association of American Railroads, *Railroad Facts,* 1990 edit. (Washington, D.C.) p27.

[2] Ministry of Industry, *Statistics of Canada,* 1988 & 1989 edits. (Ottawa, 1991).

[3] Frank N. Wilmer, *Railroads and Productivity,* (Washington, D.C. : AAR, 1991) pp. 24 & 25.

[4] *Railroad Facts,* op. cit. p. 21

[5] For the theory of planning without complete information, as in the case of Freight Car Fleet Planning, see, for example, George B. Dantzig, *Linear Programming and Extensions,* (New Jersey: Princeton Univ. Press), pp. 462–465

[6] Association of American Railroads, *Railroad Ten-Year Trends,* (Washington, D.C.) p90.

[7] Ibid., p. 59.

[8] Winston E. Barton, *Optimum Car Repair Strategy,* (Privately Printed, 1991)

[9] Dantzig, op. cit., "The Simplex Method", pp. 94–111.

[10] Winston E. Barton, *The ELOR System,* (Privately Printed, 1992)

[11] Association of American Railroads, *Freight Car Surpluses 1986–1991, Class I Railroads,* (Washington, D.C.)

Shipper-Carrier Partnerships: Improving Customer Service And Productivity

Paul F. Inglis, A.T. Kearney
William J. Markham, A.T. Kearney

1. INTRODUCTION

We often hear of companies striving to be customer focused. They want to be known as quality leaders. They seek world class status. They recognize that to accomplish these ends they must think globally and empower their employees.

But because so many companies have adopted similar sounding statements of mission, goals, and values, mere words will not differentiate a company in the marketplace. Instead, the deciding factor will be the company's ability to execute the key business processes that deliver the customer value and quality the words promise. One such business process is logistics.

An effective logistics process is essential to satisfy customers and to gain competitive advantage. Improving the service quality that the logistics process provides increases customer satisfaction and builds customer loyalty. These in turn lead to market share and margin increases. At the same time, focusing on true customer needs eliminates cost for services not valued. Improving the productivity of a logistics process also reduces cost. Together these actions help make products and services more attractive in the marketplace.

But rarely will a manufacturer be in control of the full logistics process. Most companies utilize third parties to transport, store and distribute their products. This has created interfaces within the logistics process. Unless these interfaces can be developed so that they appear seamless, there are discontinuities which can adversely affect both the quality and productivity of the overall process.

For many years, manufacturers concentrated on their core activities such as manufacturing and marketing. Product quality was the competitive advantage. But today, more and more we are observing that product quality is a necessity for even short-term viability. Product quality is the "ante to stay in the game". Only within the last two to three years have companies actively pursued the improvement of the logistics process.

Companies improve the logistics process for one or two basic reasons: to enhance the effectiveness with which the logistics process meets the customer requirements or to upgrade the efficiency or productivity of the process as a means of driving down cost. In this paper we discuss one of the "breakthrough improvements" that has resulted in significant improvements in the process.

2. ACKNOWLEDGMENT

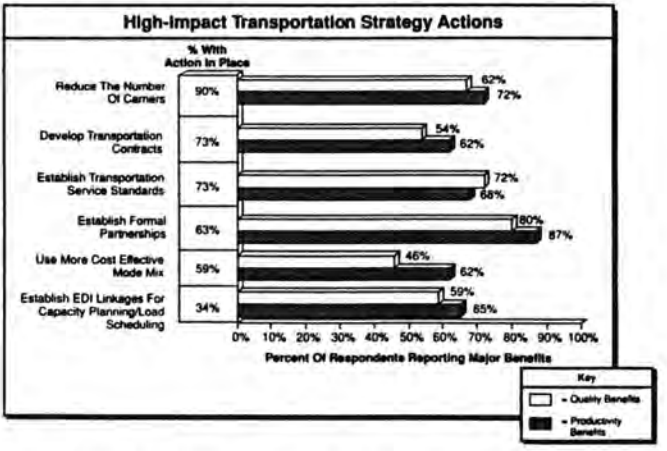
We gratefully acknowledge the Council of Logistics Management who engaged A.T. Kearney to investigate and analyze how companies improve quality and productivity in logistics. This paper is based on the research conducted during 1991 as part of this project. It builds on earlier studies conducted by A.T. Kearney for the Council in 1978 and 1983 which dealt with productivity improvement in logistics. A similar research project is being conducted in Canada this year as part of the Canadian Association of Logistics Management research program.

3. HIGH IMPACT ACTIONS TO IMPROVE TRANSPORTATION IN THE LOGISTICS PROCESS

From the survey conducted as part of our study, we extracted those actions that had the greatest impact on quality and productivity improvements for the respondents. These were actions that produced major benefits in terms of quality or productivity for at least sixty percent of the respondents implementing them. We call these "high impact improvement actions."

The transportation improvement actions related to strategy, operations and fleet management. The strategic issues focused on relationships with carriers. Figure 1 indicates the nature and results from the six key high impact transportation strategy actions.

Figure 1



Generally we know that these actions were focused on improving productivity rather than increasing quality. The exception was establishing transportation service standards with carriers. But a trend is clear. Among the six high impact transportation actions, only the mode mix action showed a significant drop in the number of users since our earlier survey. In 1983, 73

percent of participants took this action compared to 59 percent in the most recent survey. Each of the other actions indicates a trend towards improving the overall logistics process by improving the relationship between the transportation carrier and the shipper.

4. PARTNERSHIPS IN THE LOGISTICS PROCESS

We often think of supplier partnerships/vendor partnerships as involving the joint efforts of a shipper and a customer. But rarely are these kinds of partnerships successful without the integrated involvement of a transportation carrier. This third partner is literally the conduit for success. Just over half of the respondents of our survey indicated that they would be using customer or supplier partnerships in their logistics planning.

Not all companies are ready for partnership either with their customers or with their transportation suppliers. Many companies still must look internally to develop the base competence which is necessary to take that next step – integration beyond the boundaries of the corporation.

5. IMPLEMENTING SHIPPER CARRIER PARTNERSHIPS

Shipper carrier partnerships are one manifestation of a broader phenomenon; a customer supplier partnership. Throughout all kinds of industries, customers are concentrating their business with a limited number of suppliers to improve quality and reduce costs for both parties. Xerox reduced its number of suppliers by 92 percent over a several year period from five thousand to four hundred companies. This is not an isolated incident but rather exemplifies the longer term trend towards partnerships. Among the companies we interviewed, developing formal partnership relationships with carriers was the most frequently used improvement action. Several firms, including Hewlett-Packard, Texas Instruments, Westinghouse, Rohm and Haas, Ford, GTE, PPG and Xerox have developed a formal cooperative approach towards improving quality and productivity with their carriers.

Basically, these corporations follow five general principals in their joint efforts with carriers:

- They concentrate their business with relatively few carriers
- They carry out joint improvement efforts with their carriers
- They have a formal system for measuring carrier performance
- They employ a two-way feedback system on carrier performance and improvement plans
- They use carrier performance as an objective basis for decisions on routing choices and rate levels

6. CONCENTRATING BUSINESS WITH A FEW CARRIERS

Because the transportation industry had been heavily regulated for many years Canadian shippers had few incentives to concentrate with one transportation supplier to gain leverage, reduce rates or help that carrier to improve productivity. Most of the companies we interviewed in the U.S. survey began creating shipper-carrier partnerships in the early to mid 1980's. They

found that because of transportation deregulation, there was a major shake out period in the transportation industry, particularly amongst the motor carriers. As shippers and carriers took advantage of new freedoms to develop tailored service and long term contracts, shippers naturally reduced their carrier base. The strong carriers as a result grew stronger and larger while the weak one fell by the wayside. It is only recently that we in Canada have had the benefits of a re-regulated environment. We too are seeing many of the same kinds of results. But we have often been much slower to respond. We can site many examples of companies which have only recently addressed this strategy. A western Canadian shipper spending less than $10 million on motor carrier transport but using more than 110 suppliers. A southern Ontario manufacturer who used 51 carriers in one month – expenditures less than $300,000.

Today those shippers who are doing business with fewer carriers than in the past have reaped many benefits. Our survey showed that many shippers that had aggressively sought out carrier partnerships during the 1980's had reduced their carrier base by as much as 90 percent over the past decade.

By focusing its business with fewer carriers, the shipper increases its negotiating leverage. More importantly, the shipper and carrier share an incentive to cooperate on improving service to the customer and increasing productivity.

The shipper has fewer suppliers to deal with – greater effort can be focused on managing the relationship and working with the supplier to enhance the overall productivity and quality of the logistics process.

But as in most partnerships the benefits are shared by the carrier. With consolidation of the number of carriers, each individual carrier has the incentive and opportunity to focus more carefully on making improvements and ensuring the high quality of service for the customer. They are able to improve communications between the companies and their understanding of both the customer and the customer's customer needs. If the shipper becomes a significant part of their business, carriers are able to revise standard operating procedures especially in areas related to the specific interfaces with the customer. Carriers are able to set higher priorities with those customers that provide a larger proportion of their business. They thus make concerted efforts to get to the root cause of problems and implement solutions.

7. IDENTIFYING THE JOINT IMPROVEMENT OPPORTUNITIES

In a true partnership, improvement is the joint responsibility of both the shipper and the carrier. Either side can take the lead in an effort to improve the process of which they are both a part. For example, Westinghouse and Yellow Freight Systems and several other carriers have worked together to redesign the freight bill payment process. At some high volume locations, Westinghouse calculates the correct rate for a given shipment, generates a pre-rated bill of lading and pays Yellow from this utilizing a full cycle EDI process. The freight invoice is eliminated altogether. Westinghouse reports that freight bill related processing costs have been reduced as a result.

Other companies we interviewed pointed to actions by their carriers to help improve loading practices (and reduce damage), to speed data exchange and to improve service and productivity.

At a recent speech to the Purchasing Management Association of Canada Symposium "Purchasing 1992: Competing in a Global Environment", Barry Davy reported on a number of interesting improvement programs which he spearheaded at CP Express and Transport. In once case, they started with a high error rate in the billing, rating and invoicing (73 percent) and systematically reduced that to less than 2 percent. The result was that the volume of business they captured from that shipper increased significantly. They became the carrier of preference rather than the carrier of last resort. As a bi-product of those actions they simplified the customers tariff and are now paying directly from the original bill, eliminating all statements and attachments. In another example, he described the situation where the shipper had not properly documented the precise delivery requirements of their customers. This resulted in missed appointment deliveries, long waits at receiving terminals and endless tracing and poor communications between the shipper, carrier and consignee. The carrier identified each of the steps in the process in detail using flow charting and worked with the customer to identify areas where improvements could be made. Significant savings accrued to the carrier which were then shared with the shipper, resulting in a solidified relationship.

In the U.S. PPG Industries and truckload carriers Schneider National worked together to develop a system for planning, scheduling, tracking and controlling truckload packaged shipments both inbound and outbound. The system, known as TOPS (Transportation Operations Planning System) helps PPG's central transportation operations staff plan schedules for the companies own private fleet and its dedicated carriers and assign loads to each carrier. Loads are entered electronically at PPG plants or other shipping locations. Carriers are notified of available loads through EDI. By accessing this central shipment database electronically, the carriers can update the schedule and actual shipment status once the goods are in transit. PPG also uses the database to monitor service quality and identify improvement opportunities. PPG's system provides service measures such as:

- On-time performances
  - Pick up versus plant schedule
  - Delivery versus customer specified times/date
  - Appointments versus scheduled time plus or minus ten minutes
- Elapsed time to confirm acceptance of a tendered load versus goal
- Percent of loads tendered that will rejected (target = zero)

8. MEASURING PERFORMANCE

Shippers that have formal partnership programs with carriers do not award their business based solely on rates. While rates are important, service quality plays an increasing role in the decision making process. Typical measures that were used by the companies we interviewed cover both quantitative and qualitative aspects. The quantitative measures include on-time performance, loss and damage rate and a series of administrative measures. In some cases, the quantitative measures also include conformance with rate

standards (that is, does the carrier's rate match the shipper's calculation of what a fair rate should be) and public safety record (accidents, moving violations, etc.)

Qualitative measures encompass carrier cooperativeness (ease of doing business) and a series of technical assistance and innovative dimensions which represent the value-added service which the carrier can bring to the relationship. In some cases, shippers have required that carriers have specific programs in place (TQM, continuous improvement processes, etc.) or that they become certified as part of a formal process managed by the shipper.

In many cases, the shipper has its own tracking system that supplies much of the quantitative data. In some cases, however, shippers ask carriers to measure themselves and report results back to the shipper. This often is tied to the shipper requirement that the carrier be actively involved in a quality improvement process of its own and carry out statistical process control analysis on its operations. In other cases, the carrier is the only agent which can provide specific information such as waiting time, percent on-time delivery, etc.

From a carrier perspective, it is important to recognize that the leading edge companies will be seeking out suppliers of transportation services that are capable of working closely with them. A shipper that has advanced to the stage of entering into vendor partnerships cannot afford to spend time teaching the supplier the basic concepts of Total Quality Management. And yet relatively few carriers can boast of a well developed program. Trimac, Reimers and CPET are three Canadian companies that have well established programs. But they are the exception amongst carriers in Canada. Beyond these examples, how many companies would be comfortable in using control charts to track performance on a wide range of service and operating measures. For example, Burlington Motor Carriers in the U.S. charts the percent on-time deliveries, cargo claims per load, percent of re-bills, driver turnover, driver law violations, out of route miles, percent of line haul loads pre-booked, DOT accidents per million miles and revenue per total mile.

9. MAXIMIZING COMMUNICATIONS IN THE RELATIONSHIP

The secret to successful relationships is the ability to properly communicate requirements. James Aaron Cook reported on a relationship that Univar, a chemical distributor has with Roadway in a recent issue of Traffic Management. He describes a "brainstorming session" where Roadway was invited to participate. Univar started the meeting by asking Roadway to describe the ideal shipper from the carrier's perspective. This is the kind of communication attitude that establishes solid partnerships. In too many cases, well intentioned, relationships are derailed by the failure of the parties to properly communicate their needs through concerns about confidentiality, or scope of a relationship.

A formal two-way feedback system was typical of most shippers in our survey having a partnership relationship. Typically, monthly or quarterly meetings were held to discuss carrier performance and factors that hindered carriers ability to provide quality service. This meeting provides the basis for the carrier and shipper to agree on an action plan for the upcoming month or quarter

aimed at addressing specific concerns and problems and ultimately improving the productivity and quality of the process.

10. REWARDING YOUR PARTNER

Some shippers directly link the amount of future business a carrier receives to its current performance. This is one extreme and is probably the area where there is the greatest difference from one shipper to another. At the other extreme companies we interviewed do not formally direct business towards carriers with the best performance. Rather they give carrier performance information to those people in their organization who are responsible for making routing decisions and let them select the carrier from the approved list.

In some other cases shippers link rates and performance very closely. For example, Xerox is using a pay-for-performance approach. Base rates were set several years ago based on benchmarking. Except for adjustments to input costs, the only way a carrier obtains an increase is to earn it through improved service performance. Despite the harsh sounding nature of this approach, both Xerox and its carriers report being satisfied.

SUMMARY

Based on statistical data, the questionnaire survey and the results of our interviews, supplier carrier partnerships appear to be a major source of quality and productivity improvement in the logistics process. Shippers benefit from more affordable, consistent and reliable transportation services that are tailored to their needs. Carriers benefit from having a more predictable business base on which to build and by having the ability to work with shippers to improve the overall productivity of the transportation process. Finally, the shippers customers' benefit from improved service and frequently lower costs.

Both our shippers and our carriers in Canada are facing significant challenges in establishing competitive parity and ultimately competitive advantage. For many, Total Quality Management programs and vendor partnerships are survival necessities. In Canada, transportation is more important than in many other countries with our long distances between major centres. Our transportation densities are lower and our input costs are generally higher. Close partnershipping between carriers and shippers is essential to avoid the costs of inefficiency and poor quality service.

TRANSBORDER RAIL FREIGHT TRANSPORTATION

By V. Wei
Transport Canada

I. INTRODUCTION

The objective of this paper is to discuss several issues related to the rail transborder market. Specifically, it examines the importance of transborder traffic to Canadian Class I rail carriers and analyzes recent trends in domestic and transborder rail movements, with a view to identifying any significant changes in traffic patterns, such as, a shift from east-west to north-south traffic and shifts in railway routing/gateways.

Several recent regulatory and economic developments have had a profound impact on the market structure and performance of Canadian railways. Major events include the National Transportation Act 1987 (NTA) and the Canada-United States Free Trade Agreement (FTA). The topics of this paper are in response to concerns raised by interested parties including both carriers and shippers, in light of these new developments.

The paper is based on the aggregated CN and CP rail freight origins and destinations data compiled by the National Transportation Agency.

II. THE IMPORTANCE OF RAIL TRANSBORDER TRAFFIC TO CANADIAN CARRIERS

Canada-U.S. trade is of vital importance to rail traffic. Based on 1990 rail freight data, the transborder rail traffic accounts for about 23 per cent of total Canadian Class I railways' tonnage, about 39 per cent of total traffic are derived from overseas trade (including 37% from exports and 2 per cent from imports) and only 38 per cent are from domestic commodity flows.

Transborder rail movements are very significant in certain commodity groups. Figure 1 presents transborder rail tonnage as a percentage of total traffic for the following six major commodity groups :

(1) Live animals
(2) Food, feeds, beverages and tobacco
(3) Crude materials
(4) Fabricated materials
(5) End products
(6) Special types of traffic (mixed carload, pool car, TOFC and COFC)

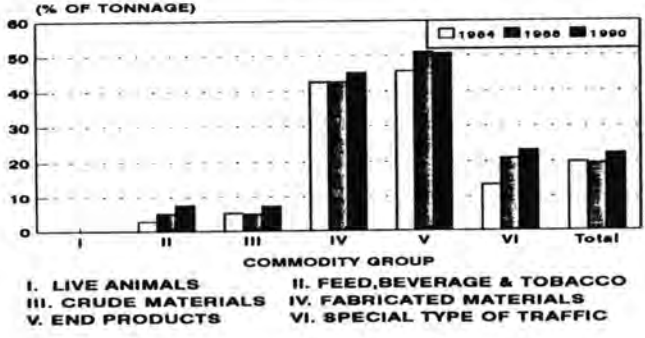
As shown in the Figure, total northbound and southbound traffic accounts for more than half of the total rail tonnage of the End Product group, and over 40 and 20 per cent of the Fabricated Materials and the Special Traffic groups respectively.

III. EAST-WEST VERSUS NORTH-SOUTH RAIL TRAFFIC

With the implementation of the FTA, it was expected that there would be a greater increase in north-south commodity flow than the traditional east-west flow. Since the demand for transportation is derived from merchandise trades, it is of interest to see if there has been any significant change in the commodity flow pattern since 1988, using rail freight data.

In fact, since 1988, transborder tonnage shares have increased in almost all commodity groups, especially in commodity Group II - Food, Beverage & Tobacco, Group IV - Fabricated Materials, and Group VI - Special Traffic (Figure 1). However, the question remains whether these increases are due to declines in domestic movements, or because the growth of transborder traffic surpassed that of domestic traffic.

FIGURE 1
TRANSBORDER RAIL AS A PERCENTAGE OF TOTAL RAIL TRAFFIC BY COMMODITY GROUP



Furthermore, in order to assess the trends in commodity flows after the FTA, it is necessary to compare them with those prior to the FTA. Thus, the following analysis includes two time periods, i.e. 1984-1988 and 1988-1990. In each period, growth rates of domestic commodity flows are compared with those of transborder flows. Then, these trends in the pre- and after- FTA periods are compared.

In the analysis, domestic origin/destination provinces are grouped into four regions: **Atlantic** (Newfoundland, Prince Edward Island, New Brunswick and Nova Scotia), **Central** (Ontario and Quebec), **Prairie** (Manitoba, Saskatchewan, Alberta and Northwest Territories) and **Pacific** (British Columbia and Yukon); transborder traffic are divided into **northbound** and **southbound** movements and commodities are aggregated into the six groups mentioned above. However, the rail traffic of the live animals group is negligible and is hence, excluded from further analysis.

The results are shown in Tables 1 and 2, while major findings are presented below:

(1) There has been a decline in east-west traffic originating in or destined for the Central region, the downward trend is more predominant in the 1988-1990 period than the 1984-1988 period. However, the north-south traffic between the Central region and the U.S. has grown continuously.

(2) During the 1984-1988 period, there were significant increases of traffic between the Pacific and Central regions. However, this trend was reversed in the 1988-1990 period. The most significant change was in eastbound traffic from the Pacific to Central region where contrary to generally upward trends during the previous period, all commodity groups showed negative traffic growth in the latter period.

(3) There have been continuous declines in intra-regional rail tonnages, especially within the Central region and in commodity group V, End Products. This is, however, more likely due to the competition of trucking than the effect of the free trade agreement.

(4) North-south rail movements of Group II - Food, Beverage & Tobacco, group III - Crude Materials and Group VI - Special Traffic increased significantly while domestic tonnages of these commodities declined in the 1988-1990 period.

(5) Moreover, during the same period, northbound rail movements of the Fabricated Materials Group into the Prairie region

TABLE 1

COMPARISON OF TRAFFIC GROWTH RATES BETWEEN DOMESTIC AND TRANSBORDER MOVEMENTS, 1984 – 1988

ANNUAL GROWTH RATE OF TRANSBORDER TRAFFIC (%)						
	COMMODITY GROUP					
REGION	II	III	IV	V	VI	TOTAL TRAFFIC
TOTAL	15.15	-7.03	1.72	2.45	20.29	1.80
CANADA TO US	21.28	-6.13	0.70	8.06	23.33	1.34
ATLANTIC	69.15	-3.01	10.08	26.46	67.00	10.29
CENTRAL	23.27	7.64	0.97	7.92	22.04	3.62
PRAIRIE	10.41	-14.59	1.02	11.71	13.05	-0.90
PACIFIC	39.30	25.50	-2.29	14.47	18.10	-1.10
US TO CANADA	10.96	-7.77	12.31	-3.52	18.76	3.53
ATLANTIC	11.88	-15.12	9.19	0.90	25.24	3.44
CENTRAL	10.22	0.68	15.47	-4.73	21.57	7.60
PRAIRIE	15.55	-15.05	3.25	3.64	7.65	-3.75
PACIFIC	9.02	-24.08	6.56	16.72	-0.04	-10.95
ANNUAL GROWTH RATE OF DOMESTIC TRAFFIC (%)						
REGION	II	III	IV	V	VI	TOTAL TRAFFIC
TOTAL OF THE GROUP	-2.17	1.69	-0.16	-5.26	7.13	0.49
ATLATNIC – ATLANTIC	-1.06	-0.85	25.95	-3.81	125.71	3.06
ATLANTIC – CENTRAL	-10.60	-1.22	-2.72	-8.11	4.89	-0.81
ATLANTIC-PRAIRIE	-9.53	-51.45	1.41	-7.50	-9.33	-7.39
ATLANTIC – PACIFIC	-6.98	-68.36	-4.07	-3.68	-6.17	-6.61
CENTRAL – ATLANTIC	-7.27	-9.36	-2.26	-6.72	9.14	-1.17
CENTRAL – CENTRAL	-5.19	-4.52	-5.29	-10.25	2.32	-4.65
CENTRAL – PRAIRIE	0.02	-10.64	1.32	-3.78	3.28	0.18
CENTRAL – PACIFIC	1.94	-2.66	-3.40	0.36	10.80	3.39
PRAIRIE – ATLANTIC	-12.48	-10.48	8.16	9.26	10.92	-6.40
PRAIRIE – CENTRAL	-9.51	5.17	2.14	1.50	-0.62	-4.62
PRAIRIE – PRAIRIE	-11.23	3.74	-0.39	-18.32	-12.02	-0.41
PRAIRIE – PACIFIC	8.12	6.04	1.57	-6.27	32.74	5.87
PACIFIC – ATLANTIC	-11.92	4.94	5.75	6.60	-1.06	4.48
PACIFIC – CENTRAL	4.80	19.82	1.71	6.76	21.84	9.93
PACIFIC – PRAIRIE	-26.68	1.32	-7.02	-22.29	7.02	-1.73
PACIFIC – PACIFIC	9.92	2.62	3.01	-33.16	-67.78	2.68

TABLE 2

COMPARISON OF TRAFFIC GROWTH RATES BETWEEN DOMESTIC AND TRANSBORDER MOVEMENTS, 1988 – 1990

ANNUAL GROWTH RATE OF TRANSBORDER TRAFFIC (%)

	COMMODITY GROUP					
REGION	II	III	IV	V	VI	TOTAL TRAFFIC
TOTAL	19.00	15.44	-0.13	-6.64	3.57	2.29
CANADA TO US	17.36	25.89	-0.97	-5.32	9.02	1.51
ATLANTIC	76.46	11.10	-14.02	45.60	-8.34	-11.73
CENTRAL	5.07	26.76	-0.39	-5.66	11.18	1.36
PRAIRIE	74.26	21.90	-0.50	-7.44	-3.89	2.63
PACIFIC	16.34	37.77	-0.72	14.74	-72.38	2.01
US TO CANADA	20.38	5.66	6.32	-8.55	-1.06	4.98
ATLANTIC	44.13	76.31	0.43	29.03	17.38	18.94
CENTRAL	12.03	1.50	3.17	-11.01	0.00	1.35
PRAIRIE	26.60	12.89	33.23	0.19	-5.30	18.72
PACIFIC	68.78	5.24	-13.26	9.45	-30.87	7.04

ANNUAL GROWTH RATE OF DOMESTIC TRAFFIC (%)

REGION	II	III	IV	V	VI	TOTAL TRAFFIC
TOTAL OF THE GROUP	-4.29	-6.96	-5.09	-5.74	-2.88	-5.72
ATLATNIC – ATLANTIC	14.45	-0.30	-2.62	-11.72	-30.95	-0.90
ATLANTIC – CENTRAL	4.14	-10.13	-16.36	4.57	-3.59	-5.51
ATLANTIC – PRAIRIE	-10.31	0.00	14.58	28.61	-6.86	2.82
ATLANTIC – PACIFIC	-31.27	*	-27.13	8.44	-19.83	-7.23
CENTRAL – ATLANTIC	-36.57	-13.37	1.92	-9.80	-2.67	-9.73
CENTRAL – CENTRAL	11.15	-14.13	-1.97	-20.42	-5.86	-7.86
CENTRAL – PRAIRIE	-9.33	-15.64	-7.12	-3.87	-0.98	-5.19
CENTRAL – PACIFIC	-0.91	11.16	-4.92	3.12	-1.09	-0.68
PRAIRIE – ATLANTIC	-16.43	-45.63	3.72	0.93	-4.04	-9.53
PRAIRIE – CENTRAL	-7.44	-10.85	-7.78	-10.91	-3.78	-8.24
PRAIRIE – PRAIRIE	17.61	-13.36	5.53	22.18	-4.38	-1.35
PRAIRIE – PACIFIC	-2.55	-8.01	-6.60	-0.05	9.09	-5.41
PACIFIC – ATLANTIC	-15.19	-23.79	-4.05	2.11	20.48	-2.56
PACIFIC – CENTRAL	-3.89	-13.34	-23.56	-0.19	-6.05	-15.02
PACIFIC – PRAIRIE	0.80	-4.25	-9.13	-21.91	1.62	-4,84
PACIFIC – PACIFIC	-5.33	-2.71	-8.31	5.36	352.77	-3.05

* Tonnage figure in 1988 was too small to make the growth rate compariosn meaningful.

increased at an average annual rate of 33 per cent while this group of rail traffic from the Canadian Central region declined at an average of 7 per cent per annum.

(6) There were sharp declines in domestic traffic originated from the Prairie region, mainly resulting from reductions in exports of grain, sulphur and potash. The Prairie drought may have contributed largely to declines in domestic rail tonnages of the Food & Beverage Group. Nevertheless, the rail traffic of this commodity group from the Prairies to the U.S. tripled between 1988 and 1990. In inbound movements, significant increases of traffic from the U.S. are found in groups II, III and IV, while commodity flow from other domestic regions to the Prairie generally declined.

(7) The northbound rail traffic from the U.S. to both the Atlantic and Pacific regions has increased significantly since 1988 while east-west traffic from the Central and Prairie regions have declined.

In summary, since 1988, the continuous growth in north-south traffic has contrasted with the decline in domestic east-west traffic. The phenomenon is widely present in every region of Canada and in most commodity groups. However, these changes in traffic patterns may not all be attributable to FTA since other factors, such as domestic production, overseas trades, competition from other modes, etc., also affect rail commodity flows.

III. RAIL TRANSBORDER GATEWAY ANALYSIS

Since the implementation of the new NTA, there has been concern that increased competition between railways would change traffic flow patterns affecting railway routings. Particularly, with the competitive access provision, it would be possible for shippers to ask CN and CP to interswitch cargo movements between each other, and for U.S. railways to short-haul Canadian railways on to connecting U.S. lines.

The transborder gateway analysis aims at detecting major changes in rail traffic routing over time. The analysis is, however, greatly limited by the data. First, the rail freight data provided by the National Transportation Agency are the aggregation of CN and CP and, as such, preclude any analysis of competition between the two railways. Second, the data only specify gateways at the provincial level. Therefore, any changes in routing between gateways within a province could not be easily identified. However, the second data deficiency

is partly compensated for by an analysis of changes in the average length of haul within Canada and in Canadian carriers' share of total waybill revenues. It is assumed that any significant shorthauling activities would result in notable changes in average length of haul and in Canadian railways' share of total transborder rail waybill revenue.

Before the passage of the NTA 87, Peat Marwick conducted a study to look into the implications of regulatory reform on railway productivity and competitiveness[1]. The study identified the following transborder traffic as most vulnerable to U.S. competition under the interswitching (competitive access) and competitive line rates provisions:

- Lumber products from B.C. and northern Alberta;
- Woodpulp originating from B.C., Alberta, New Brunswick and Nova Scotia;
- Newsprint and printing paper from Quebec, New Brunswick and Nova Scotia;
- Sulphur, fertilizers and LPG from Alberta;
- Chemicals from Alberta, B.C. and Quebec; and
- Salt cake from Saskatchewan.

These are all southbound traffic. The Peat Marwick study concluded that little northbound traffic would be exposed to the CLR provisions because the U.S. railways had already taken the longest haul possible.

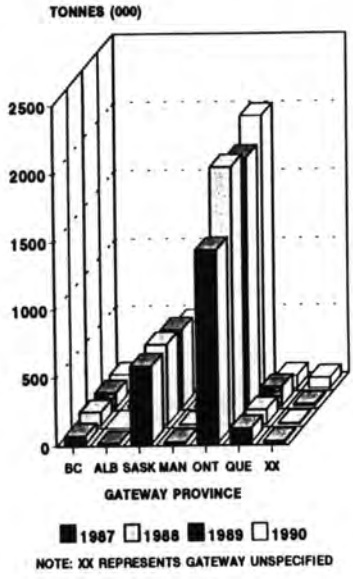
Using the above list as a base, five commodity-traffic groups were selected for analysis of the issue of rail re-routing. These are: lumber from B.C., newsprint from Quebec, sulphur from Alberta, woodpulp from Alberta, and woodpulp from Nova Scotia.

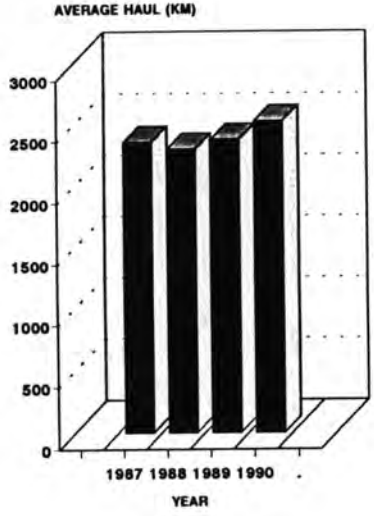
(1) Lumber from British Columbia

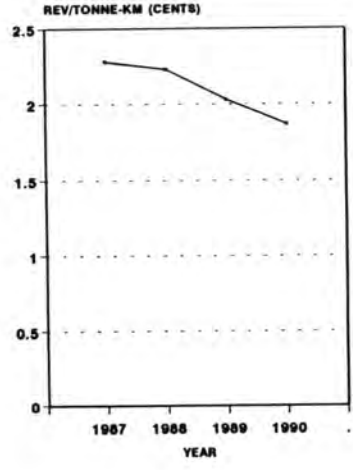
Figure 2 presents tonnages by gateway, average length of haul, revenue per tonne-kilometre and Canadian carriers' shares of waybill revenue related to the southbound movements of B.C. lumber from 1987 to 1990. The most striking picture in these trends is the decrease in average freight rate, a drop of about 18 per cent in nominal term since 1987 while the Canadian share of waybill revenue remains at the same level.

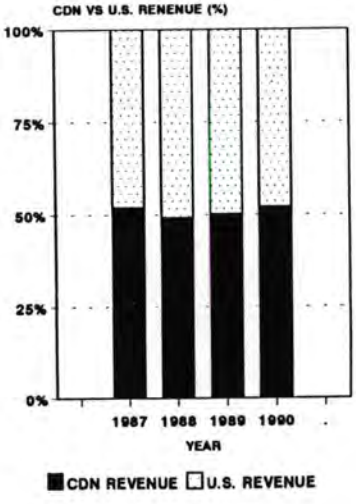
Other freight statistics only show moderate changes. Average length of haul within in Canada in 1990 is about 7 per cent higher than in 1987, resulting mainly from more traffic through Ontario. Based on O-D data, the increase in traffic via Ontario was likely due to increased lumber exports to the U.S. north-central, eastern and southern states rather than changes in traffic pattern by gateway.

FIGURE 2
LUMBER FROM B.C. TO THE U.S.
1987 -1990









(2) Newsprint from Quebec

Figure 3 presents data related to southbound newsprint traffic from Quebec. As shown in this Figure, exports of newsprint from Quebec to the U.S. have been shipped mainly via gateways in Ontario and Quebec. Although significant drops in traffic from these two provinces are shown in 1990, it may be due to data problems. In this year's data, there is a relatively large volume of traffic with unspecified gateways. These unspecified gateways are very likely in Ontario and Quebec, judging form the U.S. destinations.

Average revenue per tonne-kilometre for this traffic has declined moderately over the past three years at an average annual rate about 2 per cent. Canadian carriers' revenue share declined in 1988 and 1989 but there was an increase in 1990. Also, there was a slight increase in the average length of haul.

(3) Sulphur From Alberta

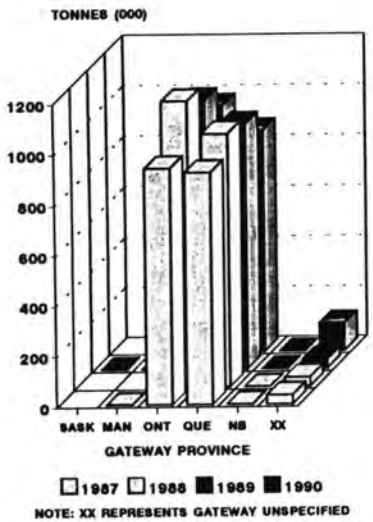
Sulphur from Alberta to the U.S. is mostly destined for the north-central and southern states via mainly Saskatchewan and Ontario. There have been significant increases in traffic through Ontario over the past two years which may be the reason for increases in the average length of haul. Moreover, the average freight rate has dropped significantly since 1987 while Canadian carriers' revenue share has increased (Figure 4).

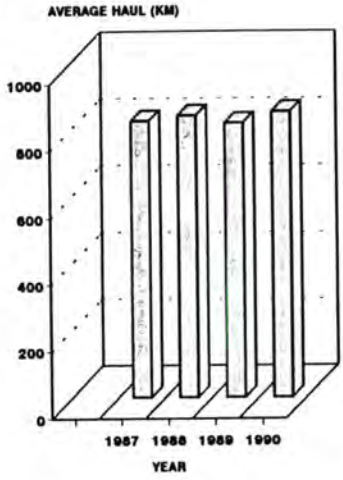
(4) Woodpulp from Alberta

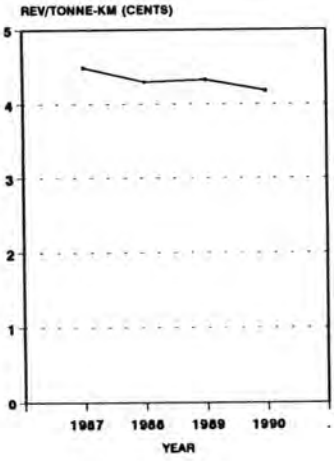
Total Class I rail tonnage of woodpulp from Alberta to the U.S. has increased at an average annual rate of 8 per cent since 1987. Main gateways are Ontario, Manitoba, Quebec and British Columbia. An analysis of the traffic by destination and gateway suggests that the rule of shortest route was applied, e.g., traffic to the western states moved through B.C., to north-east states through Ontario and Quebec, and exports to north-central state were moved through Manitoba and Ontario. The average length of haul remained largely unchanged. There has been little variation in both rates and Canadian revenue shares (Figure 5).

(5) Woodpulp from Nova Scotia

FIGURE 3
NEWSPRINT FROM QUEBEC TO U.S.
1987 -1990







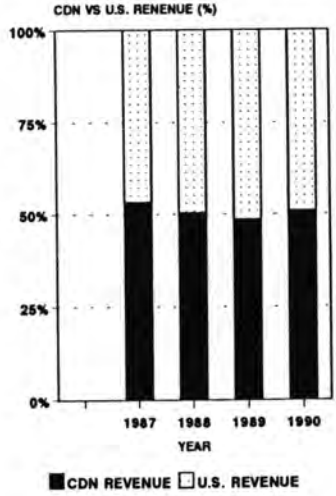
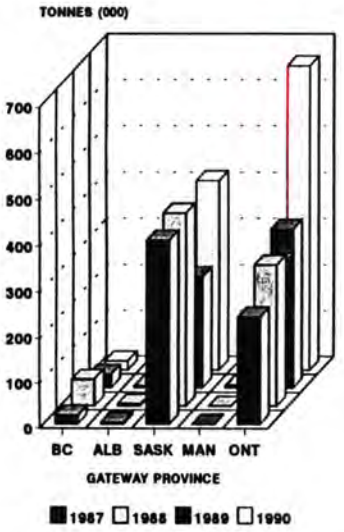
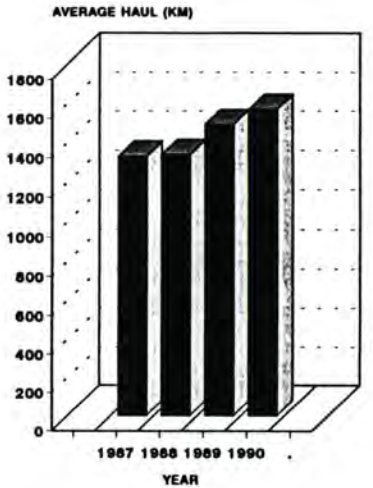
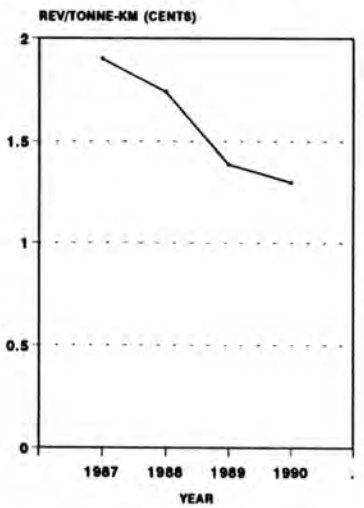


FIGURE 4
SULPHUR FROM ALBERTA TO U.S.
1987 -1990







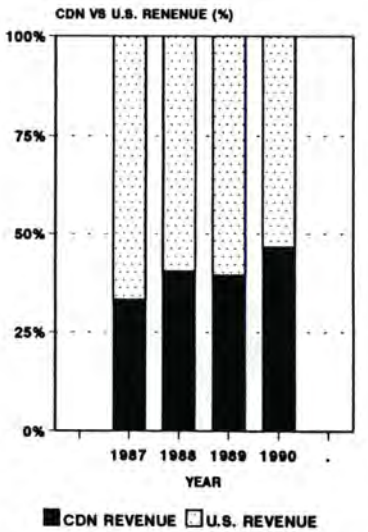
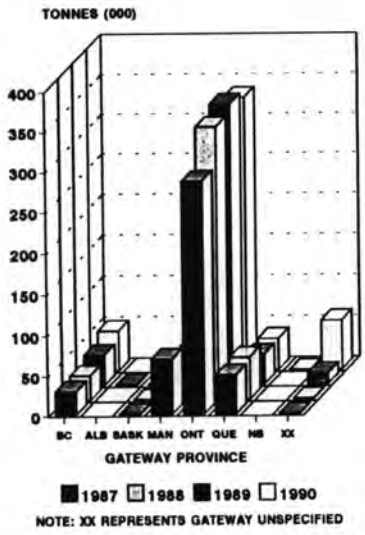
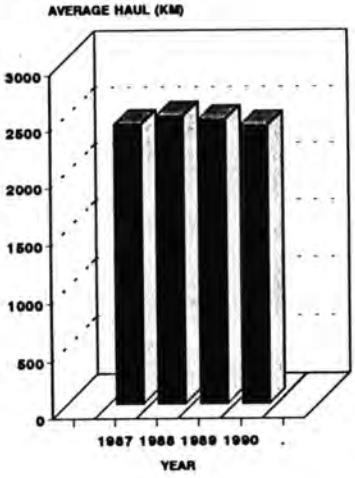
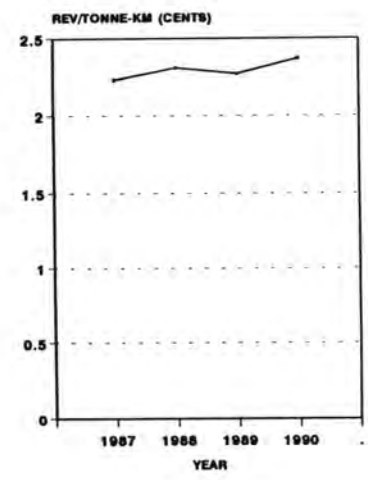


FIGURE 5
WOODPULP FROM ALBERTA TO U.S.
1987 - 1990







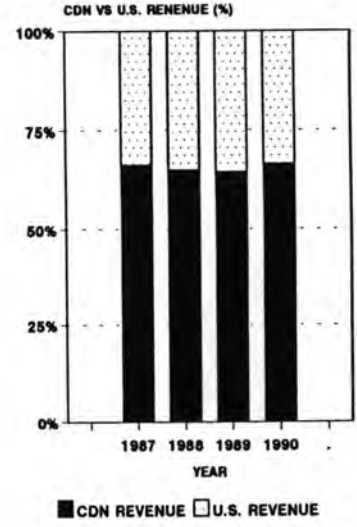
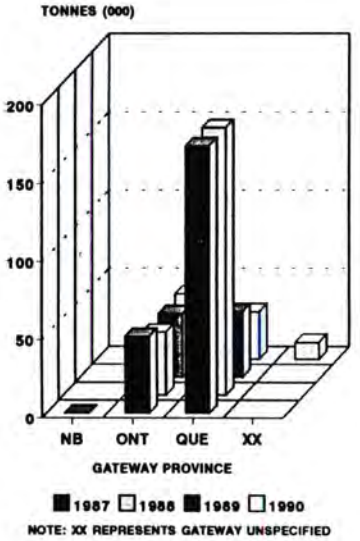
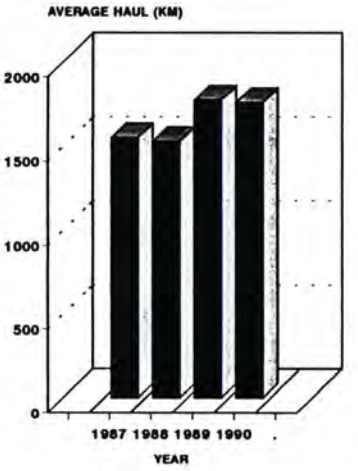
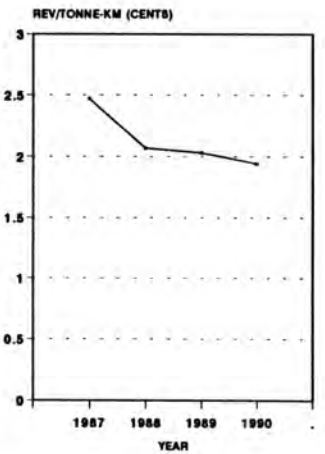
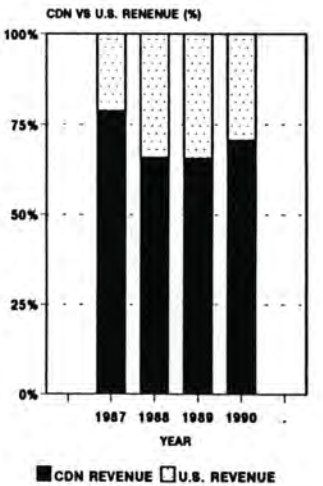


FIGURE 6
WOODPULP FROM NOVA SCOTIA TO U.S.
1987 - 1990









Woodpulp shipments from Nova Scotia involve a relatively small volume and the main destinations are in the U.S. north-east, central and southern states. Although there are year to year changes in traffic, no notable change in gateway is confirmed in the analysis. All woodpulp from Nova Scotia to north-east states were exported through gateways in Quebec and those destined for north-central states were exported through Ontario. In 1989, there was a sharp drop in traffic through Quebec due to a reduction in exports by rail. Consequently, the average length of haul increased because of changes in the relative traffic volume between Quebec and Ontario. Both rates and Canadian carriers' revenue shares have decreased since 1987. However, while the rate continues its decline in 1990, the Canadian revenue share seems to have improved (Figure 6).

In summary, based on data available, the results of gateway and traffic analysis indicate that there have not been any significant changes in rail routes or gateways. Average length of haul within Canada has increased slightly since 1987. Canadian carriers' shares of revenue remain at about the same level as in 1987, however, average revenue per tonne-kilometre has generally been reduced.

IV. CONCLUSIONS

The transborder traffic represents about 23 per cent of total rail tonnage and contributes to about 21 per cent of total revenue of Class I railways. Transborder movements of the fabricated materials, end products and intermodal traffic contribute significantly to total rail freight of these commodity groups.

From the east-west and north-south traffic analysis, it is found that the transborder traffic segment has been growing faster than domestic rail movements since 1984, especially during the 1988-1990 period. Some notable changes in trends are found between the pre and after FTA periods. For instance, the transborder northbound traffic to the Atlantic, Prairie and Pacific regions grew much faster in the later period compared with the earlier ones; on the other hand, east-west traffic originated in both the Central and Prairie regions have declined significantly in recent years despite some upward trends in the earlier period. Moreover, in some cases, the declines in domestic east-west rail traffic are contrasted by increases in transborder traffic. For instance, the drop in domestic movements of the Food group was contrasted by increased northbound transborder movements; also, there were sharp increases in northbound rail movements of group IV, Fabricated Materials to the Prairie region which was contrasted by traffic declines from the Central region.

However, these changes in traffic patterns can not be all attributed to the FTA because other factors including competition from other modes, domestic production, overseas trade, competition between ports, etc., also affect rail commodity flows. In fact, it is probably too early to draw any conclusion from the above data since the FTA was only implemented in 1989 and tariffs on some commodities will be eliminated gradually; for example, tariffs on most agriculture products will be eliminated over a ten year period.

In the transborder gateway analysis, available rail freight statistics fail to provide clear evidence of major shorthauling activities within Canada by U.S. railways despite the fact that Competitive Access provisions allows them more access to Canadian transborder traffic. One possible reason is that the ability to enter into Confidential Contracts with shippers has increased Canadian railways competitiveness against U.S. railways on transborder traffic, thus, lessened the effect of Competitive Access.

Further research is required to monitor trends in the traffic flow patterns. Instead of using the data of one mode, these studies should include all modes of freight transportation. Furthermore, it may be desirable to separate the true domestic traffic from domestic movements of exports and imports, and to exclude commodity groups not greatly affected by the Free Trade Agreement, for instance, the grain traffic.

REFERENCES

(1) "U.S. and Canadian Railway Industry Economic and Regulatory Frameworks: Implications for Railway productivity and Competitiveness", Peat Marwick Management Consultants, February 1987.

(2) Note: This paper covers only certain sections of the research report entitled "Transborder Rail Freight Transportation" which will soon be published by the Economic Analysis Directorate of Transport Canada. In addition to the data/issues dealt with in the present paper, the full report also covers an analysis of Canada-U.S. trade by mode in terms of trade values, detailed analysis of trends in both domestic and transborder freight traffic and competition between rail and truck.

Regional Economic Development and Transportation: Transportation as a Competitive Factor in Atlantic Canada

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University of New Brunswick

1. INTRODUCTION

The objectives of this study include an assessment of competitive freight rates, freight subsidies, and the level of transportation infrastructure on regional economic development in Atlantic Canada. More specifically, whether government expenditures on freight subsidies and infrastructure affect the competitiveness of local industry. The study reviewed classical economic concepts on transportation in the location of economic activity and examined contemporary thought on to the competitiveness of regional industry. The historical and contemporary economic and transportation environments were examined to consider transportation policy in these contexts. Two recent works on the role of transportation factors in regional economic development in the Atlantic Provinces were examined and a new direction for research on transportation and competitiveness was determined.

2. A NEW FRAMEWORK

While the study of the role of transportation in the location of economic activity was once considered a proxy for studying the impact of transportation on industrial development, this study examined transportation in light of a new paradigm explaining regional prosperity. The new paradigm argues that for regions or nations to be competitive in today's global economy, they must operate in an environment which encourages and facilitates innovation and upgrading.

Classical theory espoused the importance of locating to reduce transportation costs. Freight subsidies designed to reduce transportation costs have been used as regional economic development tool. However, in today's globalized trading environment, competitive advantages stemming solely from low transportation costs on inputs and outputs are precarious. Such advantages are difficult to sustain when new competitors emerge or current competitors upgrade and innovate.

The past decade has witnessed considerable changes in the global trading environment and growing concerns about deficit reduction. The Atlantic Provinces Economic Council has emphasized the importance of increased export-orientation, self-

sufficiency, and innovation and upgrading within the region (APEC, 1987). National transport policy has shifted towards greater reliance on competition and a more efficient allocation of scarce resources. The transportation environment of the Atlantic Region has seen increases in competition, rationalization of the rail network, and greater restraint on government expenditures on transportation. The operating environment for firms has changed significantly. Firms have had to keep pace with new threats and opportunities posed by increasingly globalized trade, revolutionary technological innovations, international political developments, and so on.

The role of transportation to firms has changed as well. Transportation has become more integrated into the production process. Timely, efficient distribution processes can help to improve customer service, increase production flexibility, enable reductions in inventories, provide access to diverse inputs, and so on. However, such things as timeliness and reliability of service as well as loss and damage reduction depend on well-maintained infrastructure. For these reasons, the deteriorating condition of the regional highway system is of particular concern.

In terms of infrastructure, in the past, development and expansion has been the primary focus for economic development purposes. With most of the regional infrastructure now in place, rehabilitation and upgrading of existing facilities have become more important. It should be noted that the effects of infrastructure investment depend on the type of investment and the economic conditions of the region. In regions with good economic growth potential, but with a poor transportation system, investment in infrastructure may promote industrial expansion. Alternatively, in high economic growth regions, transportation improvements can reduce bottlenecks that may retard expansion.

In light of these changes, the role of transportation in regional economic development has shifted. As funds available for transportation expenditures become more limited, the selection of appropriate transportation policy instruments is becoming increasingly important.

3. TRANSPORTATION SUBSIDES IN ATLANTIC CANADA

As part of this research, an analysis of current federal transportation expenditures and subsidies was conducted. The findings show that Atlantic Canada has not received a consistent share of expenditures and subsidies. In almost all cases, in both current and constant dollar terms, the expenditures and subsidies in Atlantic Canada have decreased relative to those provided in the rest of the country.

In terms of provincial transportation expenditures, Atlantic Canadian provinces have maintained a relatively stable proportion of all provincial expenditures. On the other hand, although all of the Canadian provinces have maintained a steady expenditure pattern in the latter part of the 1980's, in constant dollar terms, their expenditure levels actually decreased. This has occurred at a time when the federal

government's contributions to the transportation industry both in terms of expenditures and subsidies have also decreased in constant dollar terms.

In this study, the term "subsidy" is limited to assistance for the movement of freight. A brief overview of the nature of the major freight subsidies available in the Atlantic Provinces is provided below.

At and East Grain and Flour Subsidy

The "At and East" subsidy was implemented in the mid-1960's to ensure that Eastern Canadian ports could compete with US ports. The subsidy further ensured the ports of St. John and Halifax would be able to effectively compete with other Canadian ports on the St. Lawrence River. The At and East subsidy compensated the railways for maintaining their freight rates at less than compensatory levels for eligible export grain and flour shipments. This subsidy was discontinued in 1989.

Feed Freight Assistance Subsidy (FFA)

This freight assistance program was introduced in 1941 to provided a wartime market outlet for western grain and to encourage livestock production east of Thunder Bay and in British Columbia. In 1966, the FFA was embodied in permanent federal legislation and has undergone several modifications. The FFA subsidy is paid directly to feed grain recipients in eligible areas.

Maritime Freight Rates Act (MFRA) and Atlantic Region Freight Assistance Act (ARFAA)

The MFRA subsidy was first implemented 1927. It required the railways to reduce certain rates on traffic within the Maritime territory and on traffic moving westbound from the region by 20 percent. The initial Maritime territory includes the three Maritime Provinces and the region of Quebec located east of Levis and south of the St. Lawrence River. In 1949, the Island of Newfoundland became part of the MFRA territory. In 1957, the westbound subsidy was increased to 30 percent. The ARFAA subsidy was introduced in 1969. Under this subsidy program, truckers became eligible for the same level of assistance as the railways on westbound traffic.

Following various modifications, the present MFRA/ARFAA subsidy exists in three forms. Under the "Intra" subsidy, the National Transportation Agency (NTA) reimburses for-hire carriers for their provision of a 10 percent reduction in their rates on shipments with a minimum billing of $50. The Intra subsidy applies to an approved list of goods which have been manufactured or produced in the region carried on all modes of transportation.

The "Basic Westbound" subsidy provides a 30 percent reduction on all westbound traffic based on the proportion of distance in the "select territory" (ie. the initial Maritime territory and the island of Newfoundland). The Basic Westbound

subsidy applies only to for-hire truck and rail carriers.

The "Selective Westbound" subsidy provides an additional 20 percent reduction for an approved list of commodities. This subsidy applies to shipments with a minimum billing of $100 carried by for-hire truck or rail (APTC, 1988).

The MFRA/ARFAA subsidies were of primary concern in this study. The At and East subsidy has been discontinued and the FFA subsidy reflects agricultural policy rather than transport policy per se. Howard Darling (1980), describes the historical origins of the MFRA/ARFAA freight subsidies. His study dispels the persistent contention that freight subsidies were a right afforded to the Maritimes as a condition of Confederation or that they were able to present a decisive solution to the region's economic problems.

4. TRANSPORTATION FACTORS IN ATLANTIC CANADA

Two recent studies of transportation in economic development provide information about the importance of transportation subsidies and infrastructure to the region. In 1982, Holyoke examined the Impact of Transportation on Industrial Development in the Atlantic Provinces. He studied 95 firms in four manufacturing sub-sectors in the region and found that the proximity of raw materials, location of residence of the owner or manager, and proximity to markets were the three most important reasons for locating plants in the region. In terms of transportation, access to road transportation was identified as being the next most important factor. Access to other modes ranked lower. The existence of subsidized transportation rates was ranked twelfth out of thirteen factors. This led to the conclusion that transportation was not the only factor which attracted industry to the region. Within transportation factors, access to highways was considered most important by firms within the region.

Holyoke also studied factors which deterred firms located in Central Canada from locating in the Atlantic Region. Each location factor was assigned an "Impact Rating" that measured its ability to attract new manufacturing industry to the region. Accessibility of highways was considered to be important to firms in both Central and Atlantic regions. Rail, air, and water transport infrastructure were perceived to be sufficient. However, Holyoke concluded that with the exception of the attractiveness of good port facilities and year-round marine service to export-oriented firms, these factors would not be either attractive nor detrimental in drawing new industry to the region.

Holyoke's findings indicated that once a sufficient level of infrastructure is in place, expansion is unlikely to attract new industry. Instead, public expenditure should be used to maintain and manage existing infrastructure, especially highways. If a factor is allowed to degrade or is not maintained at least at its existing level in the Atlantic Region, it may well become a detrimental factor. In terms of transportation freight rates, Central Canadian firms placed a high importance on freight rates charged and

ranked the availablity of reasonable transportation rates in the Atlantic Region as low. Holyoke cautions that this does not imply that freight rates are punitively higher in Atlantic Canada, but that they are perceived to be unreasonable and the negative perception may have an impact on the industrial development of the region.

Holyoke concluded that existing subsidies are not sufficient to attract industry to the region, however he cautioned that this does not imply that subsidies are not important for cost decreases and aid for competing with industries in other regions.

In 1983, James F. Hickling Management Consultants Ltd. was commissioned by the federal government to conduct a study to provide estimates of the potential impacts of subsidy removal on shippers, carriers, and third parties in the Atlantic Region.

A sample of 43 commodities representing the top 20 users under the Intra and Westbound programs was selected for the study. A total of 71 carriers and shippers in the region were surveyed. Estimates of the impact of the removal of these subsidies was based on whether a subsidy loss would be absorbed or passed on to customers. The impact of subsidy removal varied according to the subsidy in question and between industries. Hickling concluded that if the Intra subsidy was completely removed, under the worst-case scenario, some 5400 jobs would be lost and profits would decline as much as 3 to 5 percent. The complete removal of the Westbound subsidy could cost 6700 jobs and profit losses of 2 to 5 percent.

The Hickling study concluded that over time carriers would pass on the subsidy loss to shippers. Shippers would then be faced with the option of passing on the subsidy loss to customers or absorbing it. The impact of subsidy removal may not be as severe as Hickling predicted. Most carriers reported that they would pass on subsidy losses to shippers. However, the study did not determine whether carriers would increase rates on higher value headhaul movements or on more transportation cost sensitive backhaul (westbound) shipments. Subsidy removal may pressure shippers and carriers to develop innovative transport service concepts.

In light of changes in the region's economic and transportation environments, such as the implementation of the Free Trade Agreement (FTA) and transportation regulatory reform, since the completion of the Hickling study, the effects of subsidy removal may well be different today than in 1983. Moreover, radical new ideas have emerged concerning overall regional productivity and competitiveness. The elimination of subsidies could have positive effects in the long term. The innovation and upgrading of Atlantic Region firms that subsidy removal might initiate could lead to more sustainable competitive advantages in certain industrial sectors.

5. DIRECTIONS FOR NEW RESEARCH

Holyoke's study used industrial location as a proxy for economic development. Factors important in initial location decisions may become more or less important to firms in terms of their current operating environment. Holyoke's study was completed a decade ago. The factors included in his study may have changed in importance to firms since them.

New theories about economic development suggest that in today's increasingly global environment, regional prosperity depends on the ability of regions to support competitive industries. Therefore, to examine the role of transportation factors in the economic development of the region in a contemporary setting, the role of location factors as they affect competitiveness must be the focus.

The effect of transportation on competitiveness in the goods-producing industries in the Atlantic Provinces was considered by Hickling. The Hickling study considered the effect of transportation costs and subsidies on the competitiveness and profitability of firms in the region. However, the study did not provide evidence of the importance of transportation subsidies relative to other competitive or transportation-related factors.

In summary, the role of transportation in overall industrial competitiveness in the Atlantic Region must be carefully considered. From this context, the validity of the assumption that government transportation expenditures can improve the economic development of the region needs to can be examined in the light of their impact on competitiveness. In addition, policy makers can discern the factors most likely to affect the competitiveness of firms within the region. It is this analysis which serves as the focus of this study.

6. THE RESEARCH

The primary objective of this research was to gather information about the importance of transportation factors to the competitive position of firms in each of the four Atlantic Provinces in the five goods-producing sectors: fisheries (fish processors), mining, agriculture, primary forestry, and manufacturing. To facilitate the research, a questionnaire was designed and responses were collected through telephone interviews from a sample of 188 firms located in the region.

To allow a comparison of results by sector, a minimum sample of ten firms in each sector were targeted in each province. The mining, agriculture and manufacturing sectors were divided into sub-sectors representing the most important commodities in each sector in each province. In addition, firms within each sector were also categorized by size so that large firms which have a significant impact on the economy, as well as those representing the "average" firm, would be equally represented. To determine the significance of transportation factors in terms of the competitiveness of

firms, the importance of fourteen competitive factors were rated by each sampled firm. Six transportation factors were included among the competitive factors.

A Location Factor Preference Indices Model (FPIM) analysis (developed earlier by Holyoke) was adapted for evaluating the importance of transportation relative to other competitive factors within the Atlantic region. The model was designed to assess various factors affecting industrial plant location decisions. The FPIM was adopted for use in analyzing the data collected in this study because it provides a method for objectively measuring subjective ratings of individual factors within a group of factors. By identifying factors that are important to competitiveness, appropriate policies can be developed promoting industrial competitiveness within a region.

Supplementary information was also gathered concerning origins and destinations of shipments, transportation costs, relative importance of transportation costs to the profitability of regional firms, and significance of regional freight subsidies provided as a government financial assistance program. Overall a total of 188 responses were received encompassing a total of 391 commodities and 279 inputs.

Major findings of the survey are highlighted below.

Location of Inputs and Outputs

The Atlantic Region was the primary immediate destination of shipments by regional firms. Export markets in the US and overseas were the second and third most common destination. Central Canadian markets were the fourth most common destination, followed by Western Canada. These market areas represented the immediate destination of shipments. The Atlantic Region was the predominant source of inputs. This represents the location each firm's immediate suppliers. The final market or the origin of supplies for certain products may differ from the immediate destination or source.

This information contradicts the perception that regional producers are primarily dependent on Central Canadian markets. In fact, the Atlantic Region is well situated to serve US and overseas markets and as the trading environment becomes increasingly globalized, these markets may continue to grow in importance to the region.

Modal Choice

Truck is the predominant mode of transportation for inputs, outputs and as a component of intermodal transportation. Water was second most common and with rail, air, and pipeline following. The growing importance of truck transportation reflects: trends in distribution practices favouring timeliness, maintenance of high product quality, flexibility, and high levels of service; as well as extensive regional rail line abandonment. The importance of maintaining roads supporting high service demands, and heavier commodities once carried by rail, is emerging as a serious regional concern.

Transportation Costs

Transportation cost data were collected for 62 percent of inputs and 70 percent of outputs allowing some limited observations to be made concerning transportation costs. Transportation tended to be a significant component of the cost of feed and of forest products used as inputs in the manufacturing sector. Transportation costs also tended to be a significant component of the delivered price of forest products, mined structural materials and potatoes. Transportation costs were a lower portion of the price of processed fish and agricultural products besides potatoes.

To supplement these findings, firms were asked to rank transportation costs among seven profitability factors. The results indicated that overall, in each sector, at least two other cost factors were more important than the cost of transportation within the region. One exception was the forestry sector where only wage rates appeared to be slightly more important than transportation costs within the region. Overall, in each sector, at least four factors appeared to be more important than transportation costs to Central Canada. (Although transportation costs to Central Canada remained particularly important to potato producers).

This is not to say that transportation costs are not important. In fact, they may be paramount to certain firms, especially in the primary forestry sector. However, these results provide evidence that, overall, other factors are more important to the profitability of regional firms than transportation costs.

Competitive Factors

The importance of transportation factors to firms in the Atlantic region was examined by having firms rate six transportation factors among fourteen factors which affect competitiveness. The results, as analyzed using the FPIM method, indicate that competitive transportation rates are important to the competitiveness of regional firms. Highway transportation was also important. Water, rail and air were less important. Freight subsidies were high in overall importance in only two sectors: agriculture and forestry.

The results suggest that since regulatory reform, the competitive position of firms has benefited from their ability to negotiate competitive rates. As distribution practices change, and rail line abandonment continues, access to highway transportation has increased in importance to the competitiveness of firms. However, deteriorating road conditions may adversely affect the competitive positions of regional firms by restricting service levels, reducing product quality, and preventing access to certain markets.

Transportation subsidies did not emerge as important competitive factors except in the agriculture and forestry sectors. In the agriculture sector, the FFA was of primary concern. However, the MFRA and ARFAA subsidies were also particularly important to producers of potatoes and forest products who face high transportation

costs.

Modes of transportation, besides highways, were not high in overall importance. However, their importance to certain firms indicates that deterioration of these services could result in competitive disadvantages, in some cases.

Government Financial Assistance Programs

Firms were asked to rank the MFRA and ARFAA subsidies in relation to their importance among government financial assistance programs. The results indicated that, overall, although the MFRA / ARFAA subsidies may be among the only sources of financial assistance, they are not currently perceived to be the most important form of financial assistance for regional firms. An exception is the forestry sector in which subsidies were perceived to be a very important source of assistance by the majority of firms.

Overall, these results suggest that the current economic and transportation environments do not reflect traditional viewpoints which emphasize the importance of Central Canadian markets, transportation costs, and freight subsidies.

7. POLICY IMPLICATIONS

The theoretical and empirical findings of this study suggest new directions for government expenditures on transportation as it pertains to economic development.

Arguments have been advanced in favour of maintaining the subsidy program for constitutional or economic development reasons. According Darling (1980), the belief that the subsidies are based on Constitutional obligations is unfounded. The findings of this study demonstrate that the current transportation subsidy program may not be the most effective or efficient economic development instrument.

The subsidy programs appear to conflict with current priorities concerning economic development in Atlantic Canada. By relying on subsidies, firms may not feel pressure to innovate and upgrade. If they are not developing more sustainable competitive advantages, firms become vulnerable to the threat of new or current competitors developing capabilities to undercut prices or to render current products obsolete. Similarly, the subsidy programs may interfere with new government initiatives aimed at encouraging trade with the US. Providing an incentive for a Central Canadian market orientation appears in conflict with the need to stimulate north-south trade. In addition, the subsidies may be perceived by trading partners to provide unfair advantages to local firms.

In the face of increasingly scarce government financial resources, the need for the regional industry to become more self-sufficient is increasing in importance. The subsidy program is not harmonious with promoting self-sufficiency. Also, subsidies

were not meant to apply to goods transported by vehicles belonging to a firm. Evidence indicates that this principle has been circumvented by certain firms. These practices can lead to potential abuses of the subsidy program because firms may charge unduly high freight rates on subsidized movements to maximize subsidy benefits.

Since subsidies are not perceived to be important to the competitive position of regional industry, it may be argued that subsidy levels are not sufficiently high to improve their competitive position. However, the findings of this study suggest that an increase in subsidies may further deter logistical and transportation innovation in the region.

Certainly, its low rating overall as a competitive factor does not suggest that subsidies are "vital" to regional competitiveness. According to the analysis of competitive factors, subsidies are perceived to be less important to firms (except in the agriculture sector) than highways in terms of competitiveness. Continued subsidies may actually impede long term competitiveness by diverting funds which could be used to improve highways, thus reducing bottlenecks to productivity growth and improving access to certain markets.

The general consensus by regional firms of the competitive importance of highways implies that firms will be supportive of investment in this direction. This has already been demonstrated by acceptance of decreased subsidy levels in exchange for securing compensations for the region through a five year Federal/Provincial cost sharing agreement on highway improvements. However, this will mean trade-offs which may present significant challenges for certain firms. Careful consideration must be given to mitigating the impacts of subsidy removal on the regional economy.

Freight subsidies were rated highly as competitive factors in the agriculture sector and the forestry sector. During the process of collecting information, it became apparent that the role of transportation costs in these sectors is influenced by a number of factors. These include: marketing boards; supply management policies; the terms of customer purchasing arrangements; ownership of transportation carriers in the forestry sector; the importance of the MFRA / ARFAA subsidies as distinguished from freight assistance which reflects agricultural policy; variations in the importance of subsidies to different agricultural products; and so on. What is apparent is that an in-depth examination of these two sectors is needed to more accurately determine the significance of competitive freight rates and freight subsidies. Certain commodities must also be considered in light of their role as inputs for other industries. Other national interests beyond productivity growth may justify government support for certain industries. However, the role of transportation policy, and whether transportation policy instruments are appropriate in any or all cases must be carefully considered.

In summary, the transportation sector, like other sectors, has a limited pool of financial resources. Transportation expenditures should be considered in terms of their cost effectiveness to ensure that there are not other ways to achieve a greater impact

for the same effort. The results of this study provide preliminary evidence that in the face of necessary trade-offs between upgrading infrastructure or subsidizing transportation rates, the importance of infrastructure to regional competitiveness is paramount.

8. FINAL NOTE

The subsidy program was introduced in the early 1900's to correct the inequity resulting from the existence of higher freight rates in the Atlantic region compared to Central Canada. Evidence suggests that, in today's environment, inequity is not as significant. However, the introduction of regulatory reform has introduced concerns about other kinds of inequities, which the current subsidy program does not address, such as lower freight rates enjoyed by large volume shippers or higher rates experienced by shippers located in remote areas. The nature and extent of these inequities, and an appropriate direction, if any, for government intervention should be the focus of future research.

REFERENCES

APEC, 1987, "Free Trade and Atlantic Canada: Background and Results of an Impact Study", Atlantic Report, XXII:2, Atlantic Provinces Economic Commission, Halifax, N.S.

APTC, 1988, Atlantic Region Freight Assistance Program, Atlantic Provinces Transportation Commission, Moncton, N.B.

Darling, H., 1980, The Politics of Freight Rates: The Railway Freight Issue in Canada, McLelland and Stewart Limited, Toronto, Ont.

Hickling, James G, Management Consultants Ltd., 1983, The Impact of Freight Transportation Subsidies Under the Maritime Freight Rates Act and the Atlantic Regional Freight Rate Assistance Act, Transport Canada, Ottawa, Ont.

Holyoke, T.R., 1982, "The Impact of Transportation on Industrial Development in Atlantic Canada - An Empirical Analysis Using Location Factor Preferences Indices Model", MScE Thesis, The Transportation Group, University of New Brunswick, Fredericton, N.B.

INTEGRATED TRANSPORTATION AND LAND USE MODELLING A KEY FOR ACHIEVING BRAMPTON'S GROWTH AND DEVELOPMENT FUTURE

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INTRODUCTION

The City of Brampton is a fast growing suburban community continuing the transition from being Canada's best known dormitory "new town" to a fully functioning City within a rapidly changing urban region.

At the present time, a major challenge that faces any growing community in Canada is maintaining growth with constantly decreasing Federal and Provincial expenditures for transportation servicing. Not only it is incredibly difficult for rapidly growing municipalities to build transportation projects quickly enough to keep pace with development, but it may not be desirable to do so.

Traditional Urban Transportation Planning processes involve identifying and protecting corridors for future transportation facilities for a defined future development scenario. However, this approach is not sufficient, by itself, for today's fast growing communities. Instead, strong project planning and a prioritization process, integrating Land use Planning with Transportation Planning, is the key for achieving growth while maintaining a healthy economy in a balanced community.

As part of a 30 year official plan review process, the transportation study component was required to evaluate several development scenarios and recommend a preferred scenario from a transportation efficiency and costs perspective. Other component studies such as Environmental and Natural resources, Sewer and Water servicing would also be used to evaluate the development and growth options. The final recommended development option would be the most efficient and affordable growth scenario. The recommended development option would determine the future of the City of Brampton in a fast growing competitive region.

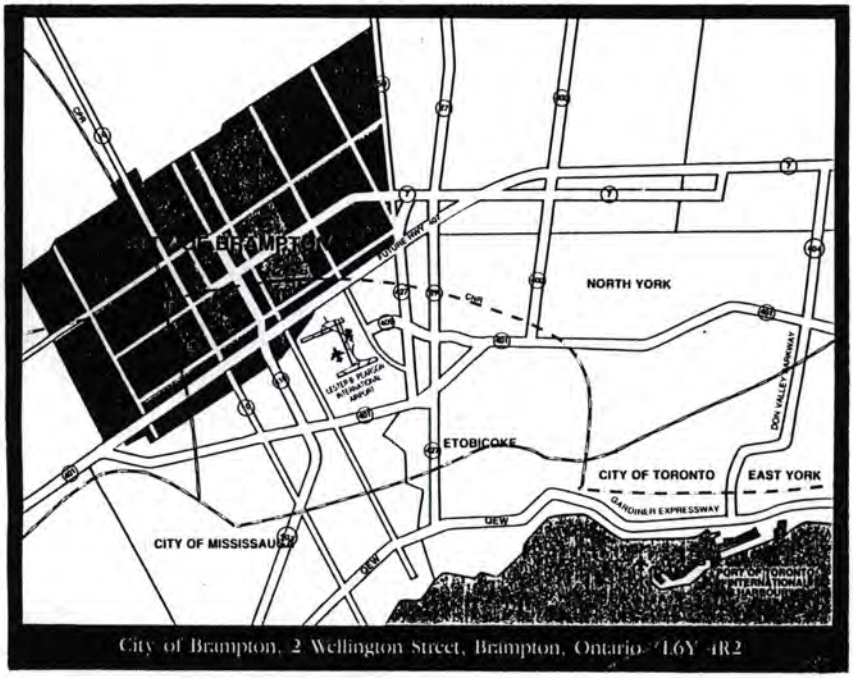
This paper summarizes from a transportation servicing perspective the land use and transportation modelling used to evaluate various growth and development options for the City of Brampton.

GROWTH OPPORTUNITIES AND CONSTRAINTS

Figure 1 shows the City of Brampton location relative to the Greater Toronto Area as a whole. The City is located near several major highways and expressways (Highway 7, Highway 50, Highway 410, Highway 427 and the future Highway 407) and the Lester B. Pearson International Airport. Given the presence of these facilities, various nodes within the City possess exceptional locational advantages.

Due to its favourable geographic location, the City of Brampton has experienced a rapid rate of urban growth in the past ten years. Brampton's population grew from 150,000 in 1981 to an estimated

FIGURE 1
CITY OF BRAMPTON LOCATION IN THE GREATER TORONTO AREA



236,000 in 1991 representing an 8.8% annual growth rate. The employment base grew from 61,000 in 1981 to 97,000 in 1991. The significant economic progress of the City of Brampton in the past decade is reasonably expected to continue. Based on historical growth rates, the City of Brampton is expected to grow to approximately 500,000 people and 235,000 employees by the year 2021.

With the City of Brampton continuing to develop rapidly, the existing approved urban development lands are rapidly being depleted. The supply of single family houses and town houses is expected to be utilized by the year 2000. The supply of general industrial employment lands is also expected to be fully utilized by the year 2006. This implies that the existing Official Plan is expected to reach its mature state within 10 to 15 years.

The fast economic growth of the City of Brampton resulted in higher levels of traffic growth, overcrowding of school facilities and similar problems. This resulted in growth management policies which developed from a complete residential development freeze in 1990 to a development phasing strategy in 1991. Recognizing the importance of long range planning, the City of Brampton initiated a 30 year official plan review that will determine the future growth potential for the City.

INTEGRATED PLANNING APPROACH

The Brampton official plan review process was broken into several component studies as a practical means of addressing environmental, land use, servicing, transportation, economic, housing and other disparate considerations that should be investigated in a long range official plan. Each component study is an integral part of the planning process used. A flow chart of the various components of the integrated planning approach is shown on Figure 2. The initial stages of the process are represented by "Vision Building" and initial results from the Economic-Land use model. "Vision Building" was defined through input from City Council, Staff, Brampton Citizens and Developers through a series of workshops and surveys.

The economic model projected the labour force demand and population and compared them to the labour force supply and population generated using the "Cohort-Survival" method.

With the resulting population and employment growth forecasted over the next 30 years, the City of Brampton was faced with a combination of the following three options:

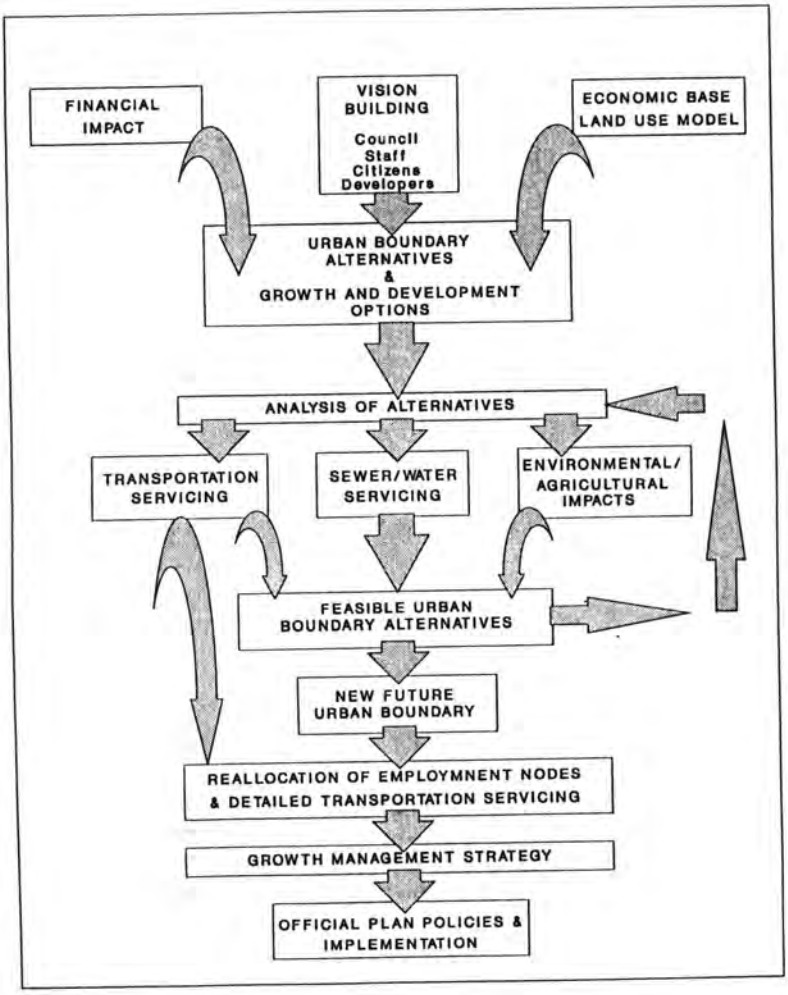
- Increase public facilities and services;
- Restrict Growth;
- Accept a lower quality of life.

Three different growth targets were considered:

- Low Growth: Intensification within the existing Urban Boundary (390,000 people);

FIGURE 2

INTEGRATED PLANNING APPROACH



- Medium Growth: Intensification plus expansion of urban boundaries (489,000 people based on historical growth);

- High Growth: Intensification plus expansion of urban boundaries (550,000 people based on highest possible growth resulting from economic models).

In addition, the following three development densities were considered for future residential development areas:

- Low Density: 8 units per acre net residential density;

- Medium Density: 12 upa net residential density (similar to existing average density in the latest major Secondary Plan);

- High Density: 16 upa net residential density.

Another major consideration in the Official Plan Review was the geographic location of future development. Various options were represented by expansion of the existing urban boundary to the East, North and West (Figure 3). Accordingly, 60 various options were developed which represented different combinations of population growth, densities, and geographic locations. Figure 4 shows one growth scenario with medium growth and 12 upa density. A preliminary evaluation and assessment of the various development options was undertaken in order to determine acceptable growth and density targets. This reduced the available growth options into a smaller set of feasible options that would be subject to further detailed analysis.

The environmental and agricultural component studies utilized Geographic Information System (GIS) mapping to evaluate the Impact of the various urban boundary alternatives. Sewer and Water servicing costs were used to compare alternatives. The transportation servicing analysis was based on transportation evaluation measurements that were estimated using a comprehensive transportation planning model which utilized the EMME/2 software. The transportation servicing component study is summarized in the following section.

TRANSPORTATION PLANNING COMPONENT

The Brampton Official Plan Review Transportation study is a major component of the overall official plan review process. This study provides input into several component studies, but also requires more detailed input from other component studies such as Population, Housing and Employment Land requirements. Accordingly, the study was designed to be undertaken in four phases.

Phase one focused on defining the transportation servicing requirements of the existing official plan. Input into the selection of several appropriate growth and development options for further detailed testing was also provided.

Phase two focused on defining appropriate transportation system

FIGURE 3
OFFICIAL PLAN REVIEW 1991
URBAN BOUNDARY ALTERNATIVES, DIRECTIONAL EMPHASIS

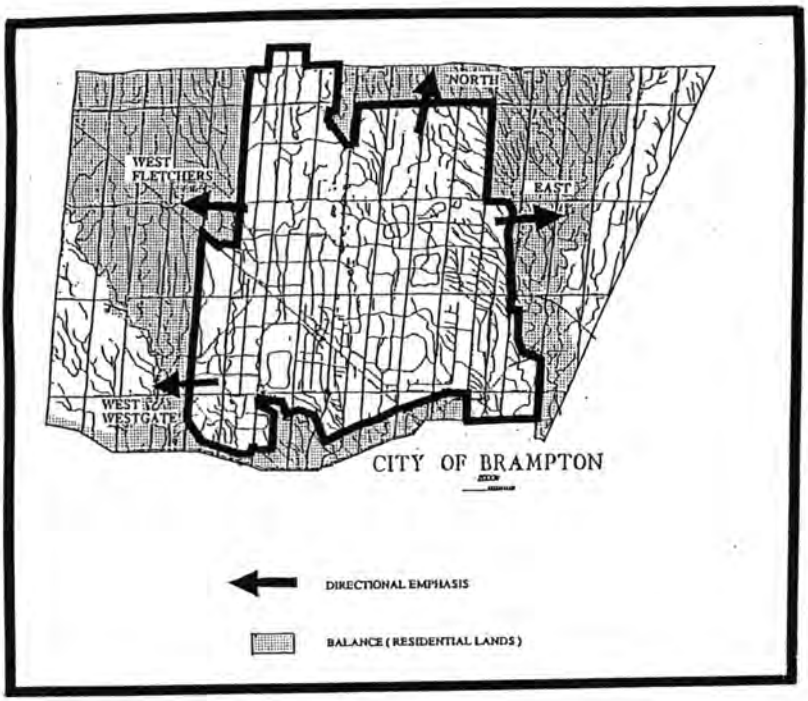
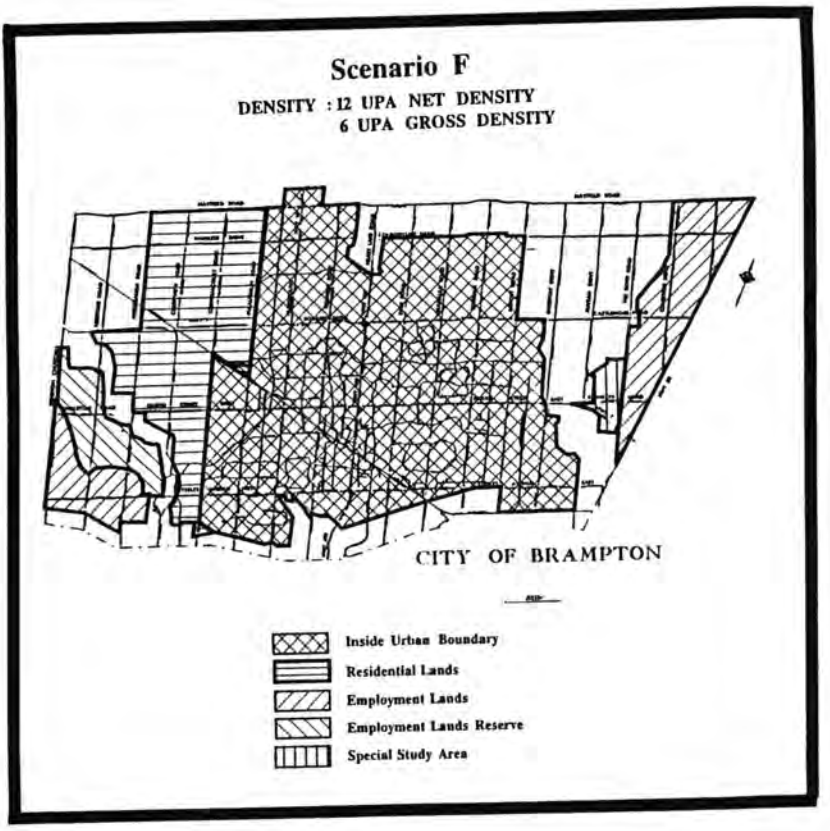


FIGURE 4
OFFICIAL PLAN REVIEW 1991
URBAN BOUNDARY ALTERNATIVE



improvements for servicing each of the selected growth and development options. Evaluation of alternative urban boundary options was a major objective of this phase.

Phase three consists of detailed analysis of the selected development option. This phase defined the detailed mature transportation network including major collector roads and major transit systems and technologies.

Phase four defines the best development phasing strategy and associated timing and costs of the required transportation facilities.

The City of Brampton Transportation Planning Model is a traditional four step transportation planning model utilizing the EMME/2 software. The model was developed and installed on the City's VAX mainframe computer system. The model includes road and transit base networks for most of the greater Toronto area extending from Halton Region in the west to Durham Region in the east, (Figure 5). The trip generation and distribution components of the model were based on the 1986 Transportation Tomorrow Survey for the Greater Toronto Area. The trip distribution component is a gravity distribution model. The trip generation, trip distribution and mode split models were all integrated into the EMME/2 software.

The alternative urban boundary options were evaluated based on transportation servicing criteria for both road and transit systems. The evaluation criteria that were used in the transportation analysis can be aggregated into two general measures:

- o System Capital and Operating Costs; and
- o System Utility and Efficiency measures.

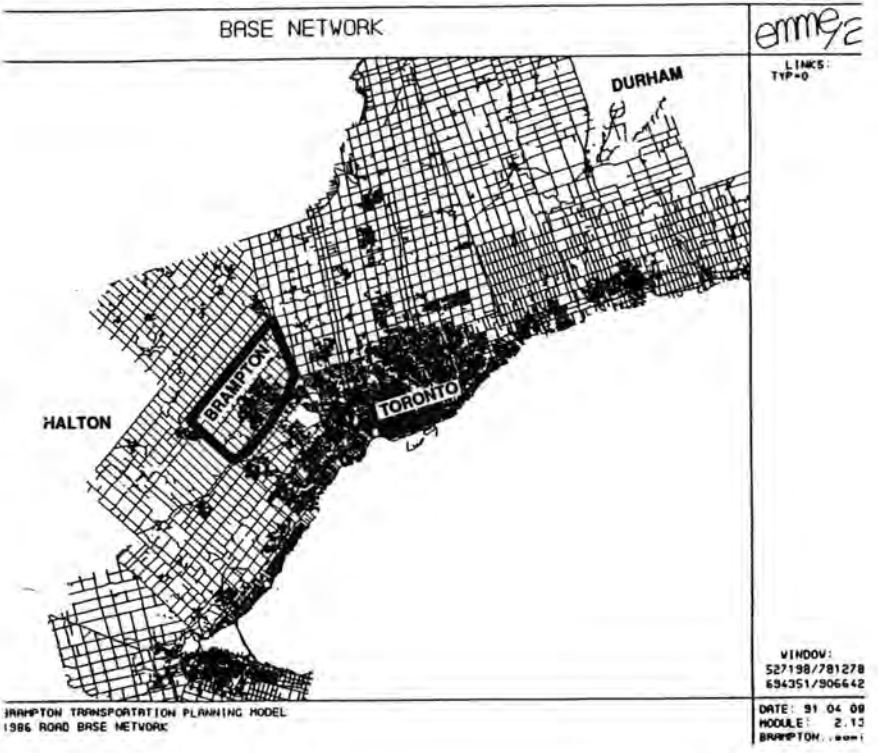
Road and transit system requirements were determined for each of the scenarios considered. Capital road costs were estimated based on the additional number of lanes required (relative to 1991) for all Arterial and Collector roads within Brampton. For each scenario, the road improvements necessary to keep the ratios of traffic volumes to road capacities at or below 1.2 were determined.

Measures of road system utility and efficiency were based on the following factors:

- o Vehicle-Kilometres/Vehicle-Hours of Travel
- o Traffic Volume to Capacity Ratios
- o Average Travel Speed/Travel Time

The transit system requirements were determined for each scenario. Transit routes were extended to serve new development areas. Transit headways were modified in order to accommodate the resulting peak transit ridership for each Brampton Transit route. A new GO Transit Commuter Rail station was proposed at Pleasant (north west of Brampton). Other transit system improvements such as Bus lanes and

FIGURE 5
TRANSPORTATION PLANNING MODEL
ROAD BASE NETWORK



"Full Day" service for GO Transit were also considered. The following criteria were used for comparing the alternative urban boundary scenarios form a transit service perspective:

- Peak Hour Vehicles Required;
- Total Capital Costs;
- Annual Operating Costs;
- Annual Vehicle Kilometres;
- Transit Passengers.

In order to compare the above evaluation measures for the alternative Scenarios, a rating system with five indices was used. The alternative Scenarios were ranked in order of preference with an index value of 5 as the most preferred and an index value of 1 as the least preferred. The following table provides the rating system categories and corresponding index values:

RATING	Index Value
High Rating	4.7 to 5.0
Medium-High Rating	3.9 to 4.6
Medium Rating	3.0 to 3.8
Medium-Low Rating	2.0 to 2.9
Low Rating	1.0 to 1.9

Each urban boundary Scenario was assigned a value Between 1 and 5 for each factor considered. The most favourable scenario was assigned a value of 5.0. The other scenarios were assigned a lower rating based on the value of the factor being considered. This numeric index rating system was considered to be the best method to combine several evaluation measures that were used to arrive at a preferred urban boundary alternative.

A weighted evaluation is presented below representing the overall average rating for the Transportation evaluation measures for six defined scenarios A, C, D, F, G, and I. The weights were selected based on the value of User operating costs in comparison with Capital Costs.

WEIGHTED TRANSPORTATION SYSTEM EVALUATION INDICES

EVALUATION FACTOR	ALTERNATIVE GROWTH SCENARIOS			
	A,C	D,F	G	I
ROAD SYSTEM COSTS WEIGHT= 0.13	5.0	3.0	4.3	4.9
ROAD SYSTEM EFFICIENCY WEIGHT= 0.42	4.1	3.0	5.0	4.4
TRANSIT COSTS WEIGHT= 0.05	5.0	4.3	5.0	4.0
TRANSIT EFFICIENCY WEIGHT= 0.40	4.5	4.0	5.0	4.0
AVERAGE	4.4	3.5	4.9	4.3

The average index values for the transportation evaluation factors for each growth scenario as presented in the above table can be referenced back to the rating system as follows:

High Rating	G
Medium-High Rating	A,C,I
Medium Rating	D,F
Medium-Low rating	
Low Rating	

Accordingly, Scenario G was the preferred urban boundary alternative from a transportation perspective. Other evaluation criteria were also used to evaluate the above scenarios from environmental, agricultural, water and sewer, and other considerations. The final recommended urban boundary alternative was scenario I as shown on Figure 6. This scenario was recommended because its high rating on the environmental and agricultural measures more than counterbalanced its marginally poorer transportation rating. The transportation component study defined the ultimate road and transit system requirements and the associated growth management strategies. Several land use objectives were also defined including:

- intensification of mixed uses within a central commercial corridor (Queen Street/Highway 7); and,
- creation of several gateways to the city that would include high density mixed uses and that would integrate several modes of transportation.

CONCLUSIONS

The Integrated transportation and land use planning approach resulted in an optimum development strategy for the City of Brampton that is affordable and that meets the economic and urban structure objectives of the City.

The various official plan review component studies resulted in several policies that would prevent the scattered, untimely, suburban development that is associated with urban sprawl. Today, the City of Brampton is closer to achieving the vision of a well planned and competitive city within a fast growing urban region.

FIGURE 6
OFFICIAL PLAN REVIEW 1991
URBAN BOUNDARY EXPANSION PROPOSAL



Railway Taxation in Canada: In Search of a Policy

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I. INTRODUCTION

> It is hereby declared that a safe, economic, efficient, and adequate network of viable and effective transportation services making the best use of all available modes of transportation at the lowest total cost is essential to serve the transportation needs of shippers and travellers and to maintain the economic well-being and growth of Canada and its regions and that those objectives are most likely to be achieved when all carriers are able to compete, both within and among the various modes of transportation . . .

This is the current statement of national transportation policy contained in the *National Transportation Act (1987)*. It is an omnibus policy statement which has been criticized as being unworkable due to its inherent contradiction in pursuing a "safe, economic, efficient, and adequate" transportation system, and that these attributes be pursued in a competitive environment. For public policy makers it is important to realize that the competitive environment is global in nature, and not restricted to the geographic boundaries of Canada. Exogenously induced competitive pressures, and the concomitant implications for Canada's competitive position in the world marketplace, is a problem facing all sectoral economies - particularly the Canadian transportation system. As Canadian economic performance has seemingly deteriorated both in absolute and relative terms, economic problems have become political problems. One manifestation of these problems have been the initiatives undertaken by the federal railways and other groups to get the issue of railway taxation[2] on the national political agenda.

The purpose of this paper is to suggest that the search for "equitable" railway taxation policies, as a means of improving railway, port, and resource commodity competitiveness, does not lie in the realms of transportation or taxation policy making, but in

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[1] This paper represents the viewpoint of the author, and should not be construed as a policy document or position of the Government of British Columbia.

[2] For purposes of discussion herein, no differentiation is made between the variety of taxes imposed on Canadian railways.

strategic industrial policy development. The paper asserts that rail transportation and taxation policies should complement national industrial strategies aimed at improving Canada's competitive position - but such is problematic as Canada's federalist composition inhibits the development of coherent industrial strategies in the face of globalization.

II. THE CANADIAN RAILWAY POLITICAL ECONOMY

Historical developments and their contemporary policy legacies form the current Canadian rail political economy.[3] This economy has been, and is today, characterized by institutional and policy rigidities of the past which advocated using transportation policy as a means of achieving national/regional social goals, industrial, and political goals. The MacPherson Commission (1961) recognized this dominant characteristic of Canadian rail transportation policy in stating:

> We must, if we are to obtain an adequate understanding of the complexities of transportation policy in Canada, recognize the fact that the transportation system . . is essentially dualistic in nature - reflecting both its functions as an instrument of national policy and as a vehicle of a private nature operating along the lines of commercial principles. The existence of this situation has meant that the national transport policy has traditionally had to serve two masters - the dictates of public necessity and the requirements of commercial enterprise. Since the objectives of the former are not necessarily consistent with the latter . . the successful execution of transport policy in Canada has never been a simple task.[4]

This statement remains true today. The Canadian rail political economy still regards the railway sector as a means to achieving non-transport ends. Legislative and regulatory provisions, whose objectives are non-transport in nature, and which affect railway conduct and performance in achieving commercial ends, account for many of the current ills of the rail transportation system with respect to its competitive ability. This is not to say that these objectives are not worth pursuing, but perhaps they can be achieved through other policy instruments which are technically more

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[3] Orenstein (1989:11) defines political economy as "a body of knowledge about alternative economic and political systems. On a broad methodological level, it is a framework that encompasses both the polity and the economy. As a result, its typical applications to policy analysis combines insights and approaches from both political science and economics, and even sociology and psychology, in explications of complex social phenomena."

[4] Canada. Royal Commission on Transportation. Volume 2, 1961:192.

efficient, cost-effective, and regionally sensitive. What is not being recognized sufficiently from a public policy perspective is the need to reorient non-transport end rail transportation policies, and fiscal policies affecting rail competitiveness, in light of the emerging transborder and global competitive dynamic.

III. ENVIRONMENTAL SCAN

A cursory scan of the Canadian transportation environment reveals that the issue of transportation system competitiveness has reached a critical mass. The federally-regulated railways, industry and shipper associations, and other ad hoc groups are making it known to federal and provincial governments that certain public policies prohibit or inhibit the transportation sector's ability to reduce costs and increase asset productivity. This in turn affects Canada's competitiveness and profitability in the transborder and global marketplace. At the same time, however, fiscal constraints and increasing environmental concerns are forcing governments, particularly at the local and provincial levels, to advocate rail line service retention and policies that promote the use of rail to mitigate future road costs. Again, the commercial needs of the transportation sector are running up against a social "loading" of public policy objectives.

An environmental scan also reveals that railway taxation is only one factor that impacts on railway competitiveness. Other factors include equipment depreciation rates, income tax rates, ability to shed unproductive or marginally productive assets, labour costs, economies of density, port costs and regulations, and maritime regulations. Despite the importance of the competitiveness issue to the Canadian railway system, the efforts to address the issue in its entirety are spread out over several atomistic, fragmented stakeholder groups. It is unfortunate that the terms of reference for the 1992 NTA Comprehensive Review constrain the opportunity to address the rail competitiveness issue at a national level.

IV. THE NATURE OF AND NEED FOR INDUSTRIAL POLICY WITH RESPECT TO RAIL TRANSPORTATION

Normatively speaking, industrial policy is a set of structured, coordinated, integrated, and complementary public policies designed to improve the relative competitive position and performance of core industries. Industrial policy tools[5], when part of a coherent policy or initiative, are intended to influence the evolution of the structure of the economy to achieve a more desirable outcome. Policy design and implementation takes place within and is shaped by the realm of the political economy, consequently a prerequisite of successful industrial policy is a supportive political strategy.

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[5] Policy tools include international trade policies, general domestic economic policies, and industry, firm and individual-directed domestic economic policies.

Harris (1986:74) suggests that industrial policy supplants the conventional theory of economic policy, in which governments "mechanically manipulate private sector agents by changing taxes and subsidies". Harris' observation is also relevant with respect to railway taxation in Canada. I suggest that railway taxation "policy" problems should be resolved within a much larger framework whereby taxation policies are recognized as a means of achieving industrial policy goals. In other words, from a public policy perspective it must be recognized that in an increasingly competitive global marketplace, taxation policies should not be ends in themselves but rather means to achieving industrial policy objectives of a higher order and importance. As an open economy, Canada cannot ignore the international aspects of taxation. Railway taxation policies which ignore the reality of import and export traffic moving across the border may in the end impose costs to governments far greater than the immediate tax revenues realized. Consequently, the decentralized taxing system in Canada will require greater efforts at intergovernmental coordination if taxing powers are to serve as a policy instrument in improving railway competitiveness.

V. FACTORS IN ADDRESSING THE RAILWAY COMPETITIVENESS ISSUE FROM A PUBLIC POLICY PERSPECTIVE

> . . . while governments seldom pursue industrial policies that are clearly contradictory, there remains a lack of policy coordination between the federal and provincial governments and between the provincial governments themselves. In most major areas of industrial policy, each government pursues its own ends with scant reference to the goals of other actors. (Tupper, 1986:347)

There are at least three factors which inhibit coordinated government action on the railway competitiveness issue: the federalist composition of Canada, budgetary deficits, and problem definition.

Federalist composition. The federal-provincial composition constitutes a constellation of fragmented political forces and territorially diverse interests. These individual "sovereignties" serve to frustrate the development of coherent industrial strategies in which taxation aspects of the railway competitiveness issue should be addressed. Policy discontinuities across the federal-provincial government landscape, and even intragovernmentally, are common and particularly so in transportation. Tupper (1986:368) suggests that

> The very existence of beggar-my-neighbour policies contributes to distrust in intergovernmental relations, because they

> symbolize the intentions of individual governments to pursue their own courses and to insulate their economies from external forces. The unwillingness of Canadian governments to debate their respective contributions to economic distortions reflects enduring conflicts of interest within the federation. And, in a basic way, their failure to grapple with the issue of economic union reveals their inability to address the cumulative impact of government policy on the economy.

Canadian federalism/regionalism creates challenging, but not insurmountable, obstacles to intergovernmental cooperation in developing policies that foster railway competitiveness. The existence of regionally specialized economies no doubt inhibits the development of a single, all-embracing industrial policy and concomitant treatment of factors affecting railway competitiveness within government's discretion; an effective strategy might well be based on a series of regional policies that recognize regional sensitivities. Although agreement on railway taxation policies may not be achievable on a regional basis, there are other policy instruments, such as provisions regarding accelerated branchline service discontinuance with funding for shortline/alternative transportation development[6], that could be used to increase railway competitiveness. This would require, however, a recognition by provincial and local governments that they are, in fact, stakeholders in the rail transportation system - not just observers.[7]

In the final analysis, however, the coordinated efforts of governments must be conceptualized as a political response to an emergent problem. A political response first requires that the rail competitiveness issue gets on the national political agenda. As the economic and social impacts of global competition become increasingly felt in Canada, perhaps intergovernmental conflicts in matters of industrial and transportation policy will be overcome by the recognition that intergovernmental cooperation is a requirement for economic survival.

Budgetary Deficits. Despite fiscal and budgetary actions taken by the federal government in recent years, the debt burden is still rising both in absolute terms and relative to GDP. The 1992 federal budget projects that federal debt as a share of GDP will rise to 62.6% in fiscal 1992/93, up from 61.5% in 1991/92 and 54.4% in 1987/88. Forecasts of provincial deficits vary widely, but the

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[6] Section 175 of the National Transportation Act provides for federal financial assistance, in certain circumstances, for alternative transportation. Its real-life application, however, is questionable.

[7] The Province of Saskatchewan, through its nurturing of the Southern Rails Cooperative and development of innovative road-rail technology, is a proactive agent in the devolution of Class 1 railway uneconomic branchlines to lower cost alternatives using the same infrastructure.

trend is for larger deficits. What is important to realize is that most of the debt is structural in nature -- resulting from either debt servicing, or funding of health, education and social services. Any significant decrease in budgetary deficits, or at least a slower deficit growth rate, is overshadowed by the universality issue.

The problem of addressing the railway taxation issue gets caught up in the federalist and deficitary nature of the country. In aggregate, railway taxes affect the competitive ability of Canadian railways -- but each government only has discretion over its respective tax base and rates. Any significant tax reduction requires coordination between the federal, provincial, and local government levels. At the same time, however, budgetary deficits and the pressing issues of health, education and social program funding overshadow the railway taxation issue.

Problem Definition. With respect to the railway competitiveness issue, there are at least three forces which inhibit the development of coordinated, pro-competitive public policy: interests, values and causal assumptions. Where the parties at hand do not agree on these forces, the policy process becomes conflictual. This conflict is further amplified due to the distributive nature of the taxation issue between the private and public sector, and within the public sector itself.

The interests and values of provincial governments is largely shaped by the political economy of the jurisdiction. Frankly, the interests of Western Canada probably differ from the those of Central Canada and Eastern Canada. Even within Western Canada, the interests and values of the four provincial governments vary and, in some notable cases, are at odds with each other.[8]

Various governments also disagree over causal assumptions with respect to factors allegedly contributing to the decline in railway competitiveness. Although the decline can be attributed to a number of factors, jurisdictions debate the relative weighting between these factors. As in the case of values, causal assumptions regarding the contribution of certain factors to the competitiveness issue are shaped by jurisdictional interests. Even those jurisdictions who share the same interests cannot, in some cases, agree on the relative weighting of the factors inhibiting railway competitiveness. In short, a different set of causal assumptions leads to a different position on proposals to alleviate public policies which inhibit railway competitiveness.

VI. IN SEARCH OF A POLICY

The public policy process is best conceived as a collective means of defining and addressing public issues. Since the process deals with public issues it is inevitably and quintessentially political given that the process involves differing values,

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[8] This is particularly true with respect to the current debates regarding the changing of the method of payment and associated issues.

interests, and configurations of power. Despite the conflictual nature of this process between the private and public sectors, as it relates to the railway competitiveness issue, globalization of economic activity and declining railway competitiveness in Canada requires policy reorientation and intergovernmental cooperation. Yet a cursory analysis of the current situation reveals that Canada has not yet to come to grips with this issue. The railway competitiveness issue falls within a larger issue, that being the lack of coherent industrial policies in Canada in the face of globalization. Canada's policies towards trade and industrial development will be absolutely crucial in determining where the long-term future of the economy lies.

In starting the search for a policy, Chandler (1986:201) cites four prerequisites for coherent policy development: (1) a common, non-ideological view of the role of the state, (2) a determination to use public funds as efficiently as possible, (3) government-industry relations based on some sort of common approach to industrial development, and (4) coordination at the highest political levels. I submit that Canada does not meet these conditions. Given the federalist nature of Canada and the scope and depth of budgetary deficits, public policy making across jurisdictions is a zero-sum game.

Ideally, what is required is a national, intergovernmental structured policy development process, one that takes a very broad perspective and whose end product is the coordinated use of a wide assortment of policy instruments to enhance railway competitiveness and the ability of Canada, and its regions, to compete in the global marketplace. Given the variety of factors that are currently affecting railway competitiveness in Canada, perhaps an expedient, national policy approach to railway taxation and competitiveness is not feasible for reasons outlined herein. A national structural approach to transportation policy would require a high level of policy coordination and a harmonious utilization of a wide array of policy instruments; these cannot be easily achieved within the federalist composition of Canada. Frankly, a national approach makes difficult the recognition of regional diversity - particularly with respect to rail infrastructure and provincial economies.[9] This is evidenced by the inability of current national transportation legislation to adequately address the branchline issue from both a societal and commercial interest perspective. Legislative initiatives in the United States have recognized the need for governments to assume a greater role in branchline and service preservation where such service cannot be provided economically by a Class 1 carrier. Concomitantly, U.S. Class 1 carriers have recognized their role in branchline devolution.

The current issues of railway taxation and competitiveness constitute an agenda for public rail policy for the remainder of this century. Rational, integrated, and perhaps radical, public policies with respect to rail transportation are needed in the face of the economic and social pressures of globalization.

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[9] Such an example is the opposite views of the provinces of Saskatchewan and Alberta with respect to the current WGTA method of payment debate and branchline abandonment.

VII. CONCLUSIONS

The dividing line between domestic rail transportation and international trade issues is already blurred and is increasingly blurring as a result of increasing global competition, particularly in the area of resource commodities. This rapid expansion of world trade has meant that for all countries economic growth has become more trade-intensive, and this requires a reexamination and perhaps reorientation of domestic rail transportation systems and public policies. The need for governments to harmonize domestic industrial policies, and reduce policy discontinuities which inhibit railway competitiveness, illustrates a key aspect of globalization: the shrinking terrain of economic sovereignty.

REFERENCES

Atkinson, M. "The Bureaucracy and Industrial Policy" in Industrial Policy. Research Study for the Royal Commission on the Economic Union and Development Prospects for Canada. Toronto: University of Toronto Press. 1986.

Blais, A. "Industrial Policy in Advanced Capitalist Democracies" in Industrial Policy.

Boadway, R. and N. Bruce. "Theoretical Issues in Tax Reform" in Approaches to Economic Well-Being. Research Study for the Royal Commission on the Economic Union and Development Prospects for Canada. Toronto: University of Toronto Press. 1986.

Chandler, M. "The State and Industrial Decline: A Survey" in Industrial Policy.

Gollner, A. "The Effects of Business-Government Relations on Industrial Policy" in Industrial Policy.

Harris. R.G. Trade, Industrial Policy and International Competition. Research Study for the Royal Commission on the Economic Union and Development Prospects for Canada. Toronto: University of Toronto Press. 1986.

Helliwell, John F. "From Now til Then: Globalization and Economic Co-operation" in Canadian Public Policy.

LaForest, G.V. The Allocation of Taxing Power Under the Canadian Constitution. Toronto: Canadian Tax Foundation. 1981.

McCallin, Nancy J. Determinants of State Tax Structures. Ph.D. dissertation. University of Colorado at Boulder. 1991.

Morici, P., A.J.R. Smith, and S. Lea. Canadian Industrial Policy. Washington: National Planning Assocation. 1982.

Orenstein, Jeffrey. United States Railroad Policy. Chicago: Nelson-Hall. 1990.

Pal, Leslie A. Public Policy Analysis. Toronto: Methuen. 1987.

Rockerbie, K. "Public Policy and Institutional Barriers to Shortline Railway Operations in Canada". Paper prepared for the American Society of Transportation and Logistics. 1992.

Studnicki-Gizbert, K.W. Transport Policy-Theory and Practice. Ottawa: Canadian Transport Commission. 1975.

Studnicki-Gizbert, K.W. "Transport Policy: Objectives and Policy Instruments" in Issues in Canadian Transport Policy. Toronto: MacMillan. 1974.

Tupper, A. "Federalism and the Politics of Industrial Policy" in Industrial Policy.

THE GLOBALIZATION OF THE U.S. DOMESTIC AIRLINE ROUTE SYSTEM

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AIRLINE INDUSTRY TURMOIL

INTRODUCTION

What do Consumer Reports, a private consulting company, McGuire Air Force Base, the U.S. Bilateral Policy, the Andean Pact, a feud in Narita, Japan and cabotage have in common? They are all part of the current turmoil in the U.S. Domestic airline industry. When reviewing the domestic airline system in the United States it is obvious that turmoil and consternation are ever-present factors.

A driving force is defined as a mechanism (system) that propels an object forward or causes an action to occur. The driving force for the globalization of America's domestic airline route system is the relative relationship between the size of the U.S. domestic airline passenger market in the United States and the size and capability of the domestic airline industry that is available to serve this market under governmental constraints. Or posed as an unthinkable thought, "Are U.S. domestic air routes being quietly opened to international foreign-based air carriers?"

For a possible answer to that question, it is necessary to take a look at U.S. Presidential executive initiatives in conjunction with congressional legislation and the United States' bilateral policy which, when taken together, foster for the discomfort of the American public such memorable events as merger mania, strategic alliances, and crowded hubs as

illustrated in EXHIBIT 1.

EXTERNAL FORCES DRIVING THE UNITED STATES DOMESTIC AIRLINE INDUSTRY TOWARD GLOBALIZATION.

CABOTAGE: Cabotage - - - the offering of domestic service between two points in the same country by carriers flying the flag of a second country - - is a congressional legislative hurdle that has prevented foreign-based airlines from flying domestically in the United States. However, it is noted in "Open Skies Over The Andes" (Airline Business, September, 1991)[1] that President Bush's Enterprise for the Americas Initiative was at least partially responsible for prompting the Andean pact nations (Colombia, Venezuela, Ecuador, Peru, and Boliva) to agree to launch deregulation within the Latin American region by December 31, 1991.

U.S. BILATERAL POLICY: LIBERAL AGREEMENTS: The U.S. initiated a new bilateral strategy in 1978 under the direction of the Civil Aeronautics Board Chairman Alfred Kahn in which it substituted new liberal agreements for the existing bilateral agreements. The major differences were in their capacity and pricing clauses. Not only were fifth freedom capacity restrictions deleted from the old agreements, but both countries were prohibited from unilaterally limiting the service of an airline of the other country (Martin Dresner, Robert Windle. Proceedings of 33rd Meeting of TRF, 10/91).[2]

The pricing agreements in the original bilateral agreements requiring both governments' approval were replaced with a requirement of a rejection by the country of origin or double disapproval clauses - where both countries reject a fare.

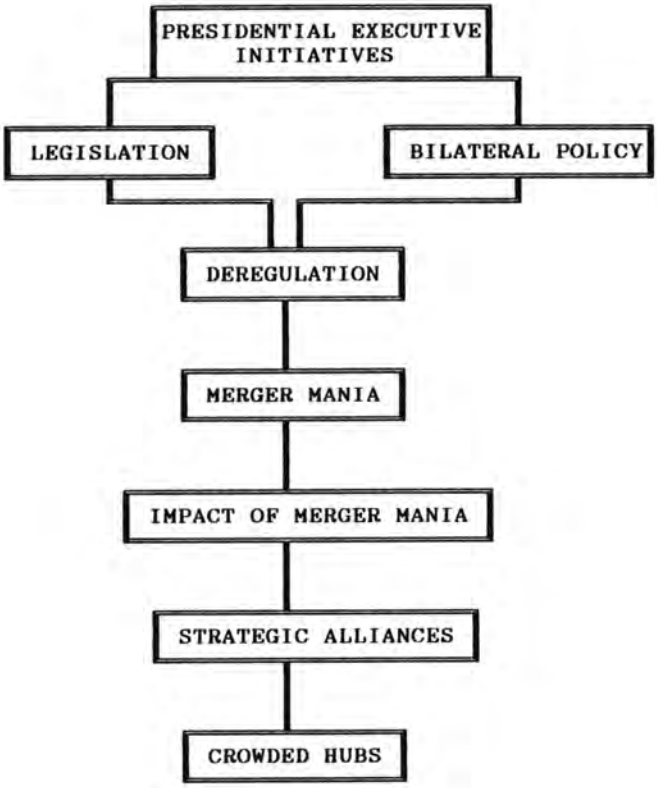
In a period between 1978 and 1982, the United States signed over 20 liberal or partially liberal agreements; beginning with the U.S. - Netherlands Agreement of 1978 (Dresner & Windle, Proceedings of 33rd Annual TRF, 10/91).[3]

THE ANDEAN PACT: These five Andean Nations have a combined population of 92 million; a gross domestic product of $125 billion and total foreign trade activity of $41.5 billion. As a single entity, these Andean Nations would rank third behind the United States and Brazil in

population; fifth after the United States, Canada, Brazil and Mexico in gross domestic product; and tied for third with Brazil and Mexico in foreign trade (Airline Business, September, 1991).[4]

EXHIBIT 1

LINKING THE ELEMENTS IN THE DRIVE TOWARD DECABOTAZATION



There is speculation that this revolutionary airline agreement could be to the future of the Andean Common Market what the

April, 1951 European Coal and Steel Treaty was to the present European Economic Community. A European Common Market that is in the process of coagulating by 1992 into a single European market that will be the largest market in the world. The Andean Pact agreement is the first of its kind encompassing air transport within a multi-nation region. The "United States of Europe" is scheduled to come on-stream in 1992. One of the elements in uniting Europe is the deregulation of the airline industry among the European nations.

THE MERCOSUR AGREEMENT: A continuation of the pattern is the proposed Mercosur Agreement which would group Argentina, Brazil, Paraguay, and Uruguay in a similar open skies free-trade agreement. According to Patricio Sepulveda, former CEO of LanChile who is currently Head of an aviation consulting group, PSC Corporation of Santiago, and an adviser to the Andean Pact Secretariat: "This Pioneering move, . . . will benefit the consumers and the economies of the nations involved." (Airline Business, September, 1991).[5]

U.S. CITIES PROGRAMME: The impact of external international agreements on the U.S. domestic markets can be illustrated by Lufthansa's US Cities Programme that demonstrated that service to non-traditional US gateways is at least viable. The **Cities Programme** has been favorable enough for Lufthansa to seek two extensions of its 179-day operating authority that is only one day short of the magical 180- day cutoff point when the U.S. Department of Transportation becomes biased towards full approval of Lufthansa's operating authority to non-traditional U.S. gateways (Airline Business, October, 1991).[6]

Most recently, USAir and the German national carrier Lufthansa entered into an agreement to consider a pact to act as a feeder and distributor of each others international flights. USAir currently serves Frankfurt and London. This could be a first step toward circumventing the cabotage restrictions on foreign-based carriers in the respective countries of both carriers (Greensboro News & Record, 11/91).[7]

U.S.A.-BIAS (BETTER INTERNATIONAL AIR

SERVICE): One of the first priorities of **USA-BIAS** is the liberalization of the **CITIES PROGRAMME.** This organization was active in the pursuit of open skies discussions between U.S. D.O.T. and Canada. Simultaneously, USA-BIAS is concerned with a substantial number of new, extra-bilateral international services to gateways in Baltimore,Charlotte,Philadelphia and Atlanta. There are four airline companies that have obtained these rights; KLM, Swissair, Lufthansa and Chile's Ladeco. (Mead Jennings, Airline Business, p. 32, October, 1991).[8]

MERGER MANIA IMPACT

The scheduled airlines are divided into three classifications: **MAJORS, NATIONALS,** and **REGIONALS. EXHIBIT 2: CONSOLIDATION OF NATIONALS BETWEEN 1986-1989 and EXHIBIT 3: CONSOLIDATION OF PRE- DEREGULATION TRUNK AND LOCAL AIRLINES INTO SEVEN MAJOR AIRLINES** help identify the carriers in the two largest classifications. For the sake of brevity, **MAJOR** airline companies are those airlines, once referred to as trunk carriers, and who are now classified as **MAJORS** because they have annual gross revenues over one billion dollars.

NATIONAL airline companies are those that generate annual gross revenues between $75 million and $1 billion. And while **REGIONAL** airline companies have a history of their own, they are classified as LARGE **REGIONALS** if their annual gross revenues fall between $10 million and $75 million and a MEDIUM **REGIONAL** if annual gross revenues are less than $10 million. For 1989, it was estimated that the Majors generated 429 billion revenue passenger miles (RPMs) (Europe 1992, The Facts,).[9]

Since 1985, approximately twenty-five (25) mergers and acquisitions have occurred; twenty-three (23) were by major carriers (Rule, 1989). There were four Major carriers who were acquired in 1986: Peoples Express, Eastern, Republic, and Western which left only nine (9) of the former thirteen (13) Major carriers which was further reduced to eight (8) Majors with the acquisition of Piedmont by USAir in 1989 (James, 1990). This number was not affected by the failure of Eastern Airlines in March, 1991. It was a part of the Texas Air Corporation Group. However, the demise of PAN AM in December, 1991 left only 7 MAJORS (**EXHIBIT 3**).

What has happened to the industry since deregulation began in 1978? In sheer numbers alone, thirty-six (36) carriers began nearly a decade of deregulation. If every air carrier that stated operation, since deregulation of the air passenger segment of the industry, were still in operation today, there would be a grand total of 234 (Europe 1992, The Facts)[10] air carriers. However, bankruptcies, mergers, consolidations, and ceased operations have claimed a staggering 68%; including the consummation of the acquisition of Piedmont by USAir on August 4, 1989. This figure climbs to 68.8% with the inclusion of the failure of Eastern Airlines mentioned above. Over seventy-three (73) carriers certificated as Section 401 scheduled airlines remained in January, 1987. **EXHIBITs 2,** and 3 tell the story pictorially.

Of the remaining seventy-three (73) Section 401 certificated air carriers in January, 1987, a net total of only twenty-four (24) compete for airline traffic within the continental (48 contiguous states) United States. Thirty-six operate outside the forty-eight states (in Alaska, Pacific, and the Caribbean) while thirteen (13) others provide feeder service to larger carriers. None of the original mid-sized Regional carriers certificated prior to 1978 exist today.

To capture the merger mania movement in terms of its impact, **EXHIBIT 4** identifies several characteristics that have/will become evident as the airline industry continues its constant change developed during the past one-dozen or so years. Of the seven MAJOR domestic airlines left in service today, four of them are relatively stable financially while two others are in some phase of bankruptcy. By the end of 1991, the industry had a total loss of just under one billion dollars during the two-year period 1990 and 1991.

CONSUMER PROTECTION

Congress gave the U.S. Department of Transportation the responsibility of protecting consumers from unfair and deceptive airline trade practices pursuant to the C.A.B. Sunset Act of 1984. The House pointed out that a continuing government role to protect airline consumers was necessary because ". . . the

solutions reached by the marketplace are not always acceptable. (Glisson, L. M., "The Non-Competitive Domestic U.S. Airline Industry")[11]

EXHIBIT 2

CONSOLIDATION OF NATIONALS

BETWEEN 1986 - 1989

START OF 1986	DISPOSITION	END OF 1989
AIRCAL	MERGED INTO AMERICAN	
AIR WISCONSIN		AIR WISCONSIN
ALASKA		ALASKA
ALOHA		ALOHA
AMERICA		AMERICA WEST
AMERICAN TRANS AIR		AMERICAN TRANS AIR
BRANIFF		BRANIFF
FRONTIER	MERGED INTO PEOPLE EXPRESS	
HAWAIIAN		HAWAIIAN
MIDWAY		MIDWAY
MGM GRAND		MGM GRAND
NEW YORK AIR	MERGED INTO TEXAS AIR CORP	
OZARK	MERGED INTO TWA	
PACIFIC SOUTHWEST	MERGED INTO USAIR	
PEOPLE EXPRESS	MERGED INTO TEXAS AIR CORP	
SOUTHWEST		SOUTHWEST
TRANS AMERICA	CEASED SCHD'L PASS.OPER.	
TRANSTAR	MERGED INTO SOUTHWEST	
WORLD	CEASED SCHEDULED PASSENGER OPERAT.	
AIR WISCONSIN		AIR WISCONSIN
JET AMERICA	BOUGHT BY ALASKA	
21 CARRIERS		11 CARRIERS

SOURCE: ADAPTED FROM AIRLINE CONSOLIDATION WASHINGTON, D.C.: AIRLINE ECONOMICS, INC 1987) P. 20, AND FAA AVIATION FORECASTS, FISCAL YEARS 1990-2001, U.S. D.O.T.,FED. AVIATION ADMINISTRATION, pp. 221-223.

A Government Accounting Office study found that DOT's authority to protect consumers from unfair and deceptive trade practices comes in large part from 49 U.S.C. 1381, which also parallels the Federal Trade Commission's authority to protect consumers in other industries.

DOT's consumer protection authority and

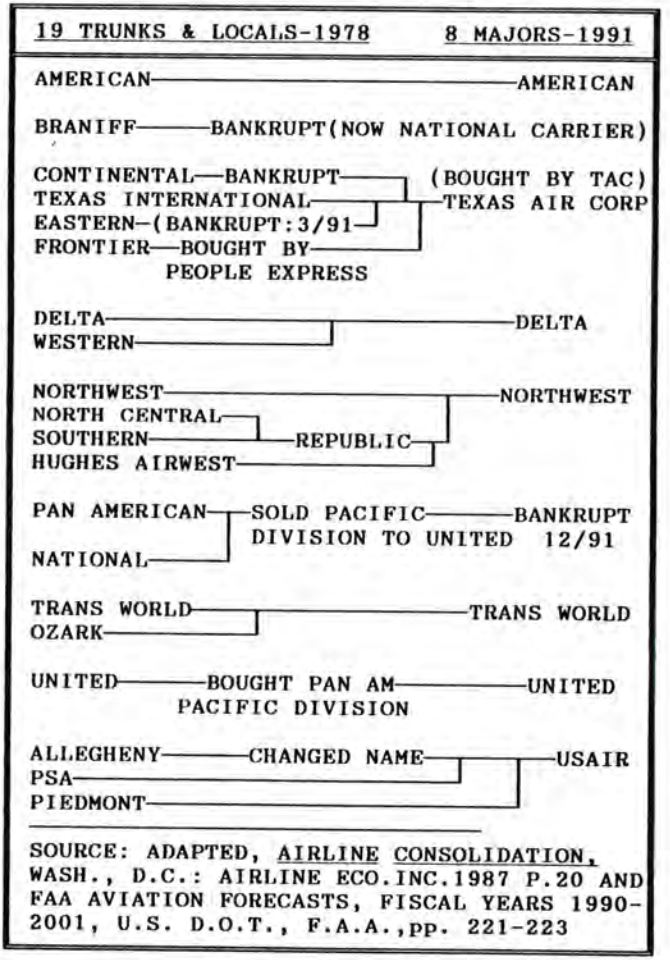
responsibility is divided between the Office of Consumer Affairs within the Intergovernmental and Consumer Affairs Office and the Office of

EXHIBIT 3

CONSOLIDATION OF PRE-DEREGULATION

TRUNK AND LOCAL AIRLINES INTO

SEVEN MAJOR AIRLINES



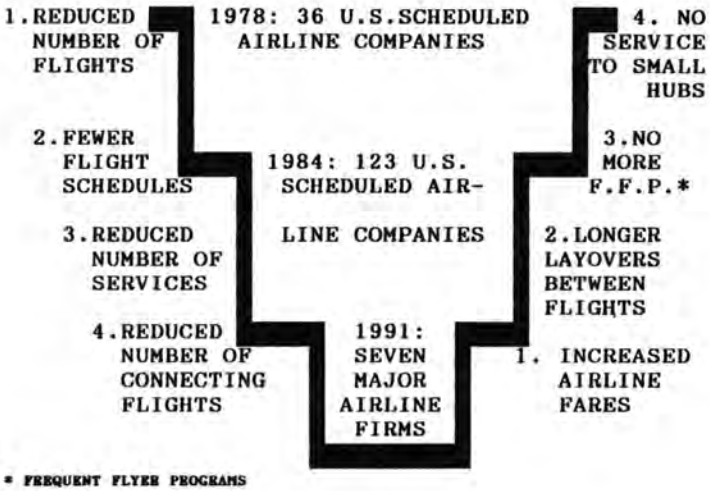
SOURCE: ADAPTED, AIRLINE CONSOLIDATION, WASH., D.C.: AIRLINE ECO.INC.1987 P.20 AND FAA AVIATION FORECASTS, FISCAL YEARS 1990-2001, U.S. D.O.T., F.A.A.,pp. 221-223

Aviation Enforcement and Proceedings in the Office of General Counsel. The Office of Consumer Affairs is divided into two divisions.

EXHIBIT 4

A SUMMARY OF THE IMPACT OF

AIRLINE MERGER MANIA



* FREQUENT FLYER PROGRAMS

The Consumer Affairs Division receives and resolves complaints from individual consumers; the Investigations Division investigates unfair and deceptive industry trade practices. The Office of Aviation Enforcement and Proceedings takes enforcement action against persons who engage in prohibited trade practices or violate DOT's regulations. (Glisson, L. M., "The Non-Competitive Domestic U.S. Airline Industry")[12]

In a GAO review of DOT's airline oversight activities, several findings of that investigation as they relate to consumer protection are worth noting. It was found by GAO that DOT:

(1) had improved the process of handling consumer complaints,

(2) increased and focused its enforcement

functions on major areas of consumer complaints,
(3) investigated airline scheduling - a major issue of consumer concern. (Glisson, L. M., "The Non-Competitive Domestic . . .)[13]

However, as a result of inadequate direction and coordination, D.O.T. missed important opportunities to:
(1) address a major pattern of violations,
(2) establish clear policy in important areas such as CRSs, airline scheduling, and airline advertising, and
(3) more effectively use limited resources. (Glisson, L. M., "The Non-Competitive . . .)[14]

STRATEGIC ALLIANCES

Of the many types of alliances, the three most important are **MARKETING, EQUITY,** and **FREQUENT FLIER PROGRAMS.** The last few years have seen a dramatic increase in all three types. Out of one-hundred, seventy-two alliances identified by Mead Jennings in the August, 1990 issue of AIRLINE BUSINESS,[15] eighty-two of the agreements (47.7%) involved equity investments. More specifically, fifty-six percent (56%) of these 82 agreements were made in the last five years.

MARKETING ALLIANCES: In the category of **MARKETING ALLIANCES,** we find agreements to coordinate schedules; to share codes of international flights; route-specific agreements regarding the contribution of each airline to a cooperative effort over a specific route (e.g., New York to Sidney, Australia) and/or market-specific agreements detailing the cooperative effort of two airlines in a specific market (e.g., the senior - 65 years or older - market; or a geographical market such as Florida or California).

EQUITY ALLIANCES: An **EQUITY SWAP** is another name for alliance partners buying into each other. It is also a relatively new variation on the much older marketing alliance theme. An interesting note is that American Airlines serves as a partner to seven other major airlines; Aer Lingus, Air new Zealand, Cathay Pacific, Finnair, Malev, Qantas, and Singapore Airlines. However, American has an equity position in only one of these airlines; Air New Zealand. Part of this "Partnershipping" is through the frequent flier programs.

FREQUENT FLYER PROGRAMS: Delta Airline was the first domestic carrier to develop an international frequent flyer mileage program for consumers. For instance, Delta Air Lines' Frequent Flier Program is supported by a partnership agreement with Air Canada, Air New Zealand, Japan Airlines, Lufthansa, KLM Royal Dutch Airlines, Singapore Airlines and Swissair. All air carriers, except Japan Airlines, allow their passenger to earn 100% of their actual mileage in Economy Class; from 125% to 150% in Business Class and 150% to 200% in First Class.

FREQUENT FLYER PROGRAM COLLAPSE: However, frequent flier programs may have become too successful. At the North Carolina Business Travel Association's biennial trade show in Pinehurst, N.C. in July, 1991, a spokesman for USAir and an American Executive said at the trade show that their airlines would terminate those programs - -if they could only figure out how to do it and get away with it. (Pete Fields, **"Frequent Flier Baggage Weighing Down Airlines,"** Triad Business Weekly, Greensboro News & Record, August 5, 1991, page 2).[16] A USAir spokesman said of the programs "We'd like to see them all just go away, but we'd like to see another carrier do it first." He also said that the programs build loyalty, but that they have gotten out of hand. The American spokesman agreed that "They work to your detriment because they discourage the kinds of economical approaches you want your people taking."

CROWDED HUBS

Some of the problems facing nearly all of the U.S. hubs today range from delayed take-offs and arrivals, to increased noise levels, to crowded airways and corridors, and aging aircraft, among others.

DELAYED TAKE-OFFS AND ARRIVALS. In a Consumer Reports annual survey (July, 1991)[17] on the issue of airline services, over 140,000 readers reported that they were not satisfied with many of the airline companies. They considered "on-time reliability" to be one of the airlines' most important services. These readers reported that more than one flight in four (25%+) was delayed 15-minutes or more while one flight in nine (11.1%) was late by more than an hour. Alaska Airlines had the best on-time

record in the survey. It arrived on schedule 86% of the time as compared to an average of 75% for the rest of the industry.

The U.S. Department of Transportation requires the major carriers to publish up-to-date on-time ratings of each flight listed in a computer reservation system (CRS). A rating of "one" means the flight arrived on schedule ten to nineteen percent of the time during the previous month; a rating of "nine", the highest possible rating, means the flight was on time at least 90 percent of the time. It is often suggested that if a flight has a rating less than a seven, find yourself another flight!

CROWDED AIRWAYS/CORRIDORS: Internationally, Japan has fought a 23- year war over construction and expansion of the New Tokyo International Airport (Traffic World, 7/22/91)[18] at Narita.

A private consulting firm, funded by US Federal Government, suggested that McGuire Air Force Base, part of the Fort Dix, N.J. complex, be opened to civilian use as an intermodal transportation hub to provide breathing room for the Philadelphia and Newark airports. "The nation's aviation system is stretched to the limit," said Senator Frank Lautenberg, D-N.J. He continued by commenting that "Congestion and delays at airports are all too common. (Traffic World, 7/22/91).[19]

The feud at Tokyo International Airport rarely interferes with the average 300 planes a day that bring tourists, business people and thousands of tons of air cargo into and out of Narita. The turmoil delayed the opening of the first stage of the Narita airport until 1978, four years behind schedule. During the first year of operation the airport served 6.4 million people; a million more than its designed capacity (TRAFFIC WORLD, 7/22/91).[20]

The original terminal building has been upgraded to handle 13 million passengers. But, that is far short of the 18 million who passed through it in 1989. After a 10- to 12-hour flight, passengers can look for delays of up to four hours between landing at the airport and arriving at a hotel room (TRAFFIC WORLD, 7/22/91).[21]

AGING AIRCRAFT: The Aging Aircraft Safety Act of 1991 ---passed by the House of Representatives but the Senate refused to consider it - - -directs the Federal Aviation Administration to establish an inspection program for planes which have been in service for 15 years or longer (**TRAFFIC WORLD**, April 29, 1991).[22] Others in the industry maintain that the chronological age is not an accurate indicator of airworthiness. The air cargo industry, in particular, would prefer to use the number of take-offs and landings for the basis of an inspection schedule (**TRAFFIC WORLD**, August 5, 1991).[23]

The General Accounting Office (GAO) thinks that a large portion of the U.S. fleet will be unable to meet the FAA's airworthiness directives by 1994. The agency reports that by the year 2000, 30.4% of the U.S. aircraft fleet will be between 20 and 25 years old while about 45% will be 15 years old or older (**TRAFFIC WORLD**, June 17, 1991).[24]

CONCLUSIONS

There are constant and continuing events taking place on the international scene that will have a direct impact on the U.S. domestic airline industry. These external events will eventually push the United States Congress to consider opening the domestic routes to international foreign-based air carriers.

The current airline industry turmoil is being fueled by delayed take-offs and arrivals, crowded airways and corridors, aging aircraft and the shrinking number of participants in the industry from 36 U. S. scheduled airline companies in 1978 to 123 U.S. scheduled airline companies in 1984, to 7 Major airline companies in 1991; three of which are in bankruptcy and the fourth has lost a billion dollars in the last two years.

The U.S. domestic industry has been significantly reduced in size as a result of the merger mania that began over a decade ago. That reduction has resulted, or will result, in (1) a reduced number of flights, (2) fewer flight schedules, (3) a corresponding reduction in the number of connecting flights, (4) a reduced number of services and (5) increased air fares.

While there have been some reductions in air fares between some of the more competitive city-pairs, studies have shown that travelers have seen an increase in airline fares especially for non-competitive city- pairs. Service has been cancelled to numerous city-pairs as a result of the bankruptcy problems within the industry but especially with Pan Am, TWA, Eastern and Continental; not to mention the problems of the Trump Shuttle. There is a current movement to consider eliminating the frequent flier program.

In a movement that originated in 1978 with the substitution of new liberal agreements for the existing bilateral agreements and extended by (1) the Andean Pact, (2) the Mercosur Agreement, (3) the U.S. Cities Programme, (4) the U.S.A.-BIAS program, (5) U.S. airline industry deregulation, (6) Merger-mania, (7) strategic alliances and (8) crowded hubs, it now appears that the globalization of U.S. domestic air routes is quietly under way without Congressional consent!

REFERENCES

1. _____. "Airlines Annual Survey," **CONSUMER REPORTS**, Consumers Union of U.S., Inc., Yonkers, N.Y., July, 1991.
2. _____. "Charlotte to Expand and Dress Up Airport to Give Taste of City," **GREENSBORO NEWS & RECORD**, Greensboro, N.C., Nov., 1991.
3. Dresner, Martin & Robert Windle. "The Liberalization of U.S. International Air Policy: The Impact on U.S. Markets and Carriers," **PROCEEDINGS OF THE 33RD ANNUAL TRANSPORTATION RESEARCH FORUM**, New Orleans, LA, October, 1991.
4. _____. "EC/EFTA Trade Relations," **EUROPE 1992, THE FACTS**, Department of Trade and Industry and the Central Office of Information, United Kingdom, September, 1989.
5. Fields, Pete. "Frequent Flier Baggage Weighing Down Airlines," **TRIAD BUSINESS WEEKLY**, Greensboro News & Record, August 5, 1991.
6. Glisson, L. Milton. "Is U.S. Domestic Airline Competition on a Flight to Oblivion?" **TRANSPORTATION PRACTITIONERS JOURNAL**, Vol. 8, No. 3, Association of

Transportation Practitioners, Spring, 1991.

7. Glisson, L. Milton. "The Non-Competitive Domestic U.S. Airline Industry," Institute of Public Administration, College of Public & Urban Affairs, Georgia State University, Atlanta, GA, September, 1990.

8. Hall, Kevin G. "House Tries End Run on Aging Aircraft Bill," TRAFFIC WORLD, Journal of Commerce, Inc., August 5, 1991.
9. Hall, Kevin G. "GAO Critical of FAA Oversight on Aging Aircraft Modifications," TRAFFIC WORLD, Journal of Commerce, Inc., June 17, 1991.
10. James, George. "How will the Future Airline Globe be Divided," FIFTEENTH ANNUAL FAA AVIATION FORECAST CONFERENCE, Mayflower Hotel Washington, D.C., March 2, 1990.
11. Jennings, Mead. "Open Skies Over the Andes," AIRLINE BUSINESS, London, UK, September, 1991.
12. Jennings, Mead. "Germany: Name Your Price," AIRLINE BUSINESS, London, UK, October, 1991.
13. _____. "Military Solution Proposed for Crowded East Coast Routes," TRAFFIC WORLD, Journal of Commerce, Inc., July 22, 1991.
14. _____. "Noise Rules Approved in L.A.; No Ontario Curfew," TRAFFIC WORLD, Journal of Commerce, Inc., May 27, 1991.
15. Solomon, Mark B. "Airports Push for Local Noise Rules Despite Proposed National Policy," TRAFFIC WORLD, Journal of Commerce, Inc., April 29, 1991.

ECONOMIC EFFICIENCY OF PASSENGER RAILWAY SYSTEMS AND IMPLICATIONS FOR PUBLIC POLICY

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Productive efficiency of the passenger railway systems in 21 countries are measured, compared, and analyzed in order to study effects of various public policy instruments (ownership form, public subsidy, managerial freedom, etc.) on efficiency. Data Envelopment Analysis (DEA) is applied as the main tool for measuring productive efficiency from a panel data for the 1978-88 period. Tobit regression is used to identify the effects of public policy instruments after controlling for the differences in operating environments such as traffic density and average trip length which are largely beyond managerial control. A frontier production function is also estimated in order to see if empirical results are sensitive to the methodology used.

The empirical results show that the efficiency of a passenger rail system is significantly enhanced by an institutional and regulatory framework which provides a greater freedom for managerial decision making. There is also fairly convincing evidence to support the establishment of a single national passenger-only corporation like VIA Rail Canada and Amtrak.

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1. INTRODUCTION

In recent years, the financial and economic performance of the passenger rail system has attracted much attention primarily because of the mounting public subsidies and alleged inefficiency imbedded in the system. The economic efficiency of passenger rail systems is believed to be heavily influenced by regulatory policy choices, institutional and ownership arrangements, the relationship between freight and passenger outputs, and the degree and methods of subsidization and/or taxation. The systems are also influenced by the external operating environments which include factors largely beyond managerial control. These include the spatial distribution of population and economic activities, the climate and topography of the nation, the extent of development of other passenger transport modes, and the economic situation of the nation, etc.

The differences in policy adopted by different countries provide an excellent opportunity to investigate the effects of policy choices on the economic efficiency of the industry. Nash (1981) sought to discover how much of the differences in the performance of Western European railways, measured by market share, traffic trends and support requirements, may be accounted for by government policies. His study found that, in the passenger sector, prices charged and the mix of services offered were the significant factors determining both market share and support requirements, and that these decisions were almost entirely conditioned by government policy. Schwier, Jones and Pignal (1990) compared the performance and policy environments of regional rail passenger services operated by VIA Rail, British Railways, French National Railways and Amtrak, with respect to organization, level and utilization of services and railways' financial performance. Perelman and Pestieau (1988) and Compagnie, Gathon and Pestieau (1991) analyzed railways' efficiency with respect to differences in the operating environments using frontier production functions. Although some recent studies (Gathon and Perelman 1990, and Compagnie, Gathon and Pestieau 1991) introduced an index of regulatory and institutional autonomy to correct for the portion of inefficiency caused by a lack of managerial freedom, we are not aware of any systematic analysis of the effects of government policy on the efficiency of railways.

The objective of this paper is to analyze the effects of various policy choices on the economic efficiency of passenger rail systems. In order to achieve this objective, the paper first measures and compares the efficiency of passenger rail systems across selected countries. These results are further analyzed through an econometric investigation in order to attribute the influence of different policy choices on the economic efficiency of the system.

Section 2 discusses methods for constructing and comparing efficiency measurement. In Section 3, we describe the characteristics of the firms included in the sample. The railways' efficiency performance is measured and compared in Section 4 while Section 5 containing the analysis of the effects of policy choices. The summary and concluding remarks are given in the final section.

2. METHODOLOGY

We selected the Data Envelopment Analysis (DEA) method to measure the overall efficiency of the passenger rail systems because DEA does not require multilateral indices for outputs and inputs while the other methods of measuring efficiency, such as total factor productivity and the estimation of frontier cost functions, require multilateral price indices for inputs and outputs. Lack of adequate data makes it difficult, if not impossible, to construct such multilateral price indices in a way that is consistent across firms in different countries. The DEA efficiency measures once constructed are further analyzed, using a Tobit regression, to identify the impact of various controllable and uncontrollable variables on efficiency. An attempt is also made to compare the DEA results with those from a frontier production function to see if the empirical results are sensitive to the methods chosen.

2.1 Data Envelopment Analysis (DEA)

The DEA method measures efficiency by estimating an empirical production frontier. The inefficiency of a decision making unit (DMU) is measured by the distance from the point representing its observed input and output values to the corresponding reference point on the production frontier.

Charnes, Cooper and Rhodes (1978) define the DEA efficiency measure as the maximum of a ratio of weighted outputs to weighted inputs subject to the condition that similar ratios for every DMU be less than or equal to unity. In mathematical form:

$$\begin{aligned} Max\ h_0 &= \frac{\sum_{r=1}^{s} u_r Y_{r0}}{\sum_{i=1}^{m} v_i X_{i0}} \\ st.\quad & \frac{\sum_{r=1}^{s} u_r Y_{rj}}{\sum_{i=1}^{m} v_i X_{ij}} \le 1 \qquad j=1,2...n \\ & u_r, v_i > 0 \quad r=1,...,s;\ i=1,...,m \end{aligned} \tag{1}$$

where the Y_{rj}, X_{ij} are the outputs and inputs of the jth DMU, the u_r, v_i are the weights to be determined by the solution of the problem. $h^*_k = 1$ if and only if DMU_k is efficient relative to the other DMUs.

Note that the above ratio form of the model is a fractional programming problem. However, since $\Sigma^m_{i=1} v_i X_{ij} > 0$, if we let $\Sigma^m_{i=1} v_i X_{i0} = 1$, the problem can be replaced by the following linear programming problem:

$$\begin{aligned} Max\ h_0' &= \sum_{r=1}^{s} u_r Y_{r0} \\ st.\quad & \sum_{r=1}^{s} u_r Y_{rj} - \sum_{i=1}^{m} v_i X_{ij} \le 0 \qquad j=1,...,n \\ & \sum_{i=1}^{m} v_i X_{i0} = 1 \\ & u_r,\ v_i > 0 \quad r=1,...,s;\ \ i=1,...,m \end{aligned} \tag{2}$$

solutions can be obtained by repeated application of a linear programming software.

The DEA efficiency measures are considered as "gross (or observed) efficiency indices". These indices are influenced by the differences in the operating environments and the regulatory and institutional arrangements. The "true (net) efficiency" of the railways can be measured and compared after controlling the effects of these controllable and uncontrollable variables.

In order to identify the impacts of policy and uncontrollable variables on the DEA efficiency index, and to measure the "true (net) efficiency", the DEA indices (h^*_k in equation (1) and (2)) are regressed on a number of explanatory variables. However, there is a methodological problem associated with such a regression. As defined in (1) and (2), the DEA index falls between 0 and 1 ($0 < h^*_k \leq 1$), making it a limited dependent variable. Consequently, an OLS regression of h^*_k would produce biased parameter estimates. In order to treat the limited dependent variable properly, we choose to use the following form of Tobit model (Tobin, 1958, Amemiya, 1985):

$$Lh_k = Z_k'\beta_k + \eta_k \quad \text{if } Lh_k < 0, \quad k=1,...,n$$
$$= 0 \qquad\qquad \text{otherwise} \tag{3}$$

where Lh_k is the logarithm of the DEA efficiency index, Z_k is a vector of the logarithms of the factors potentially influencing rail efficiency, β is a vector of coefficients to be estimated, and $\{ \eta_k \}$ are assumed to be independently identically distributed error.

This approach accomplishes two tasks. First, it identifies the effects of the government policy and uncontrollable variables on the gross DEA efficiency index. Second, it allows one to compute the true (net) efficiency index from the residuals of the Tobit regression.

2.2 Frontier Production Function

To determine if our empirical results are sensitive to the methods chosen, we compare the DEA-TOBIT results with results from a frontier production function. A deterministic logliner production frontier function is estimated by the corrected ordinary least square method (Greene 1980). The efficiency of each DMU can be evaluated by measuring the relative distance between the frontier output and the actual output, given a certain level of input. The DMUs which are on the frontier are by defintion 100% efficient.

Let y_i be the output of the ith DMU (observation), x_{ij} the inputs variables, z_{ik} the uncontrollable variables, v_{il} the controllable variables which are in the form of dummy variables, and ε_i residual term. OLS estimation gives the following equation:

$$\ln y_i = a + \sum b_j \ln x_{ij} + \sum c_k \ln z_{ik} + \sum d_l v_{il} + \varepsilon_i \tag{4}$$

where a, b_j, c_k, and d_l are the regression coefficients. Letting $E = \text{Max}(\varepsilon_i)$, one obtains the following frontier function:

$$\ln y_i^F = a + \sum b_j \ln x_{ij} + \sum c_k \ln z_{ik} + \sum d_l v_{il} + E \tag{5}$$

then the efficiency of the i-th DMU is measured by:

$$e_i = y_i / y_i^F = \exp(\varepsilon_i - E) \leq 1 \tag{6}$$

3. CHARACTERISTICS OF THE SAMPLE FIRMS

Our sample firms represent different institutional settings and operate in a variety of environments. Of our sample railways, German Federal Railways (DB), Italian State Railways (FS prior to 1985 only) and Danish State Railways (DSB prior to 1986) are owned and managed by government agencies while Amtrak (U.S.) and French National Railways (SNCF prior to 1982 only) are organized as quasi-public firms[1]. The remainder of the railways in the sample are owned and managed by public corporations.

The management of some of the railways including Amtrak, British Rail (BR), and Netherlands Railways (NS) enjoy substantial freedom for making strategic and operational decisions without government intervention, provided that the predetermined minimum performance criteria are met. On the other hand, some of the railways such as Finnish State Railways (VR), Austrian Federal Railways (ÖBB), Norwegian State Railways (NSB) and VIA Rail Canada are subject to strict governmental control.[2]

There are large variations in operating environments across the sample railways (Table 1). In Japan, rail's share in total passenger transport market (measured by passenger-km) was 37% in 1987. In contrast, Canada and the U.S. have rail traffic which represents a tiny portion of the total intercity passenger transport market, 1.6% for Canada, and 0.7% for the U.S. in 1988. Japanese National Railways (JNR, now JR) and Korean National Railways (KNR) enjoy very high traffic density measured by passenger-km per route kilometer (average density of 9.7 million for JR in 1987 and 7.2 million for KNR in 1984) while Australian National (AN), Amtrak and VIA Rail have much lower traffic density (33,000 for AN, 217,000 for Amtrak and 124,000 for VIA Rail). VIA Rail, Amtrak and AN serve substantial amounts of long distance traffic while most other railways serve mostly short distance travellers. AN provides mainly freight services. Some railways, such as SNCF, Finnish Railways (VR) and Turkish Railways (TCDD) exhibit a fair balance between passenger and freight services. Other railways, such as NS and Danish Railways (DSB) provide primarily passenger services, while VIA Rail and Amtrak are at the extreme and provide only passenger services. The Swiss rail network (CFF) is fully electrified while some railways still entirely rely on fuel traction only, such as AN, Hellenic Railways (CH) and VIA Rail.

Financial conditions vary greatly among the railways. Table 2 presents the overall operating cost recovery ratios and the ratio of direct subsidy to total (passenger and freight) operating cost[3]. It is useful to note that the subsidy ratio is not necessarily equal to (1 - cost recovery ratio) because few railways (only DSB and NSB) receive balancing subsidies[4]. It is also noted that most of the highly subsidized railways including FS, VIA, SNCB, and CH (Greece) provide primarily passenger services with passenger train kilometers accounting for more than 75 percent of their total train kilometers.

4. EFFICIENCY MEASUREMENT

An panel of 21 railways for the 1978-88 period forms the primary data base. The data are compiled from the International Railway Statistics and railways annual reports as well as Yearbooks and/or Statistical Yearbooks of the respective countries.

4.1 Output and input measures

Passenger kilometers are used as the measure of passenger service output. Some argue for the use of a gross measure of output such as seat-kilometers, car-kilometers or train-kilometers on the grounds that decisions about fares and service levels (which affect passenger-kilometers) are heavily conditioned by government policy. The use of such a gross measure of output is justified when one is interested in measuring and

comparing only the managerial efficiency of railroads rather than investigating the effects of government policies on efficiency. However, when a researcher is interested in studying the effects of government policy choice as well as managerial efficiency, it is preferable to choose one or more a revenue-generating outputs such as passenger-kilometers, number of passengers handled, or revenue-tonne-kms over measures of gross output. This is because the revenue output is the only component of gross output valued by the users and thus by the society.

Four inputs are used: labour, energy consumption, rolling stock (passenger cars and passenger train locomotives), and ways and structures. There are two problems associated with the measurements of labour, energy and passenger locomotive inputs in rail passenger services. The first is that most of the railways provide both passenger and freight services and some of the inputs used in these operation can not be directly assignable to either passenger services or freight services. There is no well defined method by which to allocate those common inputs between passenger and freight services. For this study, we have data on the inputs (labour, locomotives and energy) employed for the combined freight and passenger operations. We chose to allocate each of three inputs between passenger and freight services on the basis of train-kilometers[5].

The second problem is that VIA Rail and Amtrak use some personnel and trackage from the freight railroads, and an accurate measure of the inputs used in their operation, especially labour, are not readily available. We, therefore, adjusted upward VIA Rail's and Amtrak's own labour inputs upward by adding the estimated labour inputs of the freight railways which are attributable to passenger services. These include personnel[6] under contract with the passenger railways and the portion of road maintenance personnel allocated to passenger services. The adjustment is made on the basis of train-kilometers and is estimated through a linear regression.

The number of employees is used as the measure of labour input because the statistics on labour hours are not available consistently for all firms in the sample. Rolling stock input is measured by the number of passenger cars and the number of passenger locomotives. Energy input is measured by the total BTU consumed[7]. The length of rail lines is used as the ways and structures input due to a lack of better data.

4.2 Efficiency Comparison and Analysis

As stated in section II, we have chosen to use the data envelopment analysis (DEA) method to compute an overall efficiency index of the sample railways. Each observation (i.e., combination of railway and year) is regarded as an individual "decision making unit" (DMU). In total, there are 242 DMUs used to solve the LP problem in equation (2). Each DMU is assumed to produce one output, passenger-kilometers, using five inputs: labour, locomotives, passenger rail cars, energy, and route length. Since most railways' rights-of-way are shared by passenger and freight traffic, the use of total route length as a capital input measure tends to overestimate actual input for the passenger services. The smaller the proportion of passenger traffic, the more the input for passenger services is overestimated. Therefore, the percentage of passenger train-kilometers in a network's total train-kilometer is later used in Tobit regression analysis in order to correct for the potential bias. Electrified route and non-electrified route kilometers represent different scales of investment and should be included separately, however, some of the railways included in the sample still rely entirely on fuel traction which means that they have 0 kilometers of electrified route length. Since the DEA method cannot produce a meaningful efficiency index for those DMUs with a 0 level of an input, total route length was used in the calculation. Again, the electrification rate is used later in the Tobit regression to correct for this effect.

To compute the DEA efficiency ratings, the LP problem in (2) must be solved once for each DMU (observation). The DEA efficiency index obtained by solving the

LP problem is very sensitive to outliers as they tend to form the frontier technologies to which the rest of observations are being compared. An examination of partial productivities indicates that JNR and KNR are outliers because of their unusually high values of partial productivity in all dimensions (probably because of the high population density in their operating environment and heavy reliance in these countries on the rail mode for passenger transportation). Therefore, we excluded the JNR and KNR data when we computed the DEA efficiency index.

Table 3 reports the DEA efficiency index. An index value of 1.0 indicates that the corresponding DMU is the most efficient entity. These results show that Amtrak, BR, CFF, FS, NS, RENFE (Spain), SNCF and CP (Portugal) have attained a position close to the efficient production frontier by 1988. BR and Amtrak had achieved the largest improvement: 0.57 in 1978 to 1.0 in 1988 for BR, and 0.63 in 1978 to 1.0 in 1988 for Amtrak. DSB, CFF, CIE (Ireland), SNCF and SJ (Sweden) are among those with significant improvement as well.

DB, NSB, ÖBB, SNCB (Belgium), CH, CFL (Luxembourg), AN[8], and VR (Finland) are the low achievers. Their DEA efficiency index values are below 70% in 1988. Among these, only CFL and NSB exhibited a significant decline in their DEA efficiency index during the sample period.

5. EFFECTS OF THE FACTORS BEYOND MANAGERIAL CONTROL

Since the DEA efficiency ratings are influenced by factors which are beyond railways' control, the indices are not likely to reflect the true managerial or technical efficiency. Therefore, in order to compare the managerial and technical efficiency of the systems, the index must be adjusted for the effects of these variables. Furthermore, identification of the relative magnitude of the effects of these variables on the DEA efficiency index is itself important for evaluating future policy directions. Table 4 lists definitions of the variables to be examined.

5.1 Effects of the Policy Options and the Uncontrollable Variables on DEA Index

A preliminary experiment with the Tobit model shows that the log-linear functional form yields considerably better statistical results than the linear functional form. Note that LEFF, logarithm of the gross DEA efficiency index, is used as the dependent variable with the constraint that the predicted value does not exceed zero. In testing the various models, when the autonomy variable is used, the dummy variables indicating ownership forms (Govt. Agency, Quasi-Public or Public Corp.) are excluded as these variables are really different forms of autonomy variables.

Table 5 reports the two best TOBIT regressions, one with the autonomy variable, and another with the ownership form dummy variables. The two Tobit regressions are similar in terms of the empirical results. The results can be interpreted as follows:

(a) **Effect of uncontrollable variables:** Three variables which are largely uncontrollable by management or governments are included in the Tobit regression: DENSITY, TRIP LENGTH, and %PASSENGER. Both DENSITY and TRIP LENGTH variables have statistically significant positive coefficients in the Tobit regression, implying that, other things being equal, railways with higher passenger traffic density and/or longer average trip distances are, ceteris paribus, expected to exhibit a considerably higher DEA efficiency index than other railways. The coefficient of %PASSENGER variable has a positive sign as expected, but is statistically significant only in model 1. This implies that railroads with a higher percentage of passenger services are expected to achieve a higher DEA efficiency index. For our particular case, there are two reasons why this is expected. First, as a railway does a relatively larger share of business

in passenger services, they are likely to focus on improving the efficiency of passenger operations. Second, in our study, route miles are used as a surrogate for the ways & structure input for passenger services when, in fact, these route miles are shared by both freight and passenger services. As discussed, this over-estimates the ways and structure inputs for the carriers with a heavy emphasis on freight services as compared to other carriers. Therefore, the inclusion of %PASSENGER corrects for the effect of using proxy data for the ways & structure inputs on the DEA efficiency index.

(b) **Effects of Electrification:** The %ELECTRIC variable has a statistically significant positive coefficient. Since electrified rail lines require a higher investment than non-electrified routes, it makes the total route mileage used in DEA analysis an underestimate of the ways and structure input for highly electrified railways. Therefore, the positive coefficient for %ELECTRIC helps correct this problem. The positive coefficient for %ELECTRIC also captures the positive effect of electrification on energy productivity.

(c) **Effect of Subsidy:** The ratio of subsidy to the total operating expenses is only marginally significant in Model 1 (at 10%) but is not signifincant in Model 2. The negative coefficient implies that there is some evidence that a passenger railway becomes less efficient as the percentage of subsidy in the cost increases. This weak linkage between subsidy and efficiency may be due to the negative correlation between the subsidy variable and the autonomy or ownership variables. Therefore, it may be incorrect to interpret this to mean that subsidy level does not adversely affect efficiency.

(d) **Effect of Ownership Form and Managerial Freedom**: In Model 1, we use the autonomy index to examine the effects of managerial freedom. The significant positive coefficient of AUTONOMY in the Tobit regression shows that efficiency could be improved if management were given more freedom in making strategic and operational decisions. In Model 2, the ownership dummy variables are included to examine the effects of ownership form. The dummy variable for Quasi-public firms is not statistically significant. This implies that the existence of partial private ownership does not necessarily make the railways much different from other public firms when it comes to government control.[9] The Government Agency variable has a significant negative coefficent. This indicates that, after controlling for the other factors, passenger services provided by a government agency are about 17% less efficient.

(e) **Effect of Passenger Only Corporation**: The significant positive coefficient for the **'PASS ONLY'** dummy variable indicates that the experiment by Canada and the U.S. in setting up a single passenger only corporation to handle all intercity rail passenger services is likely to have improved efficiency. This result is consistent with the findings of a previous study by Kim (1987)[10].

The above results from the Tobit regression indicates that a passenger railway's efficiency performance is significantly influenced by the extent of managerial freedom for decision making, as evidenced by the significant negative effect of the Government Agency dummy variable and the positive effect of the autonomy variable. Subsidy levels have negative effects on efficiency.

5.2 Net DEA Efficiency Measures and Comparison Among Railways

Net efficiency rating are obtained from the residuals of Model 2 of the Tobit regression (2) after removing the effects of those factors beyond managerial control. These are listed in Table 6. Model 2 is used primarily for two reasons. First, Model 2 is considered to be slighly better than Model 1 because the former has a higher log-likelihood function value[11]; second, the information on the autonomy index is available

only for the European railways for 1988, and this forced us to assume the degree of management autonomy remained constant during the 1978-88 period[12]. Furthermore, we had to infer the autonomy levels for Amtrak, AN, and VIA Rail.

The net efficiency index became closer together than the gross efficiency index. The results show that CP, CIE, TCDD, and RENFE are the efficient performers in 1988 after controlling for the effects of the variables beyond managerial control; and NSB, ÖBB, SNCB, CH, DB and CFL are the inefficient performers. During our sample period, Amtrak, BR, CIE, DSB and SJ improved their net efficiency significantly while the performance of FS and NSB were significantly reduced.

It is noted that, in terms of the gross DEA efficiency index, AMTRAK, CFF, NS and SNCF are among the top performers. The control reduced their performance ratings from the top to the middle level. On the other hand, control of the variables beyond managerial control improved the efficiency rankings of AN and CIE.

5.3 Efficiency Analysis by Frontier Production Function

In this section, we examine the effects of the policy variables and the uncontrollable variables on the performance of the passenger rail systems by estimating a production function. The results from the production functions are compared to the results from the DEA-Tobit analysis to see if the empirical results are sensitive to the methodology used. The comparison shows that, by and large, the empirical results from the two methods are quite similar.

Although essentially the same data set is used here, this time the production function method allows us to retain the data for JNR and KNR. In estimating the production function, passenger-kilometers are used as the dependent variable for output, and numbers of passenger cars, numbers of locomotives, numbers of employees, energy consumed (measured in BTU), and the lengths of electrified lines and non-electrified lines are used as independent variables for inputs. In addition to those output and input variables, we include the (controllable) policy variables and the uncontrollable variables (which were used in the Tobit analysis) directly in the production function.

The estimated production functions are reported in Table 7. The first five variables are inputs. As expected, DENSITY and TRIP LENGTH variables have statistically significant positive coefficients. SUBSIDY has a significantly negative coefficient (-0.05) implying that government financial support tends to decrease the railways' efficiency. In particular, as subsidy increases by 10% the efficiency decreases by 0.5%. The autonomy variable has a positive coefficient but is not statistically significant. This is probably due to the inclusion of JNR and KNR[13]. It can be explained by the fact that JNR and KNR are both highly efficient according to partial productivities, but they are given the lowest autonomy ratings. Their high efficiency levels are in part due to the fact that they have a much larger market than the other railways. Similarly, SUBSIDY is statistically significant in Model 2 of production function while it is not significant in Model 2 of the Tobit regression where JNR and KNR are excluded because JNR and KNR both have low subsidy levels and high efficiency levels. The GOVERNMENT AGENCY variable in Model 2 has a significant negative effect. The positive coefficient for the PASS ONLY dummy variable is also consistent with the results from Tobit analysis. The results of the production function estimation essentially confirms those of the DEA - Tobit combined analysis.

To compare the efficiency ratings from the DEA-Tobit analysis with those from the frontier production function, the production function is reestimated after removing the JNR and KNR data. In Table 8, the net efficiency measures obtained from the production function (defined in Equation (6)) are compared with the DEA-Tobit results. With a few exceptions, the results are, by and large, similar. Model 2 of the production function is used for the same reasons as Model 2 of the Tobit regression is used. CP,

RENFE are still the top performers as indicated by the DEA-Tobit results, while CFL, ÖBB and SNCB are the least efficient railways. Noticeable differences exist in the efficiency ratings obtained by the two methods for some railways such as CFF (0.60 by DEA as compared to 0.75 by production function).

6. SUMMARY AND CONCLUDING REMARKS

The paper examines and compares the productive efficiency of the railways in 21 selected countries using the gross DEA efficiency index and the net (including managerial) efficiency index.

The gross DEA efficiency ratings are analyzed by econometric procedures to accomplish two tasks: (a) to identify the effects of the controllable and uncontrollable variables on the gross measure of DEA efficiency index; and (b) to compute the net efficiency index after controlling for the effects of the variables which are beyond managerial control. The production function provides an alternative technique to examine the effects of the controllable and uncontrollable variables on performance of the passenger rail systems. The results can be summarized as follows:

(a) JNR, KNR, CP, and RENFE are the top efficiency performers in 1988. This finding is true both before and after controlling for the effects of the variables beyond managerial control. NS, CFF and SNCF were also in the top performance category in terms of the gross DEA efficiency index. However, after controlling for the effects of the variables beyond managerial control, these firms rank somewhat below the top performers.

(b) JNR, Amtrak, BR and DSB have improved productive efficiency significantly during the 1978-88 period.

(c) AN, DB, NSB, ÖBB, SNCB, CH and CFL are the inefficient performers in terms of both gross and net efficiency indices.

(d) Our analysis of the gross DEA efficiency index and the estimated production function indicate that the efficiency performance of the passenger rail system is significantly enhanced by institutional and regulatory framework which gives greater freedom for managerial decision making.

(e) There is fairly convincing evidence to support the establishment of a single national passenger-only corporation like VIA Rail Canada and Amtrak.

(f) An increase in subsidy (ratio of subsidy to total operating cost) lowers the efficiency of the passenger rail operation, ceteris paribus.

In view of these results, we conclude that freedom of managerial decision making is an important element for improving the efficiency of a passenger rail system. Therefore, the institutional and regulatory framework for passenger system must squarely address this question. A high level of government subsidy without setting explicit cost recovery targets will tend to reduce the level of efficiency.

Notes

1. Throughout this paper, the term "quasi-public firm" is used to indicate mixed ownership by public and private interests.

2. Only recently did the National Transportation Agency of Canada grant substantial autonomous decision making power (such as choosing what markets to serve) to VIA Rail Canada.

3. Most of the railways providing mixed passenger and freight services do not report a separate revenue-expense account for passenger services.

4. Most of the railways receive payments from governments for specific services.

5. Linear regression analysis was used in the calculation.

6. This portion of Amtrak's labour input is provided by Amtrak's Department of Human Resources, while VIA Rail's is estimated using the results of Cubukgil and Soberman (1984).

7. VIA Rail's energy consumption data are available only for the period 1985-1988, the data for earlier years are estimated. Actual fuel consumption data of AN are not available, it is also estimated by dividing fuel expenses by the yearly average diesel prices in Australia (published in the OECD publication **Energy Prices and Taxes**).

8. AN Rail provided us with the number of employees attributable to their passenger services. However, we decided to use our own method of allocation between passenger and freight services to achieve consistency with other sample railwaysin the data construction. Even if their labour data are used, AN Rail is among the low achievers.

9. In private communication, Professor C. Nash indicated that he does not believe the nominal 49% private shareholding in SNCF made it in any sense different from other state owned railways when it came to government control.

10. Kim (1987) found that the US railroads suffered from diseconomies of scope associated with the joint production of freight and passenger services.

11. Strictly speaking, Model 1 and Model 2 can not be easily compared as there is no nesting relationship between the two.

12. This may be an unrealistic assumption. For example, since the early 1980s BR and SJ were given more freedom for managerial decision making.

13. When the production function is estimated over the data set excluding JNR and KNR, the autonomy variable has a significant positive coefficient.

REFERENCES

Amemiya, T. (1985), Advanced Econometrics, Harvard University Press, Cambridge, Massachusetts.

Banker, R.D., A. Charnes and W.W. Cooper (1984), "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis", Management Science, Vol.30, No.9, September 1984, pp1078-1092

Charnes, A., W.W. Cooper and E. Rhodes (1978), "Measuring the Efficiency of Decision Making Units", European Journal of Operational Research, 2.

Compagnie, I., H. Gathon and P. Pestieau (1991), "Autonomy and Performance in Public Enterprises: the case of Railways and Postal Services", presented at CIRIEC Seminar Public Versus Private Enterprises: In Search of the Real Issues, Liége, April 4-5, 1991

Cubukgil, A. and R. Soberman (1984), "Costs of Rail Passenger Service in Canada: An Examination of Institutional Problems", Proceedings of 19th Annual Meeting, Canadian Transportation Research Forum, Jasper, Alberta, May 1984, 342-365

Greene, W.H. (1980), "Maximum Likelihood Estimation of Econometric Frontier Functions", Journal of Econometrics 13, pp27-56

Kim, H. Y. (1987), "Economies of Scale and Scope in Multiproduct Firms: evidence from US Railroads", Applied Economics, 19, pp733-741

Nash, C. (1981), "Government Policy and Rail Transport in Western Europe", Transport Review 1981, Vol.1, No.3, 225-250

Nash, C. (1985), "European Railway Comparisons - What can we learn", International Railway Economics, ed. by K.J. Button and D.E. Pitfield, Gower Publishing, 1985.

Perelman, S. and P. Pestieau (1988), "Technical Performance in Public Enterprises: A Comparative Study of Railway and Postal Services", European Economic Review, 32 (1988), 432-441

Schwier, C., J. Jones and A. Pignal (1990), "Canadian Regional Railway Passenger Services: Was There Ever Any Potential for Financial Improvement", Proceedings of 25th Canadian Transportation Research Forum, Saskatoon, June 6-8, 1990, 254-267

Tobin, J. (1958), "Estimation of Relationships for Limited Dependent Variables", Econometrica, 1958, 24-36

UIC (International Union of Railways), International Railway Statistics, Paris, issues from 1978 to 1988.

Table 1

Railway Characteristics

Railways	Countries	Year	Share[1] (%) 1987	Density[2] (000) 1988	Trip[3] (KM) 1988	%PASS[4] (%) 1988	%ELECT[5] (%) 1988
VIA	Canada	80-88	1.6[a]	124	358	100[b]	0
Amtrak	U.S.	78-88	0.7	217	425	100	2.9[b]
AN	Australia	79-88	2.5[b]	32	666[b]	23	0
BR	U.K.	78-88	7.0	2398	45	81	26
CFF	Switzerland	78-88	12.6	3682	42	77	99
CFL	Luxemboug	78-88	n/a	944	21	60	60
CH	Greece	78-87	9.7	795[c]	168[c]	85	0
CIE	Ireland	78-88	n/a	714	49	70	2
CP	Portugal	78-88	7.9	1674	26	79	13
DB	Germany	78-88	6.3	1954	42	66	43
DSB	Denmark	78-88	7.4	2272	33	83	9
FS	Italy	78-88	7.2	2783	106	76	58
JNR	Japan	78-86	37.1	9657[d]	28	87[e]	47[e]
KNR	S.Korea	79-84	21.1	7243[f]	45[f]	67[f]	14
NS	Netherland	78-88	5.8	3776	42	90	69
NSB	Norway	78-88	4.5	519	62	71	58
ÖBB	Austria	78-88	9.4	1528	49	63	57
RENFE	Spain	78-88	8.5	1410	81	68	50
SJ	Swedan	78-88	6.2	648	82	59	63
SNCB	Belgium	78-88	7.6	2268	44	77	64
SNCF	France	78-88	9.2	2651	79	64	35
TCDD	Turkey	78-88	n/a	822	49	60	4
VR	Finland	78-88	5.8	721	73	57	28

1. Rail's share of total passenger traffic in terms of passenger kilometers.
2. Passenger traffic density measured by passenger kilometers per route kilometer.
3. Average trip length of rail passengers.
4. Percentage of passenger train kilometers in total train kilometers.
5. Percentage of electrified route mileage in total route mileage.

a. in 1988; b. in 1985; c. in 1987;
d. in 1987; e. in 1986; f. in 1984

Table 2

Financial Indicators

Railways	Countries	Revenue/Costs 1980	Revenue/Costs 1988	Subsidy/Costs 1980	Subsidy/Costs 1988
VIA	Canada	0.31	0.28	0.70	0.72
Amtrak	U.S.	0.39	0.63	0.71	0.31
AN	Australia	0.71	0.86	0.26	0.15
BR	U.K.	0.74	0.92	0.24	0.17
CFF	Switzerland	0.74	0.73*	0.08	0.12*
CFL	Luxemboug	0.31	0.23	0.66	0.75
CH	Greece	0.54	0.28	0.47	0.72
CIE	Ireland	0.68	0.76	0.31	0.24
CP	Portugal	0.46	0.50	0.45	0.29
DB	Germany	0.58	0.59	0.30	0.29
DSB	Denmark	0.68	0.63	0.32	0.37
FS	Italy	0.29	0.22	0.45	0.66
JNR	Japan	0.70	1.12	0.07	0.01
KNR	S.Korea	0.84	0.96	0.02	0.05
NS	Netherland	0.56	0.57	0.43	0.47
NSB	Norway	0.72	0.60	0.28	0.40
ÖBB	Austria	0.67	0.63	0.14	0.41
RENFE	Spain	0.55	0.46	0.45	0.53
SJ	Swedan	0.83	0.81	0.13	0.15
SNCBb	Belgium	0.44	0.43	0.55	0.56
SNCF	France	0.66	0.65	0.30	0.28
TCDD	Turkey	0.45	0.73	0.41	0.13
VR	Finland	0.77	0.74	0.02	0.03

*. The Government has been paying the infrastructure costs of CFF since 1987, on the other hand, CFF pay the government a contribution towards the infrastructure expenses. To be consistent with the earlier data, government payment for infrastructure and CFF's contribution towards infrastructure expenditure are excluded in calculating the financial ratios.

Table 3

DEA GROSS EFFICIENCY INDEX

	1978	1980	1982	1984	1986	1988	Average 85-88
VIA (Canada)	-	0.76	0.69	0.72	0.66	0.70	0.68
Amtrak (US)	0.63	0.80	0.79	0.84	0.92	1.00	0.94
AN (Australia)	-	0.21	0.25	0.27	0.24	0.27	0.24
BR (UK)	0.57	0.60	0.55	0.76	0.77	1.00	0.82
CFF-SBB (Switzerland)	0.87	0.94	0.89	0.87	0.88	0.98	0.93
CFL(Luxembourg)	0.48	0.50	0.48	0.44	0.41	0.41	0.42
CH(Greece)	0.46	0.44	0.43	0.46	0.54	-	0.52
CIE(Ireland)	0.51	0.56	0.52	0.53	0.63	0.71	0.66
CP(Portugal)	0.93	1.00	0.88	0.92	0.98	1.00	0.99
DB (Germany)	0.51	0.53	0.55	0.56	0.61	0.62	0.61
DSB (DENMARK)	0.49	0.53	0.64	0.68	0.79	0.86	0.81
FS (Italy)	0.91	0.97	0.99	0.88	0.95	0.99	0.97
JNR (Japan)	-	-	-	-	-	-	
KNR(Korea)	-	-	-	-	-	-	
NS (Netherlands)	0.94	1.00	1.00	0.97	0.94	1.00	0.97
NSB (NORWAY)	0.58	0.64	0.62	0.60	0.56	0.51	0.56
ÖBB (AUSTRIA)	0.57	0.56	0.54	0.52	0.54	0.57	0.54
RENFE (Spain)	1.00	0.80	0.82	0.89	0.91	0.96	0.93
SJ (Sweden)	0.61	0.76	0.70	0.72	0.72	0.76	0.74
SNCB (BELGIUM)	0.59	0.57	0.56	0.51	0.56	0.60	0.59
SNCF (France)	0.88	0.90	0.92	0.96	0.98	1.00	0.98
TCDD(Turkey)	0.82	0.83	0.73	0.83	0.77	0.93	0.83
VR (FINLAND)	0.52	0.57	0.59	0.61	0.52	0.63	0.58

Table 4

Definition of Variables Used in Regression Analysis

Variables	Description
	UNCONTROLLABLE FACTORS
LEFF	log (DEA efficiency index)
SHARE	Rail's share in passenger transport market (in terms of passenger Km)
DENSITY	Traffic Density measured by passenger Kms per route Km
%PASSENGER	Percentage of passenger train-Km in total train-Km
TRIP LENGTH	Average length of passenger trip (Km)
TIME	Time Trend
	CONTROLLABLE FACTORS
SUBSIDY/C	Percentage of subsidy to total operating costs
%ELECTRIC	Percentage of Electrified Route Miles
AUTONOMY	Degree of managerial freedom measured by Compagnie, Gathon and Pesticau (1991)*
QUASI PUB	A Dummy variable = 1 if the railway is a quasi-public corporation (VIA and AMTRAK)
GOV AGENCY	A Dummy variable = 1 if the railway is run by a government agency
PASS ONLY	A Dummy Variable = 1 if the railway is a single national passenger-only organization
DEFICIT	A Dummy Variable = 1 if subsidy covers 100 percent of deficit

* Since the information on the degree of management autonomy for the European railways was available only at a single point in time (measured by Compagnie, Gathon and Pesticau, 1991), it was necessary to assume that the railways' autonomy ratings remain unchanged during the study period. In addition, VIA Rail, JNR and KNR are given the lowest autonomy rating, and Amtrak and AN are given the same rating as BR.

Table 5

Tobit Regression Results

Dependent Variable : LEFF= LOG(DEA gross efficiency indices)

Variables	Model 1 Coefficients	Model 1 t-values	Model 2 Coefficients	Model 2 t-value
DENSITY	0.22	6.41	0.28	7.33
TRIP LENGTH	0.12	3.64	0.14	4.39
%PASSENGER	0.26	2.82	0.11	1.06
%ELECTRIC	0.02	3.14	0.02	3.16
SUBSIDY/C	-0.02	1.54	-0.0004	0.03
AUTONOMY	0.29	3.72		
GOV. AGENCY			-0.19	4.34
QUASI-PUB.			0.04	0.50
PASS ONLY	0.96	6.80	0.68	5.63
CONSTANT	-2.98	8.68	-2.19	8.07
No. of Observation:	227		227	
LOG-LIKEHOOD FUNCTION:	38.086		41.140	
R^2	0.6416		0.6507	

* Efficiency index and all the variables are in natural logarithms except for the dumay variables.

Table 6

MANAGERIAL (NET) EFFICIENCY INDEX

	1978	1980	1982	1984	1986	1988	Average 85-88
VIA (Canada)	-	0.58	0.57	7.60	0.56	0.59	0.57
Amtrak (US)	0.47	0.57	0.56	0.59	0.62	0.66	0.63
AN (Australia)	-	0.48	0.52	0.60	0.56	0.58	0.55
BR (UK)	0.43	0.44	0.42	0.54	0.56	0.71	0.59
CFF-SBB (Switzerland)	0.59	0.62	0.59	0.58	0.58	0.63	0.60
CFL(Luxembourg)	0.46	0.48	0.46	0.43	0.42	0.42	0.42
CH(Greece)	0.48	0.47	0.44	0.47	0.51	-	0.50
CIE(Ireland)	0.62	0.67	0.62	0.58	0.67	0.74	0.70
CP(Portugal)	0.80	0.84	0.77	0.80	0.84	0.85	0.85
DB (Germany)	0.50	0.51	0.53	0.53	0.55	0.57	0.56
DSB (DENMARK)	0.50	0.54	0.60	0.63	0.62	0.65	0.65
FS (Italy)	0.68	0.72	0.73	0.67	0.60	0.63	0.61
JNR (Japan)	-	-	-	-	-	-	-
KNR(Korea)	-	-	-	-	-	-	-
NS (Netherlands)	0.61	0.64	0.64	0.62	0.60	0.64	0.62
NSB (NORWAY)	0.60	0.63	0.62	0.60	0.56	0.51	0.56
ÖBB (AUSTRIA)	0.49	0.47	0.46	0.44	0.44	0.45	0.44
RENFE (Spain)	0.78	0.66	0.66	0.70	0.69	0.74	0.70
SJ (Sweden)	0.60	0.70	0.66	0.68	0.67	0.71	0.68
SNCB (BELGIUM)	0.43	0.42	0.41	0.38	0.41	0.43	0.42
SNCF (France)	0.59	0.60	0.61	0.64	0.65	0.66	0.66
TCDD(Turkey)	0.87	0.85	0.80	0.86	0.80	0.93	0.85
VR (FINLAND)	0.50	0.54	0.55	0.57	0.51	0.59	0.55

Table 7

Production Function Regression Results

Dependent Variable : LPAKM=LOG(Passenger Kilometers)

Variables	Model 1 Coefficients	Model 1 t-values	Model 2 Coefficients	Model 2 t-value
PASSENGER CAR	0.42	5.46	0.44	5.98
LABOUR	0.06	0.69	0.04	0.46
ENERGY	0.28	4.37	0.29	4.85
ELECTRIFIED LINE	0.03	4.28	0.03	4.53
NON-ELECT. LINE	0.13	7.26	0.14	8.14
DENSITY	0.56	14.01	0.59	17.06
TRIP LENGTH	0.27	5.63	0.26	6.00
%PASSENGER	0.07	0.75		
SUBSIDY/C	-0.05	3.32	-0.05	3.54
AUTONOMY	0.05	0.54		
GOV. AGENCY			-0.19	3.95
PASS ONLY	0.39	2.64	0.28	2.95
CONSTANT	-2.27	4.97	-2.17	7.84
No. of Observation:	242		242	
Degree of freedom:	230		231	
LOG-LIKEHOOD FUNCTION:	9.745		17.275	
R^2	0.9769		0.9784	

* All variables are in natural logarithms except for the dumay variables.

Table 8

EFFICIENCY INDEX COMPARISON

Railways	Countries	DEA-Tobit average of 85-88	PRODUCTION FUNCTION average of 85-88
VIA	Canada	0.57	0.56
Amtrak	US	0.63	0.62
AN	Australia	0.55	0.56
BR	UK	0.59	0.53
CFF-SBB	Switzerlands	0.60	0.75
CFL	Luxembourg	0.42	0.43
CH	Greece	0.50a	0.57a
CIE	Ireland	0.70	0.67
CP	Portugal	0.85	0.99
DB	Germany	0.56	0.64
DSB	Denmark	0.65	0.56
FS	Italy	0.61	0.50
JNR	Japan	-	-
KNR	Korea	-	-
NS	Netherlands	0.62	0.64
NSB	Norway	0.56	0.64
ÖBB	Austria	0.44	0.51
RENFE	Spain	0.70	0.73
SJ	Sweden	0.68	0.59
SNCB	Belgium	0.42	0.39
SNCF	France	0.66	0.62
TCDD	Turkey	0.85	0.69
VR	Finland	0.55	0.54

a: average of 1985-87

An Analysis Potential for Ecuadorian Crude Oil to use the Trans-Panama Pipeline Instead of the Panama Canal

David F. Bastian
Commission for the Study of Alternatives
to the Panama Canal

SUMMARY

Background.

Since its opening in October of 1982, the Petroterminal de Panama (PTP) pipeline has only handled Alaska North Slope (ANS) crude oil. The volume of crude handled by the pipeline has fallen each year for the last four years. The 1990 throughput is only slightly above 25% of the pipeline's capacity of approximately 800,000 barrels per day (bpd) but still well above the breakeven throughput of about 100,000 bpd. Recent studies forecast an approximate 100,000 bpd average annual decrease in ANS production over the next 10 years. If that materializes, it will directly impact PTP throughput.

Based upon current trading patterns, the only potential sources of crude oil to augment the decreasing ANS supply would be Atlantic-bound crude oil presently traversing the Panama Canal. Of this traffic, the major source of crude oil is from Ecuador.

Purpose.

The purpose of this paper is to evaluate the potential for diverting Ecuadorian crude oil, which is presently being transported through the Panama Canal, to the trans-Panama pipeline operated by PTP.

Method.

To determine the economic feasibility for Ecuadorian oil to use the PTP pipeline requires a transportation cost analysis.

In order to accomplish this goal, one must first identify the magnitude of the problem - potential drop in single source (ANS). Second, identify the supplementary source (Ecuador) and evaluate its potential volume. Third,

review current shipping patterns. Fourth, identify potential shipping and port constraints which would confront the larger tankers capable of using the pipeline. Finally, calculate the time and cost of using the Canal versus the potential for using the pipeline.

This effort will neither assess current operational or cost policies of PTP nor evaluate the cost of upgrading storage facilities necessary to accommodate different crude oils or the cost of upgrading the floating buoys at Chiriqui Grande (Atlantic terminal for the pipeline) to accommodate larger ships.

TRANS-ISTHMIAN CRUDE OIL TRAFFIC

PTP Pipeline Traffic.

The first year of operating saw the peak movement of oil across Panama via pipeline which averaged 701,000 bpd for 1983. During the next four years (1984-1987) the volume was relatively steady with an average for the period of 588,000 bpd. Starting in February 1988 and continuing to the present there has been a steady sharp drop in average annual throughput as seen in Table 1.

Table 1

Shipments of Alaskan North Slope Crude Oil
(thousands of barrels per day)

	Year			
Destination	1987	1988	1989	1990
West Coast	1,179	1,259	1,315	1,358
Alaska	N/A	70	70	68
Hawaii	N/A	53	43	48
Virgin Islands	141	133	97	19
PTP	584	474	321	252
Total Shipped	1,913	1,994	1,847	1,745

N/A - not available
Source: U.S. Maritime Administration

ANS production was 1,600,000 bpd when the pipeline opened. This output increased steadily and annually until it peaked in 1988 at 1,994,000 bpd. In 1989 there was a 7% drop in production and an almost equal drop in 1990. Unless the recent Iraq crisis overrides heightened environmental concerns in the United States, no new fields will be opened in Alaska and thus the production of ANS crude will steadily diminish, as predicted in recent

studies, to the point that it will be equal to or below the current U.S. West Coast consumption by 1994 (see Table 2). On the other hand, this same crisis could cause the opening of offshore oil fields in California which could benefit either or both PTP and the All-American Pipeline (which runs from California to Texas).

Table 2

Predicted ANS Oil Production Decline
(thousands of barrels per day)

Year	1991	1992	1993	1994	1995
Production	1,798	1,632	1,479	1,369	1,190

Source: Alaska Department of Natural Resources

The reasons for the drop in PTP throughput for the last three years are directly related to ANS production and U.S. West Coast consumption. Helping to slightly counteract that effect has been the recent trans-shipping of some of the Hess owned ANS crude which normally goes to the Hess refinery in the U.S. Virgin Islands around South America in foreign flag super tankers.

Panama Canal Crude Oil Movements.

The other trans-Isthmian oil route is via the Panama Canal. Because of supplier-buyer contracts and the locations of their refineries, crude oil moves through the Canal in both directions. However, the predominant direction is from the Pacific to the Atlantic as is shown in Table 3. Ecuador is the major supplier of Atlantic-bound crude oil.

Table 3

Panama Canal Crude Oil Movements
(thousands of barrels per day)

Direction	Fiscal Year							
	1982	1983	1984	1985	1986	1987	1988	1989
Atlantic to Pacific	86.3	88.2	76.4	66.6	56.7	66.6	54.8	41.1
Pacific to Atlantic	785.5	276.2	201.6	176.2	195.9	109.6	117.5	113.4
Total	871.8	364.4	278	242.8	252.6	176.2	117.5	154.5

Note: Long tons were converted to barrels based upon assumed APG gravity of 27 at 60 deg. F.

Source: Panama Canal Commission

ECUADORIAN OIL

Crude Oil Production.

Although Ecuador is a member of OPEC, it is considered a marginal producer. Ecuador's production quota is 242,000 bpd but OPEC has given official dispensation to produce 40,000 bpd above that level. Domestic consumption represents about one-third of the petroleum output which in 1988 was 31.5 million barrels.

Reserves.

Recoverable reserves, both proven and probable, were estimated at 1.8 billion barrels in a 1989 report. If the 1988 peak pace of production were to remain constant, Ecuador would have about 10 more years of proven reserves plus some 6.5 years of probable reserves.

Current explorations will undoubtedly be successful. A contract was scheduled to go into effect in 1990 with British Petroleum to produce another 15,000 bpd and a contract with Conoco could increase production of crude at the rate of 30-40,000 bpd by 1992. However, new discoveries from other firms would not be likely to be produced before the mid-1990s.

Exportation.

For the period of 1985-1989, Ecuador has been exporting about 63 million barrels of crude oil (except

in 1987 when an earthquake disrupted the pipeline for five months dropping the annual output to 38 million barrels). During these five years, the United States has been the largest buyer, importing an average of 21.8 million barrels per year. However, the volumes purchased have ranged from 9.8 million in 1987 to a high of 34.5 million barrels in 1989 (see Table 4).

Table 4

Exportation of Ecuadorian Crude Oil
from the Petroleum Terminal, Balao, Ecuador
(barrels per day)

Country	Year				
	1985	1986	1987	1988	1989
USA	68,050	68,868	27,558	36,640	94,205
Puerto Rico	26,448	25,868	22,049	25,903	14,982
Panama	13,872	13,558	6,166	8,776	11,119
Dutch Antill	2,019	0	5,662	28,065	0
Brazil	0	3,419	1,619	1,654	0
Subtotal	110,389	111,713	63,054	101,038	120,306
Peru	0	0	5,375	23,665	18,963
Chile	3,059	7,141	2,007	5,093	9,565
Taiwan	0	8,912	5,117	9,201	7,447
Others	13,252	5,173	901	1,877	5,392
Korea	57,855	50,830	25,009	43,717	5,161
Nicaragua	0	0	0	0	5,030
China	0	0	1,833	0	0
Costa Rica	0	0	1,138	1,331	0
Japan	1,638	1,353	0	0	0
Colombia	2,365	0	0	0	0
Uruguay	0	1,189	0	0	0
Subtotal	78,230	74,597	41,379	84,884	51,557
Total	188,619	186,310	104,433	185,922	171,863

Estadisticas Portuarias 1989 Ecuador, p. 62.

What apparently accounts for the wide swings in exporting volumes over the past several years is that most of the Ecuadorian crude oil that is exported is done so through one-year contracts with foreign firms.

Table 5

1989 Contracts for Exporting Ecuadorian Crude Oil

Number of Contracts	Volume Contracted bpd
7	10-12,000
3	15-18,000
1	24,000

Source: Industrial Outlook for Petroleum and Natural Gas, Ecuador, U.S. Embassy-Ecuador, June 1989.

Shipping Potential.

Ninety nine percent of Ecuador's crude oil comes from the Oriente, an area east of the Andes. The trans-Andean pipeline is the first constraint to increasing both production and exports of crude oil. At present the pipeline has a capacity of about 305,000 bpd. For an estimated investment of $200 million, extra pumping stations and increased storage facilities could increase the flow rate another 50,000-100,000 bpd. This 503-km long pipeline is supplemented by a 45,000 bpd capacity pipeline (described as unreliable) which goes to the Pacific Coast of Colombia.

In addition to the existing OPEC limits to exporting, there is a political concern to limit exports in order to conserve a non-renewable energy source.

Ecuador's crude oil exporting port is Balao, terminus to the pipeline. Balao has two fixed point floating mooring buoys capable of serving tankers of up to 150,000 deadweight tons (dwt). These are located in water depths of 100 feet about 2 miles from Esmeraldas, site of Ecuador's major refinery.

All Ecuadorian crude exports must be carried in tankers belonging to FLOPEC, a firm owned and operated by the Ecuadorian Navy, when FLOPEC tankers are available. However, because FLOPEC only owns 7 vessels, most crude is carried in foreign flag bottoms. Table 6 demonstrates the range in size of ships used during the last two years in the exportation of Ecuadorian crude oil.

Table 6

Ship Movements by Size

Size Range dwt	Year 1988	1989
	number of ships	
22,000-23,999	2	0
30,000-31,999	0	7
32,000-33,999	0	20
34,000-35,999	2	0
36,000-37,999	2	4
44,000-45,999	0	1
50,000-51,999	20	14
52,000-53,999	1	0
54,000-55,999	16	10
56,000-57,999	15	22
58,000-59,999	1	14
60,000- +	104	92
Total	163	185

Source: Estadisticas Portuarias, 1989 Ecuador, p. 129

Not all Ecuadorian crude oil exported to the United States goes through the Panama Canal. In 1989, for example, of the 29 million barrels* exported to the U.S. as reported by U.S. Department of Commerce, 80% or an average of 64,700 bpd went through the Canal, the rest having gone to the U.S. West Coast and Hawaii.

Those ships carrying Ecuadorian crude oil to Brazil, the Dutch Antilles, Puerto Rico and the Gulf and East Coasts of the United States go by tankers small enough to fit into the Panama Canal. The Canal limits sizes up to about 65,000 dwt. More specifically, the ships must be less than 1000-feet long and cannot have widths in excess of 106 feet nor draw more than 39.5 feet of tropical fresh water. This size limitation is well under the 150,000-dwt loading allowance at Balao.

* This is 5 million barrels less than reported by Ecuadorian statistics as shown in Table 4. Thus if one took a conservative approach, this lower number must be used.

If Ecuadorian crude oil was to use the trans-Panama pipeline instead of the Canal, tankers from Balao would sail basically the same distance in order to reach the Pacific terminus for PTP which is located at Charco Azul near the Costa Rican border with Panama. There the larger two unloading docks can accept ships up to 265,000 dwt. The ship size constraint for the trans-Panama pipeline system is the Atlantic loading facility which has two fixed point buoys with a rated mooring capacity of 150,000 dwt. With natural water depths of around 70 feet, the bouys are the present limitation.

Furthermore, if Ecuadorian crude oil was to cross Panama via the pipeline, it could also be transported in larger ships on the Atlantic leg. How much larger depends on the port of destination. The ports of delivery on the Gulf and U.S. East Coast are generally limited to drafts of 40 feet. The major exceptions are the Louisiana Offshore Oil Port (LOOP) which can except ships up to 700,000 dwt and the port of Yabucoa in Puerto Rico which accommodates 100,000-dwt ships. However, tankers bound for greater New Orleans or Philadelphia can and often do lighter (because of channel depth restrictions) off the mouth of the Mississippi River and the lower Delaware Bay, 100 and 70 miles from their respective destinations. Listed below are the Gulf and East Coast ports of the United States where the majority of ships with Ecuadorian crude were discharged in 1989 and 1990 showing their draft restrictions.

Table 7

Channel Depths, U.S. Ports
(lightering anchorage, authorized & maintained)

Port		Depth, feet	
Houston		40	40
Lake Charles	60	40	
LOOP		110	110
New Orleans	60	55	45
New York	45	40	40
Philadelphia	55	40	40

Source: U.S. Army Corps of Engineers

Except for New Orleans, the U.S. port channel depth constraints are about the same as the dimensional limitations imposed by the Panama Canal. Both Philadelphia and New Orleans are along fresh water channels which reduces the effective navigation draft of ships as they approach these ports.

Panama Canal Traffic of Ecuadorian Crude Oil.

The vast majority of the tankers carrying Ecuadorian crude through the Panama Canal are between 60,000-70,000 dwt. Most of the traffic is to the Delaware Bay, Mississippi River, New York, Panama and Puerto Rico, respectively. Collectively, these five port areas represented almost 75% of the ship movements during 1989 and the first half of 1990.

The tankers from Balao almost invariably transit the Panama Canal on the third calendar day from their departure. As the vast majority are Panamax ships, they go through by convoy entering the Canal during the morning only. Canal water time varies for a number of factors, but the average is about 24 hours. Once in the Caribbean, these tankers reach their destination in 2 to 9 days (except Las Minas which is near the northern end of the Canal) depending on distance, weather and speed.

Table 8 presents the volume of Ecuadorian crude oil aggregated by U.S. Customs Districts including Puerto Rico, which traversed the Panama Canal during 1989. These figures are more conservative than those given by Ecuador as presented in Table 4. However, in order to complete the table below, Ecuadorian figures were used for Las Minas. The number of shipments is based upon the first port of call as reported by Lloyd's of London which may explain the absence of calls for the Norfolk reporting district (of the U.S. Customs). The disproportion of shipments to volume can also be explained by channel limitations.

Table 8

Ecuadorian Crude Oil Transported through the Panama Canal
1989

Reporting District		Barrels	Shipments
1.	New York	801,719	14
2.	Philadelphia	9,072,754	30
3.	Norfolk	328,920	0
4.	New Orleans	11,941,860	30
5.	Houston/ Galveston	1,420,533	4
6.	Puerto Rico	7,017,437	16
7.	Las Minas	4,058,435	16

Source: U.S. Census, Estadisticas Portuarias 1989 Ecuador and Lloyd's of London

COST COMPARISON

Basis.

In order to make a cost comparison between the existing Ecuadorian oil traffic through the Canal and a hypothetical transportation system via the pipeline, several assumptions have been made.

1. Trans-Canal Voyage Cost Calculations.

   a. The existing trans-Canal voyage costs are based upon average ship operating costs for non-U.S. ships as calculated annually by the U.S. Army Corps of Engineers. The most recent publication was for 1990 cost estimates. There is a difference between cost and price. Time charter prices were not used because they represent a variable supply and demand.

   b. Because the fifty plus ships involved in the trans-Canal transport during the study period continued on to several other ports before returning to Ecuador, they are assumed to have been involved in multiple loadings and discharges and thus the calculations do not include an empty backhaul (see Table 10 for the itinerary of a typical tanker involved in the Ecuadorian crude oil transport). In other words, the transportation cost is based upon the one-way journey to the first port of call and a Canal toll for a loaded vessel and one day each at the loading and discharge ports.

   c. Panama Canal tolls were calculated using the toll structure (inaugurated October 1, 1989) which is $2.01 per Panama Canal Net Registered Ton.

2. Hypothetical Ecuador to Atlantic/Caribbean Port Cost Calculations.

   a. Tankers of 150,000-dwt are assumed for the Balao-Charco Azul leg. The voyage cost is calculated on the basis of the Corps' non-U.S. flag tanker operating costs and the time to travel from Balao to Charco Azul, discharge and return to Ecuador. The at port operating costs are used for loading/unloading time.

   b. No costs are included for either the pipeline or pilotage and berthing fees at Charco Azul and Chiriqui Grande.

   c. The maximum size tanker allowable for the receiving port for the final leg is used (but obviously not to exceed 150,000 dwt - the limit at

Chiriqui Grande). For New Orleans and Philadelphia lightering is assumed but no costs have been included for lightering.

Trans-Canal Transportation Costs.

The costs are based upon the time of departure from Balao until arrival at the first port of call based upon the movements of Ecuadorian crude oil to Atlantic ports as recorded by Lloyd's of London. The Canal tolls are determined by the Panama Canal Commission's carrying capacity analysis expressed in Panama Canal net tons. The unit cost is calculated by dividing the total calculated cost by the volumetric capacity of the tanker adjusted for draft.

As most tankers involved in the transport of Ecuadorian crude oil are Panamax, the toll for transiting the Canal is between $50,000-$60,000. The daily operating cost for these ships at sea is approximately $20,000 and $16,000 when in port. These ships can carry about 450,000 barrels of crude oil. However, most tankers would have to light load to a salt water draft of about 38.5 feet depending on the specifications of the ship.

Trans-Pipeline Tanker Transportation Costs

To carry the estimated 33,142,000 barrels of Ecuadorian crude transported through the Panama Canal in 1989 would require about 25 roundtrips for a 150,000-dwt tanker between Balao and Charco Azul. The average daily operating cost of a non-U.S. flag 150,000-dwt tanker is $28,433 at sea and $21,562 while in port. Assuming one day to load in Balao and one day to discharge at Charco Azul and two days travel between, the roundtrip voyage cost would be $156,896 or $0.12 per barrel. Thus one ship on a six-day schedule could handle that route in 150 days.

The delivery of crude oil to the pipeline facility would have to be spread out to avoid storage problems. Because one tanker could deliver this volume in slightly less than half a year, the potential tanker would not be fully occupied. To provide regular delivery on a 14-day basis would raise the chartering price.

Since the bulk of delivery is to Houston, Las Minas, New Orleans, Philadelphia, New York and Yabucoa, these ports were the only ones considered in the analysis. Table 9 presents calculated unit costs for the delivery of crude oil to the ports specified (to the point of lightering in the cases of New Orleans, New York and Philadelphia).

Pilot fees, usually a function of ship size, and lightering were not included and would add to the cost.

Table 9

Cost for Chiriqui Grande to Atlantic Port

Port	Design Ship dwt	Capacity barrels	Days sea	Days port	Operating Cost sea	Operating Cost port	Trip cost	Unit cost	Potential volume barrels	Trips no.	Total days
New Orleans	150,000	1,000,000	7.5	2	28,400	21,500	256,000	0.26	11,941,866	12	113
Philadelphia	120,000	850,000	12.2	2	26,100	20,000	358,420	0.42	9,072,757	11	152
Yabucoa	100,000	750,000	9	2	24,400	18,900	257,400	0.34	7,017,437	9	103
New York	80,000	600,000	15.2	2	22,900	17,700	383,480	0.64	801,719	1	23
Las Minas	60,000	450,000	8.5	2	20,600	16,300	42,900	0.10	4,058,435	9	23

Table 10 presents a comparison of shipping oil via the pipeline versus the Canal. The unit costs for the pipeline do not include PTP costs or lightering for New Orleans, New York and Philadelphia.

Table 10

Pipeline Versus Canal Cost
cost per barrel, $

Destination	Canal	Pipeline
New Orleans	0.52	0.38
Philadelphia	0.62	0.54
New York	0.84	0.76
Yabucoa	0.58	0.46
Las Minas	0.35	0.24

CONCLUSIONS

There is a potential for some 90,000 bpd of Ecuadorian crude oil to be diverted to the PTP pipeline if the cost and delivery schedule are competitive and convenient, respectively. Because the above analysis was based upon several assumptions described, it may not give a correct cost indication for diversion - this can only be obtained by direct negotiations with the buyers.

BORDER TRUCK MOVEMENT CHARACTERISTICS ONTARIO, 1988

Julius Gorys, Greg Little, Rob Tardif,
& Gord Ripley

Ontario Ministry of Transportation

Introduction

In 1988, an on-highway survey of commercial vehicle movements was undertaken by the Ontario Ministry of Transportation, to obtain data on trucks, loads, drivers and origin/destination characteristics. Of particular interest was information on vehicles that crossed Ontario's borders. Timely information on border movements was considered important for the following reasons:

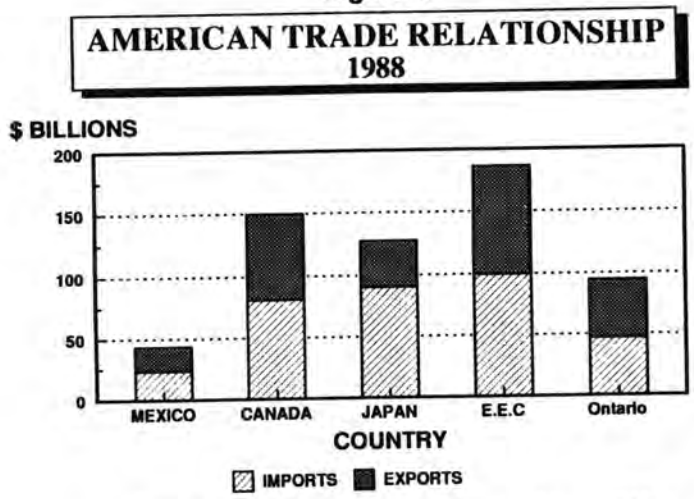
- it provided a measure of the relative degree of interaction between the economy of Ontario and either the United States or the rest of Canada;
- it highlighted the use of Ontario's highways as a landbridge between other origins/destinations;
- it identified the market share of Ontario registered vehicles in the carriage of border truck traffic; and,
- it might outline how similar or different truck travel was for such trips, which could prove useful for highway planning or protection purposes.

The intent of this paper is to detail the characteristics of border truck movements by other criteria captured by the survey. A similar survey was undertaken in 1983.

The Province of Ontario is a significant trading entity within North America. Its trade with the United States is in excess of $ 100 billion annually. Ontario exports to the United States are roughly equivalent in dollar value to what the United States receives from the United Kingdom, France and Italy combined, while Ontario imports from the United States are equivalent to what the United

States dispatchs to the United Kingdom, France and West Germany combined (Figure 1). Within Canada, Ontario is the principal generator and receiver of Canadian goods and services to and from other Provinces.

Figure 1



Source: Statistical Abstract of the United States 1990

Study Methodology

A total of 19,225 vehicles were surveyed during the course of this survey at 57 locations -- 40 inspection stations, 8 inspection areas and 9 border crossings. (Figure 2) All border crossing points were not surveyed because of limited space to conduct interviews, the volume of traffic at some sites, and the need to collect data on intercity truck movements, not account for all border movements. A representative picture of border crossing activity was believed to have captured by the survey given the locations of the interview sites. A total of 13,213 vehicles were surveyed during the 1983 survey which was conducted at 43 locations. The overall sample rate of commercial vehicle movement was 18% of the commercial vehicular flow, varying by location -- a function of time taken and traffic flows; it ranged from a low of 2% to a high of 100%. A count of vehicles passing by the interview locations was done to expand the sample to reflect a daily average of movement.

Border Truck Movement Incidence

Approximately 43% of surveyed truck movements, and 51% of associated tonnage levels involved the crossing of the provincial border. The highest proportion of these movements were east-west, between Ontario and another province (classified as interprovincial movements).

North-south trips between Ontario and the United States (classified as international movements) were almost as important with regards to trip frequency, but were more inferior with regards to tonnage carried. (Table 1 and Figure 3) A smaller proportion of movements and tonnage reflected use of Ontario highways as a landbridge between other Canadian provinces and American states.

TABLE 1

MOVEMENTS BY TYPE

MOVEMENT TYPE	MOVEMENTS	TONNAGES
International	17.8%	18.6%
Interprovincial	19.6%	25.7%
Intransit (U.S.A.)	1.8%	2.1%
(Canada)	1.3%	1.5%
(USA/Other Provinces)	2.3%	3.2%
Border Movements Total	42.8%	51.1%
Intraprovincial Mvmts	57.2%	48.9%
TOTAL	100.0%	100.0%

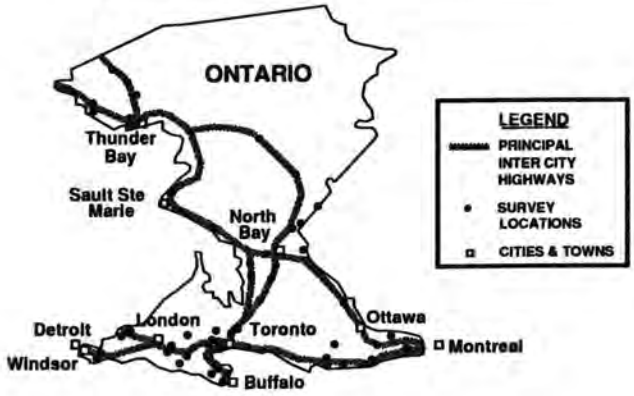
Truck Characteristics

The type and size of truck used in border movements was different than for the general intercity truck population. Tractor trailer units, particularly 5 axle tractor and semi-trailer units, were used to a far greater extent, and straight trucks less so, for this type of activity. (Figure 4)

In total, the expanded survey sample of border movements represented some 40,000 truck trips.

Figure 2

LOCATION OF SURVEY STATIONS



All trucks were directed into the inspection areas and stations, until the desired sample of trucks was obtained, typically between 2 and 5 trucks, depending on available space. Other trucks were allowed to bypass the station until the interviews were completed and more trucks sought. There was no predetermined quota of certain truck styles. The likelihood of one truck being captured by the survey process was entirely random, and participation in the survey was voluntary. The survey was administered by summer students or contract personnel.

The cumulative result of this survey is thought to reflect a single day "snapshot" of provincial intercity truck movement. However, because of possible seasonal variations in truck or commodity movements, it is not recommended that the data be adjusted to represent an annual pattern of travel. Where it is deemed appropriate, comparisons with 1983 data is presented. While a detailed statistical analysis of the comparability of the 1983 and 1988 surveys has not been undertaken, it is believed that the addition of further survey locations and other logistic alterations in the 1988 survey would affect only detailed corridor specific analyses.

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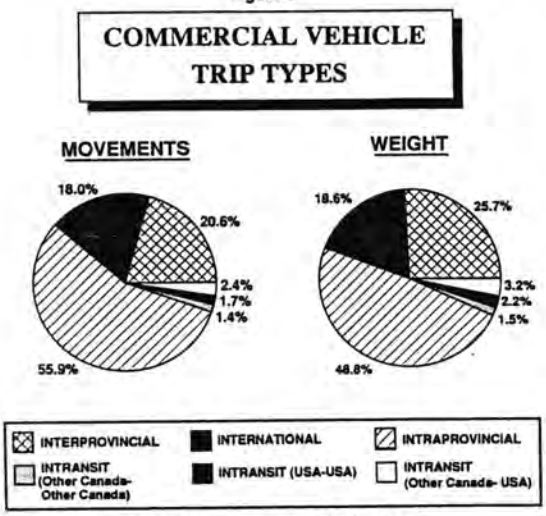
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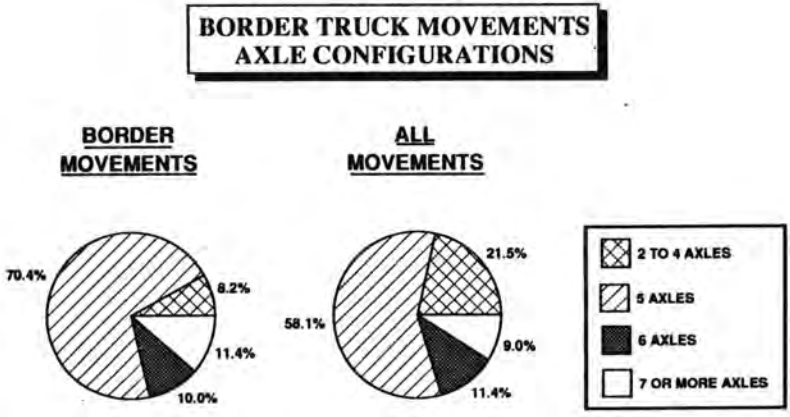
The type and size of truck used in border movements was different than for the general intercity truck population. Tractor trailer units, particularly 5 axle tractor and semi-trailer units, were used to a far greater extent, and straight trucks less so, for this type of activity. (Figure 4)

Figure 3



Source: 1988 Ontario Commercial Vehicle Survey

Figure 4



About 87% of border truck trips were done through use of tractor and trailer units, compared to 77% for all trips. Tractor and semi-trailer units were most deployed on international trips; the largest proportion of tractor and two trailer units were found on interprovincial trips because of the greater distances travelled, and the ability to carry heavier loads, particularly on trips to/from Western Canada. (Table 2)

TABLE 2

TRUCK TRAITS BY TRIP TYPE
(Percent)

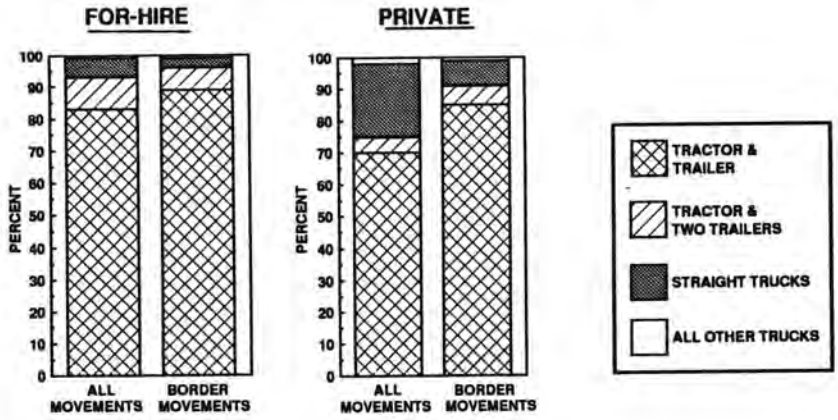
TRUCK CHARACTER	INTRA PROV.	INTER PROV.	INTER NAT'L	IN TRANSIT
Straight Truck	24.6	5.0	6.2	1.3
Tractor/Semi-trailer	67.3	84.9	89.6	87.8
Tractor/Two Trailers	5.9	9.2	3.4	10.0
Other	2.2	0.9	0.8	1.9
TOTAL	100.0	100.0	100.0	100.0
2 to 4 Axles	31.3	9.2	9.1	2.5
5 Axles	47.2	61.6	81.6	81.3
6 Axles	11.9	15.5	5.5	11.2
7 or more Axles	9.7	13.7	3.7	10.7
TOTAL	100.0	100.0	100.0	100.0
Vans/Box	56.1	69.7	65.9	67.1
Flat Bed	15.0	12.3	13.3	14.5
Tanker	9.0	6.6	7.6	3.6
Stake	2.7	4.3	2.2	3.3
Float	1.6	1.3	3.1	3.5
Container	1.7	1.7	1.9	3.2
Other	3.9	4.1	4.0	4.8
TOTAL	100.0	100.0	100.0	100.0

Only modest variations were found amongst the different border movement trip types, given body styles. The van or box style of truck/trailer accounted for about two-thirds of all border movement vehicles. Some 70% of vehicles involved in border movements were 5 axle tractor and semi-trailer units compared to 58% generally. Vehicles with 6 or more axles were largely associated with interprovincial movements.

For-hire carriers -- firms whose primary business is transporting goods for other firms -- typically used the same vehicle for border movements as was deployed for other movements. Private carriers -- firms who transport only their own goods -- utilized a very different fleet for border movements than for other movements. (Figure 5)

Figure 5

OPERATING TRUCK FLEET BY CARRIER TYPE BORDER MOVEMENTS



It was found that vehicles with slightly greater registered gross vehicle weight were used for border movements than was found generally: 3%, but the actual gross vehicle weight was quite higher: 11%. (Table 3)

Interprovincial trips had vehicles that exhibited the highest registered gross vehicle weights and commodity weights by a considerable extent over their international and intransit counterparts, for reasons outlined earlier.

TABLE 3

MEAN TRUCK WEIGHT

CARRIER	REGIS'D G.V.W.	ACTUAL G.V.W.	COMMODITY WEIGHT
Interprovincial	43,400 kg	30,100 kg	17,400 kg
International	38,600 kg	25,900 kg	13,200 kg
Intransit	41,000 kg	30,500 kg	15,200 kg
Border Movements	40,900 kg	28,400 kg	15,300 kg
All Movements	39,700 kg	25,700 kg	15,100 kg

Carrier Characteristics

The survey established that for-hire carriers were in the majority with respect to each border truck movement trip type. In contrast, private carriers are in the overall majority based on their domination of the intraprovincial goods movement market. (Table 4)

Ontario registered vehicles accounted for 70% of international movements, compared to 27% for American carriers and 3% for other provincial carriers. This does not accurately reflect ownership levels, given that American and other international trucking firms (e.g., Yellow Freight, TNT) have vehicles registered in both Ontario and the United States, having previously acquired existing carriers or established subsiduaries.

For interprovincial trips, the share held by Ontario registered vehicles was much smaller -- 61%, compared to 38% for other provincial carriers (Figure 6).

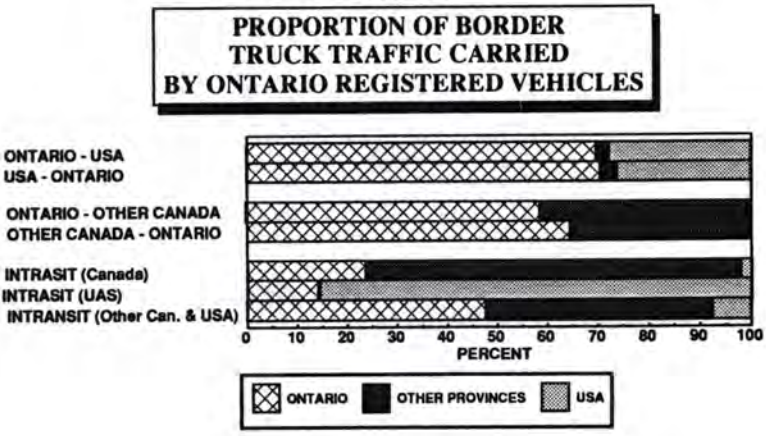
Ontario carriers accounted for less than one-half of all intransit movements: 48% of trips between other Canadian provinces (principally Quebec) and the United States, 24% of trips between other Canadian provinces, and 14% of trips between American states.

TABLE 4

CARRIER TYPE & AREA OF REGISTRATION

TRIP TYPE	FOR-HIRE CARRIER	PRIVATE CARRIER	ONTARIO REGISTERED
International	61.1%	38.9%	70.1%
Interprovincial	55.1%	44.9%	61.7%
Intransit (U.S.A.)	56.9%	43.1%	14.0%
(Canada)	61.2%	38.8%	23.4%
(Other Prov/US)	59.8%	40.2%	47.6%
All Border Mvmts	58.1%	41.9%	61.3%
All Movements	48.5%	51.5%	81.4%

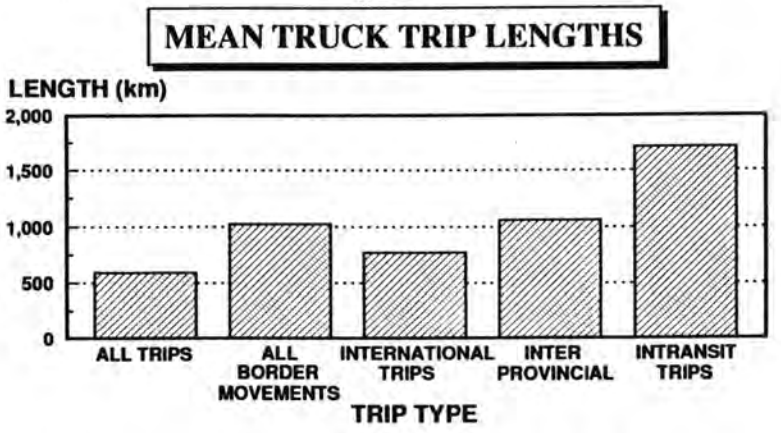
Figure 6



Trip & Load Characteristics

The average trip length for border movements was about 1,020 kms, or 74% longer than the entire survey sample of 590 kms. (Figure 7) Distances travelled for interprovincial trips: 1,060 kms, were longer than for international trips: 770 kms. This is a function of the closer proximity of major Ontario manufacturing and population centres to the international border, rather than the interprovincial border. The greater mean length of intransit trips: 1,710 kms are the result of the effect of longer interprovincial intransit movements.

Figure 7



There was far fewer empty border truck movements (17%) than was the case with intraprovincial movements (25%), in part a function of the economics associated with longer distance travel. (Table 5). There were more full border movement trips (in terms of volume) compared to all movements surveyed. Interprovincial and intransit trips were found to be most full.

Not surprisingly, given the extent of Ontario-USA trade in some goods, there was a higher incidence of the following being transported on a transborder basis, as opposed to generally: road motor vehicle and auto parts (14.0% vs 10.4% respectively), mixed goods (9.6% versus 8.5%), and paper and paperboard products (5.9% vs 4.6%).

TABLE 5

LOAD/VOLUME UTILIZATION
BORDER MOVEMENTS

TRIP TYPE	EMPTY MOVEMENTS	FULL MOVEMENTS
Interprovincial	17.2%	60.4%
International	20.2%	53.7%
Intransit (U.S.A.)	15.7%	60.4%
(Canada)	6.8%	74.6%
(Other Prov/USA)	7.7%	72.5%
Border Movement Sub Total	17.5%	58.7%
Intraprovincial Movements	30.0%	39.8%
All Movements	24.7%	47.7%

There were few dangerous goods border trips (4%) as well as overall trips (6%). On the order of 22% of all dangerous goods movements observed during the entire survey involved crossing of one of Ontario's borders, particularly the interprovincial border.

The likelihood of a vehicle being overweight on a border trip was less definite compared to other trips. For example, on the order of 13% of vehicles hauling a load on a trip that crossed the provincial/international border had a gross vehicle weight in excess of the registered gross vehicle weight, compared to 10% generally. However, about 7% of the same type of vehicles had an axle weight violation compared to 10% generally.

Driver Characteristics

While company drivers were used to transport freight for the majority of all trip types, there was a higher incidence of contracting out for driver services to undertake border movements than was the case normally. About one-third of drivers (34%) involved in a border movement were broker/owner operators, or hired from an outside agency, compared to just under one-quarter (23%) for all trips. (Table 6)

A much higher percentage of broker/owner-operators involved in a border trip were employed by for-hire carriers: 80%, compared to only 54% of agency drivers and 49% of the company drivers. Broker/owner-operators undertook 27% of international trips, 25% of interprovincial trips and 29% of intransit trips, compared to 18% overall.

Drivers involved in a border movement were comparable in age and years of driving experience to other drivers, but more likely to: not belong to a union (37% versus 40% on average),have undertaken more driver training (38% versus a mean of 36%); work less hours on average (63% worked 9 hours or more compared to a mean of 72%).

With respect to use of union personnel, there was a considerable difference between Ontario and American carriers on international trips -- 31% of the Ontario drivers belonged to a union, compared to only 22% for the American drivers.

TABLE 6

DRIVER EMPLOYMENT
(Percent)

CATEGORY OF DRIVER	INTRA PROV.	INTER PROV.	INTER NAT'L	IN TRANSIT
Broker/Owner Operator	12.1%	24.6%	27.5%	29.8%
Agency Driver	5.5%	7.9%	7.4%	10.0%
Company Driver	80.1%	66.3%	62.3%	59.9%
Self Employed	2.3%	1.2%	2.8%	0.3%
TOTAL	100.0%	100.0%	100.0%	100.0%

Trends & Comments

The intent of the 1988 Ontario Commercial Vehicle Survey was to collect a variety of information to provide as much as possible, a composite picture of intercity trucking activity. A review of the characteristics of a sub component of that activity: border movements, was useful given the proportion of such activity in the Province.

The 1988 survey established that there were considerable differences in the characteristics of trucks and trips between Ontario and another Province, between Ontario and the United States, and those only within Ontario. A comparison with 1983 data suggests that, in spite of the Canada/United States Free Trade Agreement, which would most likely translate into an increase in the north-south flow of goods, that there was far greater growth in interprovincial or east-west movements, by a factor of almost 4 to 1. This suggests that there were considerable gains made by the trucking sector vis-a-vis their rail competitors for domestic movements.

This hypothesis is confirmed, in part, through a review of average trip distance information. In 1988, the average trip distance for interprovincial trips was 1,060 kms compared to 910 kms, a 16% difference. While an even larger increase in average international trip distances was found, this effect was counterbalanced by an improvement in (more inferior) utilization rates.

There was greater use of larger trucks -- more tractor and semi-trailer units (87% vs 81% in 1983), and with more axles --29% of the vehicles involved in an interprovincial trip in 1988 had 6 or more axles, compared to 24% in 1983. While the truck's capability to haul goods remained unchanged (i.e., the RGVW), there was modest improvement (2%) in the actual gross vehicle weight of the vehicle since 1983. Utilization levels were also enhanced -- 58% full and 18% empty in 1988, versus 56% full and 23% empty in 1983.

There was greater use of for-hire carriers -- 58% in 1988 versus 46% in 1983, and the contracting out of work to owner operators and agency drivers -- 34% versus 13% in 1983, reflecting the impact of regulatory reform in both Canada and the United States. There was also less incidence of non-Ontario registered vehicles for all border movement trips -- 39% in 1988, compared to 45% in 1983.

Within the non-Ontario component, there was a decline in use of Quebec registered vehicles -- to 12%, from 14% in 1983, while American carriers decreased their share to 15% from 22% in 1983. This circumstance is largely a function of the greater role of interprovincial movements of all movements. When international movements alone are considered, American registered vehicles accounted for 27% of those trips in 1988, compared to 20% in 1983. There was also found to be a greater use of owner operators on international trips in 1988 (27%) versus 1983 (13%), given the need for more flexibility in dealing with market expansion and adjustments, and as a useful cost cutting measure.

More recent analysis suggests that gains made by non-Canadian carriers is increasing (1) in the international trip area, given the effects of a high Canadian dollar, greater economies of scale, and lower unit costs enjoyed by American carriers.(2) It is also a function of the ability afforded to larger regional and national American carriers to offer single line service within a broad market area and thus integrate their domestic and transborder operations.(3) In addition, U.S. carriers have been found to have a productivity advantage because their management systems and processes are superior, and they can achieve greater loaded ratios and higher tractor utilization rates. (4)

This has since translated into a loss of transborder business to major Canadian trucking firms (5) and to Canadian owner operators who have responded with charges of an unlevel playing field and with angry demonstrations and blockades. (6) Other investigations suggest however, that while non-tariff barriers potentially reduce the ability of Canadian domiciled carriers to sell their services in this market, they are more than offset by lower Canadian input costs.(7) The matter is of continued interest to the Province of Ontario, given the significant proportion of total revenue to Ontario for-hire carriers drawn from international trips -- 28%, twice that for carriers from other Canadian provinces.(8)

The data collected in the 1988 Ontario Commercial Vehicle Survey is expected to be most useful given concerns expressed about the impacts resulting from regulatory reform of the trucking industry and from the signing of the Canada/United States Free Trade Agreement. In addition, the survey provides background and scope that assist a number of on-going government and non-government research efforts.

Examples of projects for which the survey data is being used include: locational opportunities for truck stops with motels, the feasibility of high speed rail service in selected corridors, ascertaining the damage to roads caused by trucks, input for axle load & bridge design models, modal and corridor specific market share identification, truck enforcement personnel shift scheduling, justification for highway extensions and enhancements, and international bridges.

The intent of the Ministry of Transportation is to continue the program of undertaking such studies on a five year basis. The next survey would be undertaken during 1993.

ENDNOTES

(1) Statistics Canada, Transportation Division, Transborder Trucking Survey, Ottawa, April 1991.

(2) Jocelyn Leclerc, "Differences between Deregulation in Canada and the United States", Canadian Transportation, October 1990, 37-40

(3) National Transportation Agency of Canada, Annual Review 1988, Supply & Services Canada, Ottawa, 1989

(4) Deloitte & Touche, The Competitiveness of the Ontario Transborder Trucking Industry, Ontario Ministry of Transportation, September 1991, p. 8

(5) "It was the day the roof caved in", Motor Truck, December 1989, pp 15, 22

(6) Patricia Cancillic & Ken Pole, "Truckers Warn of More Blockades", Cargo Express, Vol 12, No 5, May 1991

(7) Garland Chow & James J. McRae, "Non-Tariff Barriers and the Structure of the U.S.-Canadian (Transborder) Trucking Industry", Transportation Journal, Winter 1990, Vol 30, No. 2

(8) Ontario Ministry of Transportation, Report of the Advisory Committee on Truck Transportation, August 1991, p. 33

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DISCLAIMER

The opinions expressed in this paper are solely those of the authors and in no way reflect the policy or position of the Ontario Ministry of Transportation.

Financial and Operating Characteristics of ICC-Regulated Transborder Trucking Companies

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American Trucking Associations

I. Introduction

U.S.-Canada transborder trucking is an important and growing market, according to many researchers (Chow and McRae, 1990; Chow, 1992), anecdotal evidence and trade journal articles on individual carriers and commodity groups. Statistics Canada's commodity origin and destination statistics showed that international traffic increased between 1987 and 1988, although there was a decrease from 1988 to 1989 (Statistics Canada, 1990 and 1992). Trade between the two countries has now reached $170 billion (Chow, 1992) and there are an estimated 255,000 transborder trucking movements, 62% of which are carried out by Canadian-based carriers (Statistics Canada, 1991). Everyone asserts that transborder trucking is increasingly important, but how important is it and which carriers are involved in it?

Statistical sources in both countries (Capelle and Chow, 1991) provide some data, but there is not a ready answer to that question. Although a U.S. -Canadian joint committee of various federal agencies is working on it, there is no sure way yet to identify the magnitude of the importance of transborder trucking. For example, although the annual reports filed with the Interstate Commerce Commission (ICC) in the states include great detail on individual carriers there is no line item which identifies the proportion of total revenue that comes from transborder trade. Percentages are available for some companies, such as J. B. Hunt and Yellow Freight, which indicate that about 1% of their revenue comes from the transborder Canada market.

Simply identifying which U. S. carriers are involved in transborder trade is a challenge. No single public source provides comprehensive information. But once transborder-involved carriers are identified, the ICC annual reports provide rich financial and operating statistics (F & OS) detail.

The objective of this paper is to assess the magnitude of importance of the transborder market in the U. S. trucking industry and begin to identify which carriers are involved.

Transborder-Involved Carriers

Asking trucking industry researchers for a list of U.S.-based carriers involved in transborder trade with Canada elicits knitted eyebrows in almost every case. Everyone seems to have snippets of knowledge about particular carriers, corridors or commodities. Traditional motor carrier directories provide some but not comprehensive information. And such sources as rate bureaus' tariffs are LTL-oriented and are not publically accessible. Statistics Canada has tried and concludes the following:

> A project was started in cooperation with the provinces and territories with the aim to establish an US Domiciled Carriers Universe. We soon realized that very scarce information was available. This avenue might, however, be feasible [on] a longer term [basis]. (Cantin, 1991)

However, Statistics Canada's 1991 Transborder Trucking Survey included a total of 1,181 U. S. for-hire trucking companies, with only 118 of them making five or more trips across the border. Therefore, it is reasonable to expect that the number of medium and large companies that are operating consistently and continuously in the transborder market is probably in the low hundreds rather than the thousands.

To try to insure replicability and later expansion of this research, an attempt was made to use publically accessible sources. To identify transborder-involved (TI) and potentially transborder-involved (PTI) carriers, the latest issues of the following sources were consulted:

1. Motor Carrier Annual Report (MCAR) (American Trucking Associations, F&OS Series)
2. "Top 200 Carriers..." (American Trucking Associations)
3. Blue Book (Transportation Technical Services)
4. National Motor Carrier Directory (Transportation Technical Services)
5. State Sorted ICC Regulated Motor Carriers (ICC)
6. Directory of Truckload Carriers (Optimum Transportation Services)
7. American Motor Carrier Directory (K-III Information Co.)

8. Attendee and mailing lists for transborder symposia and newsletters oriented to motor carriers
9. Phone and fax information from contacts at companies, consulting firms, agencies and other organizations

With minor exceptions, most of the above sources can be accessed by anyone. An important source identifying PTIs was obtained from a consulting firm doing a study for a Canadian agency.

A list of 167 U. S.-based motor carriers was developed and 1990 revenues were collected for each, using primarily the MCAR (Source 1), supplemented by the Blue Book and NMCD (Sources 3 and 4) where necessary. Estimates of revenue were made for some carriers in either of two ways: (a) multiplying the number of tractors listed for them in the NMCD times an MCAR-based per-tractor revenue average of $132,000; or (b) using the ICC list (Source 5) for a revenue estimate based on the carrier's listed Class (II or III). There were 72 U. S. carriers that were classified as TI and the 95 remaining, which were primarily from sources 8 and 9, were PTI. Each carrier was also classified into a segment of the trucking industry -- less-than-truckload general freight (LTL), truckload general freight (TL), heavy machinery hauler, motor vehicle hauler, tank truck carrier, and so on.

Conclusions below are primarily for Class I and II (above $1 million in annual revenue) for-hire ICC-regulated carriers, although some Class III carriers are included because they were identified in directories as dealing in U.S.-Canada trade. The $50-billion-plus Class I and II ICC-regulated intercity for-hire industry does not include the following important segments:

- Private carriers
- Owner-operators
- Class III carriers (less than $1 million annual revenue)
- ICC-exempt carriers
- Government fleets
- Most intrastate and local for-hire carriers

Since no detailed F&OS data are collected on the these segments, it is difficult to measure their transborder components.

United Parcel Service companies (Class I) and most other package/courier/expedited carriers were not included in the list developed for this study or in the final revenue estimates for transborder-involved and potentially transborder-involved carriers.

U. S. Trucking Industry Segments

Total trucking revenues in the United States amount to $272.5 billion -- the total for private trucking and for-hire trucking, both long haul and local. Latest data place the ICC-authorized intercity for-hire segment at just over $75 billion (Eno Transportation Foundation, 1991). Table 1 breaks down that figure into the various segments into which analysts usually divide the trucking industry.

Table 1

U. S. For-Hire ICC-Authorized Trucking Industry Segments
(1990 annual revenue in billions of U. S. dollars)

	Class I and II Carriers Filing Reports at ICC (ATA's '90 MCAR)			All For-Hire ICC-Authorized (Estimated)		
General Freight						
Package/Courier (e.g., UPS)	$10.868	21.4%	(2)	$14.0	18.7%	(5+)
Less-Than-Truckload	15.937	31.4	(187)	16.2	21.6	(187+)
Truckload	9.938	19.6	(642)	18.3	24.4	(40k+)
Household Goods Carriers	3.456	6.8	(102)	4.9	6.5	(102+)
Tank Truck Carriers	2.805	5.5	(144)	4.0	5.3	(144+)
Refrigerated Carriers	1.946	3.8	(119)	2.0	2.7	(119+)
Motor Vehicle Haulers	1.514	3.0	(27)	2.0	2.7	(27+)
Heavy Machinery Haulers	0.424	1.0	(18)	1.0	1.3	(18+)
Bulk Commodity Carriers	1.195	2.4	(130)	1.6	2.1	(130+)
Other Specialized	2.808	5.3	(280)	11.0	14.7	(rest)
	$50.891[•]	100.2%	1,651	$75.0	100.0%	47,890

[•] '90 MCAR Summary Table 0, Column 1total ($50.780m) for 1,629 carriers plus revenues from 22 carriers not included in the summary tables.

Since the Motor Carrier Act of 1980 partially deregulated the trucking industry, the segment representation has changed drastically. The truckload general freight sector, representing perhaps 10% of the Transportation in America total revenue in 1980 now represents over 24%. That along with the rise in the share for package/courier carriers (9% in 1980, 19% now) has taken its toll on the LTL sector (about 37% in 1980, 22% now).

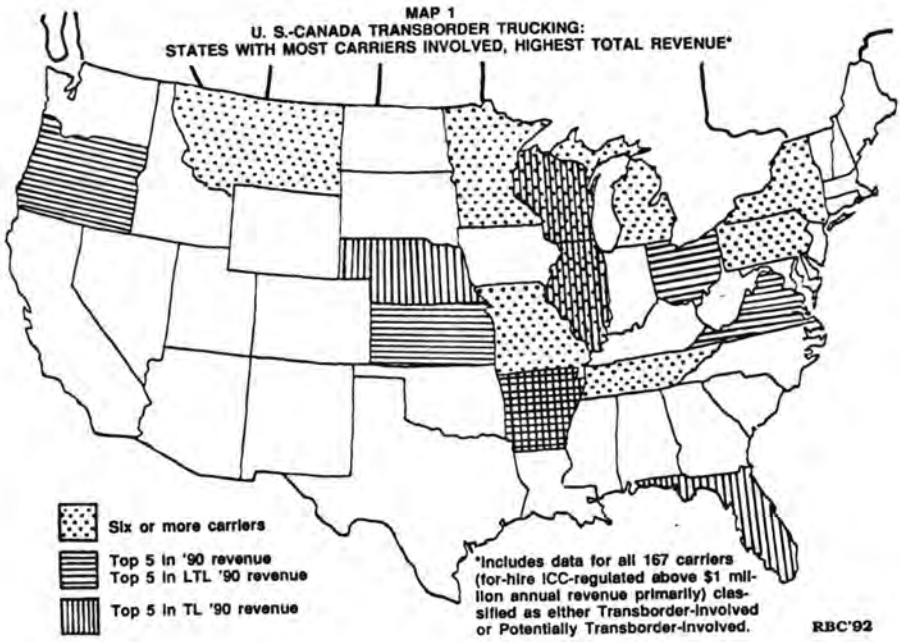
Using the figures in Table 1 as a foundation, one might wonder how much of the "pie" do transborder-involved and potentially transborder-involved carriers represent?

Most of the U. S. Carrier Revenue Capacity is Involved in Transborder Market

One might think that carriers involved in transborder trade are a few specialized carriers strung along the border between the two countries; a knee-jerk conclusion might suggest that the friction of distance allocates most transborder trucking companies to within a few hundred miles of the border. However, the transborder market is more complex than that.

Comparing Table 1 data to revenue totals for carriers determined to be transborder-involved or potentially transborder-involved yields perhaps surprising results. Over one third of the ATA "Top 200" were TI or PTI carriers. Revenue for the LTL carriers on the transborder carrier list developed for this study is over four fifths of the U. S. LTL segment total. Revenue for the TL general freight carriers on the list is just above one fifth of U. S. TL segment total. Because of interlining, joint sales agreements and other arrangements common in the LTL industry, the LTL segment is more heavily transborder involved than the TL segment.

Two cautions should be emphasized. The revenue comparisons are on the basis of total carrier revenue and not on the usually small portion which derives from transborder trade, an unknown that researchers are trying to estimate. And the concentration at the top in the U. S. LTL industry means that the top few carriers represent the lion's share of the TI/PTI revenue total. Knowing that those largest carriers are transborder-involved makes it easier to understand the four-fifths figure mentioned above. Certainly the number of carriers involved in transborder trade with Canada is small in comparison to the overall total number of carriers; the list for this project included less than 200 carriers while the ICC-authorized list has 47,890.


MAP 1
U. S.-CANADA TRANSBORDER TRUCKING:
STATES WITH MOST CARRIERS INVOLVED, HIGHEST TOTAL REVENUE*
Six or more carriers
Top 5 in '90 revenue
Top 5 in LTL '90 revenue
Top 5 in TL '90 revenue
*Includes data for all 167 carriers (for-hire ICC-regulated above $1 million annual revenue primarily) classified as either Transborder-Involved or Potentially Transborder-Involved.
RBC'92

Spatial Distribution of Transborder-Involved Carriers

When all 167 companies are plotted, the top 5 states by number of companies are New York (14), Pennsylvania (12), Michigan (11), Wisconsin and Illinois (each 8) (see Map 1). When distinguishing between TI and PTI, the distribution hugs the border more closely for TIs (top states NY,MI,WA,MT,IL,PA and NJ). The largest LTL carriers are heavily involved in transborder trade and Yellow Freight, Roadway and ABF have significant networks of terminals throughout the Canadian provinces. The American Motor Carrier Directory (Source 7) shows, for U. S. carriers, the following proportions of total U.S. and Canadian terminals located in Canada: ABF (AR) – 2%; Hyman (MN) -- 4%; and Roadway (OH) -- 3%; CF's and Yellow Freight's terminals are not listed. Corresponding percentages for Canadian carriers are: Kingsway (ON) -- 80%; Motorways (MB) – 97%; and TNT Overland (ON) -- 66%. Interestingly, however, the average number of LTL carriers providing regular service in ten border states has decreased 28% since 1976 (Athearn, 1991), which probably says more about concentration in the industry than it does about lack of potential in the transborder market.

Interlining is one way of operating in transborder trade -- U.S.-based LTL carriers that have no terminals in Canada arrange interlining and other agreements with Canadian carriers to ship goods into Canada. Another common arrangement is ownership of subsidiaries in Canada. And a number of U. S. carriers may have sales offices in Canada, although they don't have terminals as such. The ways in which revenue is earned by U. S. carriers in the transborder market are many.

All Transborder-Involved carriers were divided into LTL, TL and other segments. Total revenue of the TI U. S. carriers was $12.8 billion, with $10.8 billion in the LTL sector, $1.2 billion in the TL general freight sector and $0.86 billion in other segments of the for-hire industry (motor vehicle haulers, heavy machinery haulers and tankers primarily). The distribution of TI LTL carriers is heavily weighted toward the home states of the largest U. S. LTL carriers – CF (OR), Yellow (KS), ABF (AR), Roadway (OH), Overnite (VA) and Carolina (NC). With the exceptions of 7 states, all TI truckload general freight states were north of the Ohio River and east of the Mississippi. Transborder TL carriers are located in states near the major Ontario-Northeast-U.S. market concentration in part because they do not have the extensive networks of terminals that LTL carriers may have in states nearer the border than their headquarters state.

When the same was done with the PTI carriers for whom very clear proof of actual transborder activity was not available, a similar pattern occurred but even more far afield from the Canadian border for both LTL and TL carriers. Whereas 33 TI LTL carriers were plotted in 18 states, there were 55 PTI LTL carriers in 28 states. And similarly, while 23 TI TL companies were located in 16 states, there were 27 PTI TL carriers in 16 states only 4 of which were east of the Mississippi River and north of the Ohio River. The "Second Tier" of carriers (PTI) which may not now be heavily involved but soon will be are more widely dispersed throughout the U. S.

When the state revenue totals for all 167 carriers were plotted, there were only 9 of the contiguous 48 states with no TI or PTI carrier revenues -- NV, AZ, NM, WY, SD, KY, RI, VT and NH. When the reader sees such border states as Vermont and New Hampshire in that list, one must remember that Class III carriers for the most part are excluded from this investigation because of their low revenue-importance and lack of available data. Certainly there are a number of small specialized carriers based in border states who are involved in transborder trade; however, definitive data on them are not available except through anecdotal information. Building the TI + PTI list through such information is possible but will have little effect on the overall revenue distribution conclusions because of Class III carriers' low revenue-importance in the overall "pie."

The 167 TI + PTI carriers together account for $18.5 billion in revenue and the top states again appear primarily because they are the home of the largest U.S. LTL carriers. Nearly one third of the TI and PTI revenue total clusters in eleven border states plus Illinois and Indiana. Over $5.7 billion of the $18.5 billion total is arrayed there.

Trucking Industry Segment Representation

Using 1990 revenues, it is estimated that the TI LTL carriers represent $10.8 billion while the PTI LTLs represent $2.7 billion; their total of $13.5 billion is 83% of the $16.2 billion LTL sector in the United States. For the TL carriers, the totals are smaller -- $1.2 billion for TI TL and $2.6 billion for PTI TL, for a total of $3.8 billion. The U. S. TL segment is about a $18.3 billion segment, so Transborder-Involved and Potentially Transborder-Involved companies represent just 21% by revenue (but 38% of the Class I and II TL total shown in the '90 MCAR).

Revenue Representation of Transborder Trucking

No readily available information allows estimates of the transborder proportion of revenue generated by each motor carrier that is involved in transborder trade or potentially involved in it. Indeed, many carriers who have interlining agreements with Canadian carriers cannot be presumed to be earning revenue from transborder trade continuously; many times the interlining revenues are "zeroed" at particular periods or for a year or two.

As mentioned earlier, some large carriers state the revenue proportion earned in the transborder Canada market at 1%. Applying that conservative estimate -- 1% of the total revenue is from transborder trade -- and a 10% figure explained below, shows the importance of transborder trucking (Table 2):

Table 2

	One Percent of Total TI &/or PTI Revenue (billions)	Ten Percent of Total TI &/or PTI Revenue (billions)
All 39 States, TI & PTI	$0.185	$1.849
Border States (plus IL and IN), TI & PTI	0.057	0.573
29 TI States	0.128	1.282
33 TI LTL Carriers in 18 States	0.108	1.076
23 TI TL Carriers in 16 States	0.012	0.119

Comparison Data

Statistics Canada (Cantin, 1991) estimates the "U. S. for-hire and private domiciled carriers" at "+ or - $2.6b." Chow (1992) uses a $2.5 billion figure.

Using the all-39-states-TI-PTI total of $18.5 billion as the total carrier revenues (UPS not included) of which most of the $2.6 billion would be a part, one can calculate a figure of 14%. Certainly if more carriers were added to the TI/PTI list, and their revenues were added to the denominator, that percent would come down, as it would if UPS and other package carrier revenues were added. And if we had an estimate of the private carrier component of the $2.6 billion, the numerator would decrease. Using round numbers of $2.0 billion over $20 billion produces a figure of 10%. While it is true that some carriers derive only 1% of their revenues from transborder trucking, a good number of them derive more than 10% of their revenues – particularly those poised near the Michigan-Ontario and New York-Ontario gateways.

Importance of Transborder Trucking

When we speak of the importance of transborder trade between the Canada and the United States using the $170 billion figure, we need to add that over $18.5 billion of the revenue capacity of the U. S. trucking industry is involved or potentially involved in that trade. That amounts to almost twice the size of the entire Canadian trucking industry ($10.2 billion [Statistics Canada, 1992]) and a quarter of the U. S. for-hire industry (see Table 1). Revenue derived from U.S.-Canada transborder trade is most likely between $1.85 billion (Table 2, UPS not included) and $2.5 billion estimated by other researchers.

Conclusion

There are several ways to improve our knowledge of the importance of transborder trucking. Adding one line item to the ICC "Form M" annual report so carriers provide the percentage of their total revenue derived from U.S.-Canada and U.S.-Mexico transborder trade has been suggested by Statistics Canada. In addition, Census' annual survey of the trucking industry, the National Motor Freight Traffic and Warehousing Survey, should collect such line items. With just those simple additions researchers could more accurately assess the growing magnitude and importance of the transborder trucking, which is the means to a more economically integrated and globally competitive North America.

REFERENCES

Athearn, Folger, Jr., "Availability of Less-Than-Truckload Service since Deregulation in the Ten States Bordering Canada," Proceedings of the Canadian Transportation Research Forum, 1991, pp. 69-83.

Cantin, Raymond, "U. S. Domiciled Carriers: Frame Creation," September 18, 1991, Version 1. Photocopy provided by David Dodds of Statistics Canada, September 27, 1991.

Capelle, Russell B., Jr. and Garland Chow, 1991, "U. S. and Canadian Statistical Sources for Transborder Trucking Information," Proceedings of the Canadian Transportation Research Forum, 1991, pp. 215-227.

Chow, Garland, "Transborder Trucking Issues," Presentation to Joint Meeting of the Transportation Research Forum International and Washington Chapters, January 15, 1992.

Chow, Garland, and James J. McRae, "Non-Tariff Barriers and the Structure of the U. S.-Canadian (Transborder) Trucking Industry," Transportation Journal, Winter 1990, pp. 4-21.

Eno Transportation Foundation, Transportation in America (by Frank A. Smith), Leesburg, VA: Eno Transportation Foundation, September 1991 Supplement.

Statistics Canada, "Transborder Trucking Survey 1991," Ottawa: Statistics Canada, April 1991.

Statistics Canada, Trucking in Canada 1988 and 1989, Ottawa: Statistics Canada, November 1990 and 1992 forthcoming.

Wimpffen, Janos L., Russell B. Capelle, Jr., et. al, "Assessing the Early Effects of Emerging Trade Blocs: Research Agendas for North America and Europe," Canadian Journal of Regional Science, Summer-Autumn 1990, Vol. XIII:2/3, pp. 367-373.

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THE TRUCKING INDUSTRY: AN INDUSTRY IN TRANSITION

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INTRODUCTION

With the globalization of market places and the changes in logistics practices, the truck mode is an important component for the economic growth of all nations.

At the same time, the trucking industry, a non-monolithic industry, is undergoing major structural changes. Although that industry is not afraid of changes, it is generally concerned with the pace at which these changes are taking place. Furthermore, transport deregulation introduced a new paradigm where the experimentation is done before the theory.

On the demand side, there are many factors that seem to indicate that the road mode will grow even more. On the supply side, the characteristics of that mode are such that although it fits well with the characteristics of the new demand for freight transport these same characteristics may discourage the use of trucks under certain conditions.

The decline of the rail mode is not easily accepted. This decline may, in fact, be irreversible due to new demands for freight transport.(Grubler & Nakiicenovic,1991) So the evolution of freight transport may lead to an unexpected modal substitution based on technological advantages in areas where the road mode cannot fill the needs.

This paper will attempt first to cover the new environment surrounding the transport industry, then touch upon the factors or issues the trucking industry is likely to concern itself with over the next three to five years. In closing, this paper will suggest a research agenda in response to the issues faced by the industry in the short, medium and long term.

1. THE BACKGROUND

There is no doubt that transport companies, in order to survive, need to understand the forces of changes surrounding them. The survivors will pay particular attention to the evolutionary environment in which they operate and how it affects their companies.(Healy & Ilbery,1990)

1.1 Macro Economics Trends

On the macro economic side, the collapse of communist regimes in the western hemisphere has raised the role of the market economy to new unprecedented heights. The new customers from around the world are shaping

the"global" economy and along with it the manufacturing and transportation industries. (Peters,1990)

But not only are we facing the coming of new mass market consumers but we are also facing profound changes with the consumers of the old mass market economies. We don't have enough statistics yet to properly evaluate these changes but the ones we have indicate a trend towards customers being more selective looking for quality at the lowest cost possible. Really no difference there between the new consumers and the buyers of transportation.

To illustrate these points; Americans now keep their cars an average of 7.5 years. A few years ago that number was 6.5 years. Canada's car population of 13 million is almost 50% higher than it was in the mid-1970s, but gasoline consumption is no greater than it was 15 years ago. (Globe & Mail, 1992)

In this new environment, conservation, sector tailoring, lifetime of products and individualising seems to emerge as important factors. Thus, it becomes significant to add value to products and services. (Peters,1990)

Other macro-economic factors include: demographics of countries, financial flows between countries and the political environment.

Demographics: Pretty well everybody agrees that the bulk of the increase in most OECD countries population will come from immigration and that there will be an aging of the population. (Denton, Feaver & Spencer, 1980) The one factor we should not overlook, however, is this increase in more homogeneity in population. This feeling seem to emerge in some countries of the old mass market economies.

It will be important for every business to understand the demographic changes taking place as they will undoubtedly influence the local markets and the nature of home demands so important to every advanced industry. (Porter,1990)

Financial Flows: Borders are fading; especially in the old mass market economies. Half of the total trade between OECD countries is done between companies of the "global companies". (Julius,1990) Financial flows is an important factor as some now believe that it often precedes trade. (Drucker,1990)

Political Environment: The missed opportunities due to political instability may have been acceptable under the old world order. They certainly will not be tolerated under the new world order.

Are these macro-economic factors important to freight transport? Yes, these and other macro-economic factors are important. When you look closer it has everything to do with the transport companies' customers: the buyers of logistics services. The next section will deal specifically with the micro-economic factors affecting more directly the trucking industry.

2. MICRO ECONOMIC AND TECHNICAL PARAMETERS

2.1 Demand Parameters

There are elements playing important roles in the decisions of the buyers of transportation services. Let's briefly review these factors.

2.1.1 Just-in-Time

Just-in-time or JIT as it is now commonly known is now an integral part of the strategy of many buyers of transportation services. The need to better control inventories, to reduce the rent on expensive land and maintain the flows of

components in the manufacturing processes are significant factors in the planning and survival of key manufacturing companies. (Flanagan & Morgan,1989) The economic benefits are significant as the nominal ratio of business inventories to final sales have gone from 26% in 1980 to just under 20% in 1989; and the trend is calling for more reduction in the value of inventories. (Delaney,1992)

2.1.2 Quality Control

The need to do something right the first time or to reduce if not totally eliminate the defects in a product will become a significant factor in 1992 and for years to come. Service may be, however, a pervasive concept where perception may be more significant than actual survival outcome. The key to success in that respect may be to involve the customers in defining what quality means to their specific needs. (Peters,1990)

2.1.3 Globalization

This sometimes over-abused concept must be better understood if we are to better focus our research and planning for the future. Are we talking about globalization in the production factors? Or are we looking at globalization at the sales level? Or is it happening in a significant way at both the production and sales ends?

Although some companies are obsessed with globalization, some research suggests that the home base is still the dominant factor in creating the competitive advantages necessary for these companies successful in global markets. (Porter,1990)

While parts used in the manufacturing process travel between countries, some manufacturers are at the same time trying to reduce the average length of haul of their total transportation movements. Thus, we need to better understand these developments as they all influence the choice of modes and ultimately the choice of investments in infrastructures.

2.1.4 Speed

Perhaps of all the parameters speed is the most constant one. Going back to some of the studies done in the 60s, 70s and 80s speed has always been among the top factors for mode selection by transportation buyers. Therefore, anything to do with speed is not revolutionary but evolutionary. Some even claim that it will be the most significant basis for competitive advantage in the years ahead and that it will also mean the transforming of the organisations to speed up our processes. (Peters,1990)

2.1.5 Flexibility

An important characteristic of the trucking industry, it will probably remain its strongest asset. The road infrastructures have given that flexibility to the road mode and the perennial debate about who is paying for the road will continue to be not a priority of the buyers of transportation services as the line between a buyer of transportation and a provider of transportation services is quite thin. Many retail and manufacturing companies own their fleet and many transport companies are now more than just transport companies.

Flexibility also means geographic coverage. In order to respond to the needs of new equidistant products there is a need for a broader geographic coverage forcing partnership arrangements between transportation companies. New evidence seems to indicate that some companies have understood that message. (Traffic World,1992)

Geographic coverage is also important as it allows to adjust to the constant shift in purchasing or manufacturing base. This "footloose" approach is essentially characterized by a tremendous flexibility to relocate or to shift its purchasing base in search of lower costs. (Cooper,1992)

2.1.6 Information Technology (IT)

IT is a key factor in the increased productivity of the logistics industry. Electronic Data Interchange will take a bigger role and it is possible that new Customs procedures will speed up the informatics process.

At the same time the buyers of transportation involved in a JIT process will demand that their transportation suppliers provide them with constant communications on the status of their shipments.

This could be significant as in some cases it will allow transportation companies to sell IT as an added value necessary to maintain decent rates. (Traffic World,1991)

2.1.7 Recycling Issue

The push for recycling is developing into big business not only for municipal garbage collection but also for every single product that is not bio-degradable. The case of newsprint has recently emerged as a major development and so did new German regulations on recycling.

Suffice it to say that for most countries the total amount of waste recycled is only a fraction of the total produced. In the U.S. for instance, recycled products are only a fraction of the total waste produced. Some data has been produced: paper is only 25% of the total produced;aluminum 32%; glass 12% and plastic at only 1%.(The Economist,April 13,1991) Other countries are in some cases as bad as the U.S.

2.1.8 Packaging

The container evolution will continue and will likely take on a new meaning with the expansion of free trade deals in the work all around the world. The increase productivity of the railways in their ability to double stack will support this growth along with the inability to guarantee the safe passage of cargo by truck in some countries.

But perhaps even more significant in the packaging issue is the trend towards lighter packagings. For instance, a baked bean can weigh 75 grams in 1960. In 1990 the same product comes in cans at a weight of 56.6 grams. Beer cans in 1950 were 91 grams and in 1990 their weight is 17 grams. (The Economist, April 13,1991) These are only but a few data on the evolution of the weight of packagings used for certain products. This trend, if maintained or accentuated, would confirm the role of trucks and would point towards a greater competition from the air mode (Bell & Feitelson,1991).

2.1.9. Transport Rates

Constantly among the top factors for mode selection, it will remain a key factor in the 90's. Even for manufacturer's involved in JIT, selling price is also mentioned as an important factor along with service level and on-time delivery. (Flanagan & Morgan,1989)

Transport rates have been reduced significantly since deregulation and no change is expected on that front. Trucking Costs are now in the United States $30 billion below the level of 1981. On the truckload side in the U.S., trucking costs to

the buyers of transportation are even below the 1973 level.(Traffic World,March 11,1991)

2.1.10 Single Sourcing

The phenomena of single sourcing will become more common place as more trade agreements are signed between countries. Proctor & Gamble is perhaps a prime example of this trend. Rather than having a plant making several products for a market, that plant produces one single product for all markets. (Cooper,1992)

In transport, this trend has meant a reduction in the number of carriers used by buyers of transportation services. Again, the question of location and deregulation are significant. On the one hand, the location of the buyer of transportation seem to influence the selection of the carrier and on the other hand with deregulation, the unlimited geographic coverage has meant that there is no restriction on access to markets.

2.2 Supply Parameters

Transport companies will need to be alert in watching the signals from the above macro and micro economic factors and detect where the next opportunity is coming from. The pace at which the companies will need to adjust to change will create obvious problems in an industry as diversified as the trucking industry.

2.2.1 Customization

To respond to new demands, transport companies will need to customize their services. This will no doubt force a specialization of services offered forcing the thousands of motor carriers to become niche carriers. Even though you may have in these niches a few large companies, they will essentially be niche companies. (Peters,1990)

2.2.2 Geographic Coverage

Geographic coverage is a major issue for motor carriers. The ability to handle freight with a minimum of interlining will be important as it will keep the cost of transportation down. At the same time, and as part of this geographic coverage, there will be a need for transport companies to determine for themselves whether they want to fit the production part or the sales part of the logistics chain. The two may need different types of operations, different information technology and will likely take place in different geographic arenas.

Freight brokers, forwarders and owner/operators will also continue to be significant players for years to come as they will continue to be important factors in this issue of geographic coverage. On that aspect, the need for partnership with these third parties will be necessary. Sub-contractors will have to be seen as full-time partners who share the same value. (Peters,1990)

2.2.3 Internationalization

As for financial flows, borders mean nothing to transport companies. The thorny issue of cabotage will evolve with the new agreements in the air industry and we are likely to see the use of the fifth freedom principle applies to trucking. Full implementation of Free Trade Agreements will also reduce the importance of this issue.

This internationalization of transportation services will also mean more uniformization of rules and regulations.

2.2.4 Quality Control

Quality control will be significant in 90s: quality people and quality in the choice of equipment offered. For trucking companies, the challenge will mean difficult choices in terms of investment in the equipment and the servicing of that equipment. In the case of JIT service, the risk of mechanical breakdown must be eliminated. The real challenge will rest, however, with the human resources the transport industry will be left to choose from.

As the pressure on transport rates will be maintained trucking companies will be competing for human resources not easily attracted by the benefits they will have to offer. (Canada Employment and Immigration,1990) Information technology, geographic coverage and downward pressures on rates will likely mean constant contact with head office, away from home for long periods of time and non-unionized jobs.

2.2.5 Information Technology

Transport companies have no choice but to invest in Information Technology. EDI, global positioning system and Intelligent Vehicle Highway Systems (IVHS) simply mean that Information Technology will play a bigger role in the future of every company. (Bell & Feitelson,1991)

These technologies will likely allow trucking companies to sell their services more effectively as they will be able to show their added value to customers. (Traffic World,1991)

2.2.6 Partnership

It is clear that with a globalization of trade and a trend towards the integration of transport functions as part of the total logistics concept long term partnership between carriers and shippers and between transport modes will grow. No single mode can claim to be able to do it alone. Partnership will, in fact, be another way to add value to transport services. It adds geographic coverage, it will address some of the human resources issue and will help solve the congestion issue.

In the case of JIT service, trucking companies are already integrated in the manufacturing process. Soon the same will apply to carriers involved in a situation where speed-to-markets will be significant. (Harvard Business Review,1992) (Garrison & Souleyrette, 1990)

2.2.7 Transport Rates

The need for the establishment of partnerships will hopefully lead to stable rates. As it stands now, transport rates are creating a great deal of instability in the transport community.

For most buyers of transportation, the transport activity is nothing but a "black hole" where they keep throwing money at. As transportation costs take less significance for the high value goods produced in the old mass market economies, the need to add value will be a most important objective for all modes. (Grubler & Nakicenovic,1991)

In that respect, transport companies will need to focus on the best service at the lowest cost. The focus of all transport operators should, therefore, be geared towards maximum utilization of the existing infrastructures as it really is one of the factors of production that cannot be substituted.

3. TECHNICAL PARAMETERS TYPICAL TO TRUCKING

The above factors should be on the mind of all transport executives. But as the truck mode captures a greater share of not only the transport dollars but also of the transport tonnage it will also mean that it will face specific policy issues particular to its own characteristics.

3.1 Safety

The fact that trucking is a highly visible mode sharing the same infrastructures as car drivers makes it sensitive to public opinion. In that respect, trucking companies must pay special attention to the two aspects important in the safety issue i.e. the drivers and the vehicle(s). And more emphasis should be put on drivers as human errors are a causal factor in more than 90% of all accidents involving a commercial vehicle. (Office of Technology Assessment,1988)

Human errors can be corrected in different ways and one of the more basic approaches lies in a better selection and training of commercial drivers on the road. (Tardif,1991)

Safety improvements must be a continued effort and must be aimed at reducing the number of incidents on highly travelled traffic lanes as the tolerance levels of the general public is essentially non-existent. And lastly, the good operators must also publicize their good safety records as it will be one of the ways to add value to their services.

3.2 Configuration

On the vehicle side, the issue of sizes and weights will focus, at least for North America, on the use by the trucking industry of Longer Combination Vehicles (LCVs). LCVs are the double 14.63 metres and triple 8.53 metres units the trucking industry presently operates in some U.S. states, Australian states and Canadian provinces.

3.3 Environment

The Environment will take more importance mostly because truck transportation emits greenhouse gases, produces noise and transports a significant portion of the dangerous goods produced out there. (Cooper,1992)

The issue of greenhouse gases is being addressed as part of the more global warming issue. So far, it looks like the industry will be able to retain the reliable diesel engines until the year 2,000. The trucking industry is all but a small player in this global issue and it will likely develop its own solution as a fall out of the car solution.

Noise is a big issue in Europe and we are likely to benefit from the research now underway.

The transport of dangerous goods represents a significant portion of all goods transported by trucks. In Canada, the trucking industry has done some tremendous efforts to properly train its people for the handling of dangerous goods. The trucking industry supports high quality training and technical specifications for dangerous goods transported in bulk. Again, an element of plus value for some operators if they can show a good safety record.

3.4 Training

Training will occupy an important place in the future of the trucking industry as human resources will play an important role in the future of the trucking industry. (Canada Employment and Immigration,1990) Training will allow the trucking industry to maintain top quality in its services. Training will likely focus on skills related to safety and marketing and on information technology.

Governments could play a significant role in helping finance private initiatives developed by the industry. On a more general note, governments must improve high school and college curriculums in order that better graduates be made available to the public and private sector alike.

3.5 Intermodalism

Intermodalism will likely feature as an important element in the strategic planning of most trucking companies. It will, however, be as the rest; a niche market. (Traffic World,1991) Intermodalism will compensate for some of the problems encountered by the road mode. For instance, the problems of congestion are now being addressed by a road/rail solution. The difficulty in getting drivers for the long-haul lanes have created a market for a road/rail solution. The globalization of the markets has introduced intermodal solutions where three modes are involved e.g. the Asia-European trade via Vancouver.

As long as speed, reliability and prices are part of the intermodal moves chances are that there is growth in that market. The latest trial by DHL between Paris and Brussels shows that these factors can be overcome. (CargoWorld,1992)

3.6 Infrastructures

Of all the issues important to the trucking industry, none rate as high as the quality and quantity of infrastructures. In North America as well as in Europe, the renewal of the road infrastructures is a major challenge because financial resources are scarce and because of the emergence of a trend to better manage the existing resources. (Traffic World,1992) In most countries, several studies have recommended substantially greater investments in public infrastructures; however, no sense of national emergency has developed to spark the kinds of changes in social and fiscal policies and political attitudes that could make this happen.(Page,1992)

Nevermind the political mood, it is generally agreed that the basic long-term commitment of governments is to provide adequate infrastructure and to maintain it to an acceptable service level.(The Economist,1991) The major problem is likely to be a relative scarcity of investment resources combined with the increased demand for resources to renew the existing infrastructure and to maintain a reasonable service level. Thus, governments will need to have their fingers on the pulse of the economic geography of the trading zones for which they have helped to create so that they know "where" to invest these scarce resources.

Among the decisions for new investments the need to maintain service levels through proper user charges and technical innovations will be the more pressing. As the issue of user charges is probably the least political effective, technological innovations should be the favoured option. At the same time, there will be a need for a major review of the institutional framework within which these decisions are made to ensure that it is meeting the new challenges.(Transportation Research Board,1991)

This new policy process should provide for a faster response time and be international in scope.

IVHS will likely play an important role in this "better management" concept. One has to wonder if the countries that do not invest in IVHS won't simply be left behind? But as for infrastructures, we face the tasks of restructuring intergovernmental financing and institutional arrangements if we are to succeed with IVHS initiatives. (Transportation Research Board,1991)

3.7 Uniformity of Rules

It will be important that all governments see that trading zones be accompanied or precede by a uniformization of rules and regulations. Also, the rules will need to be enforced in a more uniform manner. IVHS may hold some interesting value in that respect. Be it safety regulations or the size of the vehicles, the rules have to be uniform. Perhaps the most important and also the most delicate will be the uniformization of labour regulations. As motor carriers move towards quality control programs, governments will have to recognize the changes taking place in the employers/employees relationship.

In the case of trucking, uniformity of rules is important in view of the more traditional regional approach of regulating the industry.

3.8 Technology Transfer

One of the roles of the governments in the 90s will be to put in place the proper mechanic for technology transfer within countries and between nations. The funding of 'centers of excellence' and institutes constitute excellent investments as it often moves R&D to a demand mode rather that the more traditional supply mode. It is important, however, that governments adopt a 'hands-off' approach with the delivery of research results.

This issue of technology and research results transfer to the industry at large is one of the primary objectives of the CTA Research Institute.

4. RESEARCH AGENDA

Having described the parameters of change for the next three to five years to come, this more or less sets the stage for the CTA Research Institute. Following is the agenda we will follow for the next few years: Please note the themes of SAFETY-TECHNOLOGY-PRODUCTIVITY-EFFICIENCY.

Safety

- Safety Technology
- Educational material for the promotion and enhancement of safety in the industry.

Technology

- Intelligent Vehicle Highway Systems
- New technologies to improve the efficiency and productivity of the trucking industry.
- Vehicle Technology
- Training Technology such as driving simulators.

Productivity Improvements

- Research on the changing demand side of transport i.e. just-in-time, quality control, logistics trends, etc..
- Research on management practices and education

Energy and Environment

- Research on new and alternative fuels
- Research on environmental concerns

Management Information Data

- Improvement of database on the industry.

5. CONCLUSION

Modal evolution and substitution is not immune to changes taking place at both the demand and supply for transport. The proposed above-parameters and the ensuing Research Agenda are based on parameters that recognizes the positive side of transportation by which value can be added to its services. Through the maximization of these factors, transportation will slowly emerge out of its mold of being seen as a "Black Hole" and a"Disposable Industry".

REFERENCES

- Bell,M.E. & Feitelson,E., U.S. Economic Restructuring and Demand for Transportation Services, Transportation Quarterly,October 1991
- Canada Employment and Immigration, Canadian Trucking Industry:Human Resources Challenges and Opportunities, 1990
- Cargoworld, January 1992
- Chow,G & Waters II,W.G. Evolution of Intermodal Freight Transportation Implications for Research on Transportation Demand Analysis, Canadian Transport Research Forum 26th Annual Meeting, 1991
- Cooper,J.,Application of Advanced Logistics Techniques and Strategies: A Global Perspective, Transportation Research Board 71st Annual Meeting, 1992
- Delaney,R.V., The North American Scene: A Macro-Economic View, Transportation Quarterly, January 1992.
- Denton, F.T.,Feaver, C.H. & Spencer,B.G.,The Future population and labour force of Canada: Projections to the Year 2051, The Economic Council of Canada, 1980
- Drucker,P.,Management Briefings Special report No. 1202 in Drucker, Ohmae, Porter and Peters, The Economist, 1990
- Flanagan, J. & Morgan,J.P., Just-In-Time for the '90s, Distribution Research and Education Foundation, 1989
- Garrison, W.L. & Souleyrette II,R.R.,Relations Between Transportation and Production, The University of California Transportation Center, 1990
- Globe and Mail, February 1992.
- Grubler, A. & Nakicenovic, N., Evolution of Transport Systems: Past and Future, International Institute for Applied Systems Analysis, 1991
- Harvard Business Review, January-February, 1992

- Healy, M.J. & Ilbery, B.W., Location and Change: Perspectives on Economic Geography, 1990
- Julius, D.A., Global Companies and Public Policy, Royal Institute of International Affairs, 1990
- OECD, Road Transport Research, Technico-Economic Analysis of the Role of Road Freight Transport,1986
- Office of Technology Assessment, Congress of the United States, Gearing Up for Safety: Motor Carrier Safety in a Competitive Environment,1988
- Page, E., Financing Transportation: Who Pays and How, Transportation Research Board, 71st Annual Meeting,1992
- Peters,T.,Management Briefings Special Report No. 1202 in Drucker, Ohmae, Porter and Peters, The Economist,1990
- Porter, M., Management Briefings Special Report No.1202 in Drucker, Ohmae, Porter and Peters The Economist,1990
- Tardif,L.-P., Human Resources in the Trucking Industry, Canadian Transportation Research Forum, 26th Annual Meeting,1991
- The Economist, 1990-1991
- Traffic World, 1991-1992
- Transportation Research Board National Research Council, Special Report 232, Advanced Vehicle and Highway Technologies, 1991

Truck Brokers and Greenhouse Gases: A Cloud with a Silver Lining

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All forms of freight transportation have some detrimental effect on air quality because of "greenhouse gases" that are produced through the combustion of fossil fuels. The environmental impact of freight transportation can be reduced by improving the efficiency of engines to alter the quantity of fuel consumed, or by substituting current energy sources for alternative fuels that produce less destructive gases. Significant progress has been achieved on these engineering approaches to the problem, but the economics of engineering solutions are not always favourable to their implementation. Short of a technological revolution in motive power, further reductions in the fuel consumption of truck engines will be increasingly costly to achieve. As for the use of non-conventional transport fuels, Cronin (1990) suggests that the additional costs of alternative fuels are hard to justify given the relatively low percentage changes in total greenhouse gas emissions.[1] Unless the economic disincentives can be overcome, it will be difficult to convince industry to adopt more "environmentally friendly" technologies.

This paper proposes a non-engineering approach to reduce the production of greenhouse gases and other air pollutants. The energy required to propel a large highway truck is similar, whether or not the vehicle is carrying a full load. Even when travelling empty, a tractor-trailer combination still consumes about 95 percent of the fuel it requires with a load.[2] As a result, a reduction in the incidence of empty miles would directly ameliorate the environmental impact of the trucking industry by eliminating the unnecessary combustion of transport fuels.

The problem of empty moves is generally attributed to spatial imbalances in the demand for freight services. Variations in the demand for freight movements can occur because of differences in population and incomes, or the advantage of a strategic industrial location that creates a larger market for more transport services. The market adjusts for freight imbalances, however, by differentiating the cost of freight movements. At some price, all trucks should be able to find a return load,[3] or to identify an intermediate shipment that would permit the vehicle to follow a triangular pattern back to its origin. The economic problem is imperfect information and the high search costs that characterize such markets. If a carrier is unable to find a load quickly, it may be more economic

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to undertake an empty re-positioning move than continue to search. Consequently, the solution proposed in this paper to reduce the total consumption of transport fuels is to develop a better system of market information for the trucking industry.

The incidence of freight imbalances and the problems of empty returns are examined in the following section. Subsequently, the discussion focuses on the role of freight brokers and the use of an electronic interchange to facilitate the matching of empty trucks and potential loads.

Incidence of Empty Truck Moves

There are few costs that can be avoided when a truck is running empty. Consequently empty returns are of critical importance to trucking operations and full/empty mile records are carefully monitored. Although the carriers record these variables, there is no systematic collection and publication of the data by Statistics Canada.[4] As a result, comprehensive estimates of the number of empty truck moves are not available.

Some transportation research has been undertaken that provides a rough measure of empty truck movements. In 1987, the Ontario Ministry of Transportation operated a road side interview for 48 hours at two sites on Highway 400 (north of Toronto) to assess the incidence of empty moves, Raney (1988). A total of 3,200 truck drivers were interviewed, and 99 percent agreed to cooperate with the survey. The study revealed that 36 percent of the southbound, and 24 percent of all northbound trucks were empty. While the percentage of empty moves tends to fall with the length of haul, it is estimated that as many as 18.5 million truck kilometres could be eliminated by matching loads between southern and northern Ontario. Raney suggests that the greatest potential savings (63 percent) could be achieved by matching loads carried in private trucks.

Information on empty truck movements between Canada and the U.S., has also become available recently as a result of the Minister's Task Force on Trucking. The Task Force commissioned Statistics Canada to determine the market shares of Canada-U.S. carriers operating in the transborder trade. Over a six week period (February 4 - March 15, 1991), Statistics Canada interviewed 13,475 truck drivers at 24 border crossings from Woodstock, N.B. to Aldergrove, B.C. Although not the original purpose of the survey, the number of empty border crossings are reported as a variable to calculate truck utilization/market share.

As a properly constituted probability survey, Statistics Canada expanded the collected data to provide an unbiased estimate of the entire population. These estimates of empty returns, which have been extracted from the final report

of the Task Force are presented in Table 1 for Canadian and U.S. for-hire carriers.

The data in Table 1 indicate that approximately one-third of all northbound for-hire trucks travel empty across the Canada-U.S. border. On the southbound movements, the Canadian carriers have considerably fewer empty trucks than their U.S. counterparts, but combined the Canadian-U.S. empty trucks equal about one third of the total. From an environmental perspective, these data suggest that a significant volume of air pollution caused by the for-hire carriers in the transborder market is potentially avoidable.

Table 1: Capacity Utilization of Transborder For-Hire Carriers

	Canadian Trucks		American Trucks	
	thousand	percent	thousand	percent
Capacity utilization - Northbound				
Empty	41.5	36.7	23.4	33.4
Under 75%	8.6	7.6	6.0	8.6
75% to full	63.0	55.7	40.7	58.0
Total	113.1	100.0	70.1	100.0
Capacity utilization - Southbound				
Empty	31.2	27.6	31.0	44.2
Under 75%	4.8	4.2	1.6	2.3
75% to full	77.1	68.2	37.5	53.5
Total	113.1	100.0	70.1	100.0

Source: Heads, Prentice and Harvey (1991), Table 2.9

Similar data on empty truck movements are presented in Table 2 for private trucks. Given that operating licence restrictions limit private trucks to the movement of their own goods, more empty trucks should be expected. These data reveal that over half of all northbound Canadian trucks return to Canada empty. U.S. private carriers fare better than the Canadians on the northbound route, but the positions reverse on the southbound moves. Using a weighted average, 37 percent of the southbound, and 50 percent of the northbound private trucks cross the border empty. Although there are fewer private than for-hire trucks on the road, the greater incidence of empty returns implies that, on a unit basis, the private carriers create more unnecessary air pollution.

Table 2: Capacity Utilization of Transborder Private Carriers				
	Canadian Trucks		American Trucks	
	thousand	percent	thousand	percent
Capacity utilization - Northbound				
Empty	23.8	53.8	12.2	44.4
Under 75%	4.1	9.3	2.6	9.4
75% to full	16.3	36.9	12.7	46.2
Total	44.2	100.0	27.5	100.0
Capacity utilization - Southbound				
Empty	15.9	36.0	10.7	38.8
Under 75%	2.8	6.3	1.2	4.3
75% to full	25.5	57.7	15.7	56.9
Total	44.2	100.0	27.5	100.0

Source: Heads, Prentice and Harvey (1991), Table 2.10

The number of empty truck miles can not be calculated from the Statistics Canada data because there no are distances associated with the movements. No doubt the empty mileage is significant, however, because cabotage restrictions on both sides of the border prevent foreign trucks from undertaking point to point moves within their jurisdiction. Thus, if a foreign truck crosses the border empty, it must continue empty to the pick up point for a return backhaul across the border.

De-regulation, Load Brokers and Empty Moves

Changes in the economic regulation of trucking occurred approximately eight years earlier in the U.S. than in Canada. It was also more abrupt. In Canada, the phasing in of the Motor Vehicle Transport Act (MVTA) 1987 will not be complete until January 1993, whereas in the United States, the loosening of economic regulations on the trucking industry occurred literally overnight. Although the impacts of regulatory change are occurring more slowly, the repercussions appear to be similar.

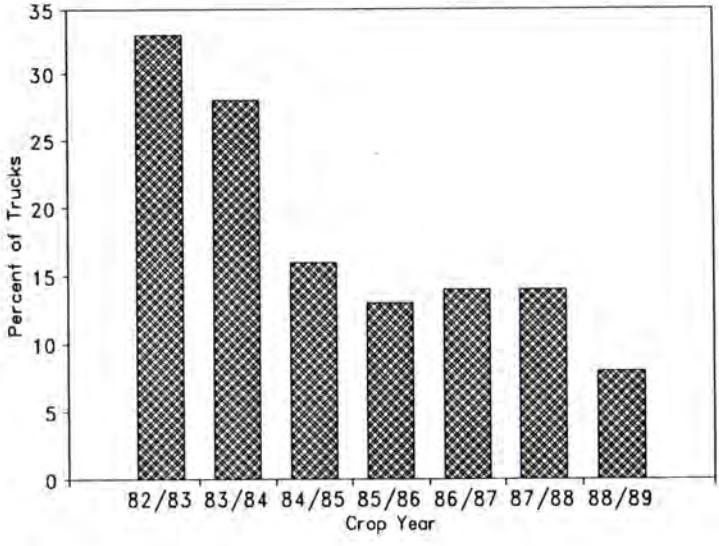
One feature of regulatory change in the United States has been the expansion of "load brokers". Load brokers act as intermediaries between the shippers and carriers to arrange shipments. They more frequently act on behalf of shippers to screen available carriers for the best freight rate, but are also used by carriers to assist in the search for a load. Between the late 1970s and 1988, the number of licensed freight brokers in the U.S. increased from less than 100

to nearly 6,000 (Beilock and Shell, 1991). Although data are not available for Canada, a similar trend appears to be emerging.

The growth of load brokerage has coincided with a reduction in the number of empty returns. Beilock (1991) reports that the number of empty refrigerated trucks entering Florida have fallen from approximately one-third of all trucks in 1982/83 (two years following the U.S. Motor Carrier Act of 1980) to less than 10 percent by 1988/89. These data are reproduced in Figure 1. No doubt the mere loosening of economic regulations would have helped most carriers to broaden the list of commodities they can transport, but there is evidence that rise in the number of load brokers has also contributed.

Beilock and Shell (1991) examined the number of inbound and outbound loads from Florida that are arranged by load brokers. Based on a survey of 1,776 refrigerated trucks, they found that 63 percent of all outbound, and 42 percent of all inbound loads were arranged by load brokers. These data, which are presented in Figure 2, also list other means of arrangement. It is worth noting that shippers and receivers arrange the freight for only 19 percent of inbound, or outbound, loads. This suggests that most shippers/receivers believe that load brokers provide a valuable service. It would be an understatement however, to say that load brokers are not as highly regarded by the carriers.

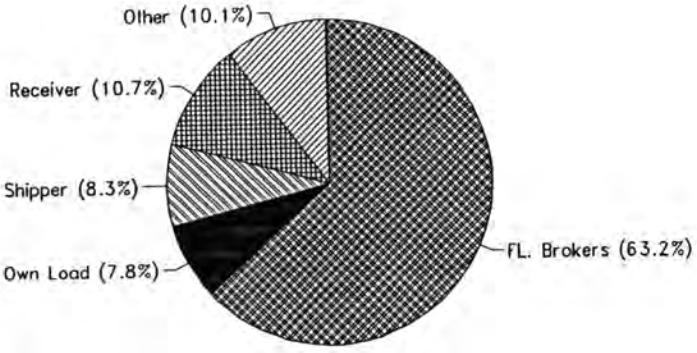
Figure 1: Empty Returns to Florida



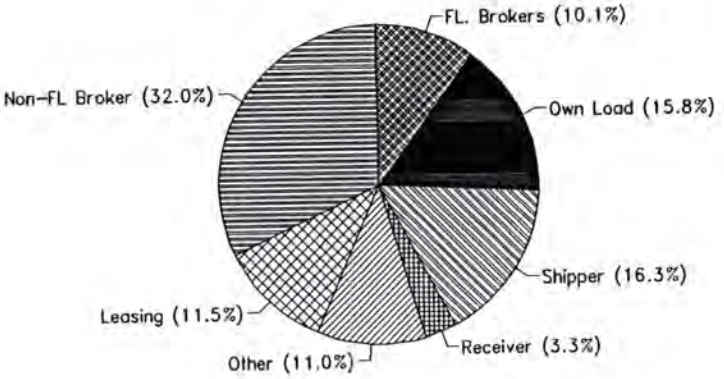
Source: Beilock (1991)

Figure 2: Arrangement of loads for refrigerated trucks serving Florida.

Outbound Loads



Inbound Loads



Source: Beilock and Shell (1991)

The "excessive" fees charged by load brokers is a major compliant of the carriers. These fees can average 10 to 12 percent of the freight rate, but some load brokers use the power of their position to extract still higher returns from the market. For example, an unscrupulous load broker can book a load with one carrier, then search for another carrier that will agree to a lower freight rate. If a lower bid is found, the broker may cancel the prior arrangement (after the first carrier may have already committed a truck and driver), without passing on the benefit of the lower rate to the shipper, or compensating the first trucker. This problem is associated with the lack of defined responsibilities and sufficient regulations to make the load brokers accountable. "Doubt exists in particular transactions as to whether the broker is acting as principal or agent, and whether the broker is acting as agent for the shipper or the carrier, or indeed for both." (Special Task Force on Owner-operators, Report, 1991:p.17) Carriers also allege cases of "double brokering", slow payment, and non-payment for their loads.

Beilock and Shell (1991) asked brokers, shippers and owner operators in Florida to comment on the honesty of load brokers. The Florida load brokers indicated that about 15 percent of their professional colleagues are dishonest. The shippers suggested that 13 percent of the brokers quote higher rates than they pay to the carriers. The carriers' views are more negative; 72 percent believed the load brokers lie about freight rates; 40 percent claim the brokers fail to pay the agreed upon freight rates; and, 70 percent conclude that brokers make more than a fair return.

The "untrustworthy" image of load brokers has obscured the important economic and environmental role that these intermediaries can perform, as well as giving the reputable brokers a public relations problem. Lane Kranenburg, of Laker Freight Systems Ltd., stated the case cogently in a submission to the CCMTA Special Task Force on Owner-operators (June, 1991):

> The broker industry has a black eye at this time because of less than honest individuals booking loads, having trucks haul them and then pocketing the proceeds and leaving town, sticking the trucker with all the costs.
>
> My company, a Calgary brokerage firm, was formed because I saw a legitimate need for an agency to act as a load arranger for trucks that are presently travelling the highways empty and that do not have the benefits of a sales force or that are just too small to justify time to hunt for freight themselves.
>
> After reading an article in the paper put out by the Ontario Trucking Association about the number of empty trucks travelling the highways in Canada I saw an opportunity to assist in the more efficient use of both our trucks, and our highways. *Empty trucks*

> *cost everyone as it is polluting the atmosphere as much travelling empty as it is when full.* [emphasis added]

Dishonesty in business is a serious problem. As Akerlof (1970) demonstrated in his seminal article, the uncertainty created by dishonest dealers tends to drive the honest dealers out of the market. As a result, the costs of dishonesty in load brokerage lie not just in the amount that some truckers are cheated; the costs also include the loss incurred by driving legitimate load brokers out of business. Because the truckers are not willing to accept the risk of "adverse selection" (choosing a dishonest broker), many extra trucks run empty. This results in two kinds of losses for society. First, the costs of operating empty trucks are ultimately passed on to shippers in freight rates that are higher than would be the case if the extra capacity were not required.[5] Second, the additional fuel that is consumed by empty truck moves adds unnecessary pollution to our atmosphere.

Efficient Information Markets

There are at least three aspects of load brokering that need to be addressed in order to eliminate the abuses of dishonest dealers and enhance the economic and environmental benefits to society. First, the load brokering industry needs to have a licensing body to provide a legal framework that can prohibit unscrupulous load brokers from continuing in the business. The licence would define the responsibilities of the load broker, such as the disclosure of fees and conflicts of interest to the client, and prevent brokers from acting as principals.

The issues surrounding the legality of licensing load brokers are discussed in the final report of the CCMTA Special Task Force on Owner Operators. The best course of action would appear to be the introduction of legislation at the federal level because this would permit the scope of licensing regulation to span provincial boundaries. As with extra-provincial for-hire trucking, this legislation could be administered provincially. The CCMTA has followed up on its report with a model of the legislation that would licence truck brokers and regulate their activities (CCMTA, 1992).

The second requirement for an efficient information market is the formation of a self-regulating body to monitor complaints and make sure that licensing provisions are enforced. The model for this organization of load brokerage could be the provincial Real Estate Boards. In order to be a member of a Real Estate Board, a set of examinations must be passed and a code of conduct must be adhered to. Although non-members can practice if they hold a licence, they are denied access to certain privileges, which is a cautionary signal to the buyer. This provides a powerful incentive for the member firms to observe the accepted code of conduct.

The third requirement for an efficient information market is a method of pooling information. In the case of the real estate market this is accomplished by the Multiple Listing Service (MLS). The MLS increases the efficiency of all its members because pooling information gives each member access to more potential sales and eliminates the duplication of effort that would be required if each broker operated alone.

The system that I envision for the trucking industry would combine features of MLS system and the commodities exchanges to create an electronic market for trucking services. The exchange would operate as a "bid and ask" computerized trading system for truckload freight. As in the case of the MLS, the market would be open only to bona fide members that meet the licensing and code of conduct requirements. As in the case of the commodities exchanges, the trucking companies would also have brokers that could offer to buy and sell truckload services. Brokers would operate on fixed commissions, which would be much lower than current rates, and the exchange would collect a small transaction fee to cover its costs of operation.

Economic Advantages of an Electronic Freight Market

An electronic market for truckload freight could have significant economic benefits for carriers and shippers, as well as the environmental advantages, and the reform of the freight brokerage industry, previously considered. The obvious gain for the carriers is the higher utilization of equipment that could be obtained by avoiding empty returns. This is significant. With profit margins so thin in the trucking industry, a small percentage change in the number of empty miles travelled can make the difference between a profit and a loss.[6] Although the additional revenues may be enough incentive to encourage the trucking industry to participate in an electronic market, there are other more subtle advantages for the trucking industry. For example, the availability of an efficient brokerage market would eliminate the need for a large marketing staff at many trucking companies. Some of these individuals may in fact be converted to freight brokers who would arrange loads/space on behalf of their former employers.

If the electronic freight market were organized with a clearing house, the carriers could also gain certain financial efficiencies. At the present time, Canadian carriers have to contend with the problems of overdue accounts receivables. This problem is avoided in financial and commodity markets because the brokers operate through a clearing house. Before a broker can make a transaction, the buyer/seller has to provide a guarantee that the account can be settled through the clearing house within a specified time frame. Payments for contracted services in an electronic freight market could be immediate and enforced by its rules. The more rapid payment of accounts receivables would reduce the operating capital requirements of the trucking industry, as well as its losses from bad debts.

Although the shippers would have to settle their accounts more quickly, freight rates would adjust to reflect this difference. Ultimately, the costs of financing the accounts receivable of the trucking companies must be reflected in higher freight rates for all shippers. Currently, shippers who pay their accounts on time tend to cross-subsidize those who are delinquent.

The major gain for the shippers would be the assurance of a reliable carrier and a reduction in overhead costs. Access to a highly competitive electronic freight market would reduce the time spent by the traffic manager soliciting offers and arranging freight services. The determination of freight rates in an open and efficient market would guarantee the traffic manager that the rates were competitive. This could be especially important to small shippers who have weak bargaining power to negotiate favourable freight rates.

In addition to facilitating the trade of truckload freight services, the electronic exchange could provide a record of average daily transaction prices. This information would assist both shippers and carriers to make better planning decisions. Records of daily prices would help carriers decide whether to expand or contract their fleets. For shippers, freight rate trends could help them plan their pricing strategies and the introduction of products into new markets. Price information would also signal shippers and carriers of opportunities on specific traffic lanes and markets. In the longer term, this would tend to stabilize prices and improve the financial performance of the industry.

Concluding Remarks

The transportation industry has an unavoidable impact on the environment, but steps can be taken to make certain this impact is minimized. The solution proposed in this essay is to avoid empty truck movements by improving the information market for matching loads. Although improvements in engine efficiencies and the use of alternative fuels can also make an important contribution to the reduction of pollution, the incentives to change are not as great. Using an analogy from the experience of energy conservation programs: it has been easier to convince home owners to insulate their attic, than to install a more "energy efficient" furnace. The economics are much more favourable, and consequently, they are more readily adopted. If an efficient and reputable electronic load brokering market could be established, it is very reasonable to expect that it would be quickly embraced by the truckload sector of the motor carrier industry.

REFERENCES

Agriculture Canada. Annual Fresh Fruit and Vegetable Unloads Report on Ten Canadian Markets.

Akerlof, George A. "The Market For "Lemons": Quality Uncertainty and the Market Mechanism" Quarterly Journal of Economics. Vol. 84 (1970): 488-500.

Beilock, Richard. Trends in the Adequacy of Trucking Services for Produce. Report prepared for the Domestic Transportation Branch, Agricultural Marketing Service, United States Department of Agriculture, June 1991.

Beilock, Richard, and Timothy Shell. "Brokerage of Produce Trucking." Proceedings. Canadian Transportation Research Forum, 26th Annual Meeting, (1991):409-421.

Canadian Council of Motor Transport Administrators. Draft Model Legislation and Regulations respecting Motor Vehicle Transport Brokers and Owner-Operator Contract Standards. (Mimeo) January, 1992.

Cronin, Michael R. "Australian Transport and Greenhouse Gases". Australian Bureau of Transport and Communications Economics, Paper presented at the Transportation Research Forum, Long Beach, California, October 1990.

Heads, John, Barry E. Prentice, and Mahlon Harvey. The Transborder Competitiveness of Canadian Trucking. Minister's Task Force on Trucking, Study 8, June 1991.

Raney, William F. "The Costs and Potential Savings of Empty Truck Movements Occurring between Northern and Southern Ontario." Proceedings. Canadian Transportation Research Forum, 23rd Annual Meeting, (1988):353-367.

Special Task Force on Truck Owner-Operators Report to the Canadian Council of Motor Transport Administrators, June 1991.

Special Task Force on Truck Owner-Operators Submissions to the Canadian Council of Motor Transport Administrators, January 1991.

Endnotes

1. Methanol produced from natural gas only reduces CO_2 emissions by 3 percent relative to conventional gasoline, while methanol from coal actually increases total CO_2 emissions by 51 percent, Cronin (1990).

2. Personal communication, Reimer Express Lines Ltd.

3. A good deal of anecdotal evidence exists to support this contention. For example, the large volumes of peat moss exported from Canada can be attributed mainly to the availability of low "backhaul" freight rates.

4. Statistics Canada has added questions regarding empty vehicle kilometres to its current (1990) "Motor Carriers of Freight Financial and Operating Statistics" survey (levels 1 and 2). Personal communication, David Dodds, Director, Transportation Division, Statistics Canada.

5. Beilock (1991) argues that the reduction in empty returns to Florida between 1982/83 and 1988/89 explains the drop in the real cost of truck services to this market.

6. Personal communication, Fred Arnold, Assistant General Manager, Arnold Brothers Transport Ltd.

The Effect of Engineering and Mechanical Reliability on the Line Haul Performance of a Single Track Railroad

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I. INTRODUCTION

The reliability of train service on single track rail lines is increasingly important to the North American rail industry. Railroad rationalization has increased the traffic density on railroad main lines and reduced the amount of double track, while the shift toward intermodal and unit train operations has allowed most rail traffic to bypass classification yards. In broad terms, two types of delays affect train performance. Engineering and mechanical delays arise from the failure and repair of track components, locomotives, cars, and communications and signaling systems. Operating delays to trains occur because of meets and passes, variations in running time, bad weather, and congestion in terminals. The primary purpose of this paper is to study the effect of engineering and mechanical reliability on line-haul performance.

The three primary attributes of line-haul performance are capacity, level of service, and cost. In this section, we will describe each of these attributes briefly. The physical capacity of a line segment is greater than the operational capacity. The physical capacity is "the maximum number of trains that can be moved through the line-haul per unit time," while the operational capacity is a lower number such that train delay is in some sense tolerable [Manheim, 1982]. This paper addresses operational capacity, which is a function of train length, headways, distance between sidings, signaling, communications between crews and dispatchers, and the average acceptable level of delay to a train.

Railroad customers are concerned with origin-to-destination (O-D) service, which includes both average trip times and trip time reliability. Together, the performance of yards and of line segments determines

the overall level of O-D service. Line-haul performance can be represented by the mean trip time, variability of trip time, and schedule adherence. The mean trip time depends on the operating speeds, meet/pass delays, and any engineering delays faced by the trains. Variability of trip time arises because of changes in horsepower/ton ratios, engineering and mechanical delays (which are often unforeseen), line congestion, and weather. Because of this variability in line-haul time, trains will not be able to adhere to their schedules unless some slack is included.

Line-haul operating and maintenance costs depend on line-haul characteristics, the nature and duration of operating delays, the number and type of trains operating on a line, unit costs such as fuel and crew costs, and the incidence of mechanical and engineering problems.

II. PAST WORK

Petersen and Taylor [1982] developed analytic expressions for interference delays on a partially double tracked railway with intermediate signaling. They make an important assumption that the departing times for trains are independent random variables that are uniformly distributed over the time period of interest. They also developed a simulation model that allows an arbitrary number of trains to be dispatched with different speeds and priorities on an arbitrary track configuration. The model was implemented as a general purpose discrete event simulation model in which different dispatch goals or criteria can be included. Harker and Wong [1990] developed a model to estimate the mean and variance of total travel time for a scheduled railroad on a partially doubled track line with operational uncertainties.

The primary emphasis of the above models and of similar models is to study line-haul dispatching and meet-pass planning, rather than to analyze the effect of engineering and mechanical reliability on line-haul performance, which is the central theme of this paper. However, several studies have documented the extent of mechanical and engineering delays. Belovarac and Kneafsey [1972] found that "operating, mechanical and electrical, and other delays are observed to be only minor determinants of line-haul reliability." They found that such delays accounted for less than 3% of the train's trip time, 10.4% of trip time variance, and 19.2% of the delay time variance. More recently, Smith [1990] found that power (5.9%), other mechanical (4.5%), and engineering delays (13%) together accounted for less than a quarter of the recorded time for train delays; meets and passes were, by far, the largest cause of train delays.

When there is a mechanical or engineering failure, traffic along the line will be disrupted, as trains queue up on either side of the problem area. As a result, many trains may be delayed, not just the ones that experienced a mechanical failure or the ones that were forced to stop because of a broken rail. These other trains may be delayed at sidings, held in yards, or canceled altogether. The costs resulting from such traffic disruption are a function of traffic volume, the duration of the problem (e.g. the number and size of maintenance windows), the operational capacity of the line, and average delay costs. Dontula [1991] used deterministic queuing theory to estimate the total delay to trains caused by maintenance windows of 1-8 hours. He showed that the costs of delay to trains could exceed the direct costs of routine maintenance and even be a sizable fraction of major track renewal costs.

III. STRUCTURE OF SIMULATION MODEL

As the incidence of engineering and mechanical problems increases, both the capacity and level of service of a line-haul decline. By using a simulation model, it is possible to relate component reliability to train reliability, which in turn can be related to terminal and O-D reliability. Engineering and mechanical delays to a train generally affect many other trains, but these other delays are likely to show up as operating delays. We would like to determine, through the use of simulation, the extent to which train delays attributed to engineering and mechanical problems underestimate the true effects of such problems, especially on high density lines. A discrete event simulation model was therefore developed to simulate line-haul operations. A discrete event simulation represents a system in terms of a set of state variables that change only at discrete points in time at which certain events occur. An event is defined as an instantaneous occurrence which may change the state of a system. [Law and Kelton (1982)]. The events that drive the simulation model are the departure of a train from its origin and the departure of a train from a segment. Engineering or mechanical failures are represented in the departure events and do not require creation of additional events.

There are several line-haul trip time components that must be defined before presenting the model itself. The difference between actual and scheduled departure time is referred to as departure delay. The difference between actual and scheduled arrival time is referred to as arrival delay. The total line-haul time will be the time

period from actual departure time to actual arrival time consisting of three components, namely free running time, meet and pass delays, and line-haul failure delays.

Inputs to the Model

Train schedules: Train schedules, if available, can be used to dispatch the trains by reading from an input file. If not, trains will be dispatched in the model at regular intervals throughout the day, alternating between the left yard and the right yard.

Train characteristics: train identification number, direction of dispatch outbound (OB) or inbound (IB), train length, priority of train, normal speed, and actual departure time.

Track configuration: the line is divided into M segments, each of which is a stretch of track between adjacent turnouts. Thus, each segment represents a section of single track between sidings or a section of double track where there is a siding. The segments are arbitrarily numbered from m=1,..., up to m=M (from left to right).

Engineering and mechanical failure patterns: the probability of delay to a train on each segment plus the delay time distribution. The model does not distinguish among the causes of delay, so that engineering, signal, and equipment failures are all represented by the failure probability distribution.

Execution of simulation

In any discrete simulation, the order of execution of events is of paramount importance, and the simulation clock is always updated to the next event. As the simulation proceeds, all the events that are generated are put in a priority queue, based upon the time of the event. The recursive procedure of priority queueing is as follows: if the current event is the first event, create a priority queue. Whenever an event is generated, search the priority queue and place the event such that the weights of the events are in an ascending order. If there are several events that are scheduled to occur at the same time, the order of execution of these events is FIFO (First in first out).

The event that is to be executed next is picked up from the top of the priority queue, thus generated. The state of a line is completely specified if we know the status of all the trains on it, a set denoted by T and the following parameters. Note that:

x_i = the time that train i will complete its current activity.

L_i = location (segment number) of train i

B_i = indicator variable to represent if train i is stationed on a siding

S_i = indicator variable to represent if train i is stopped on a segment or moving

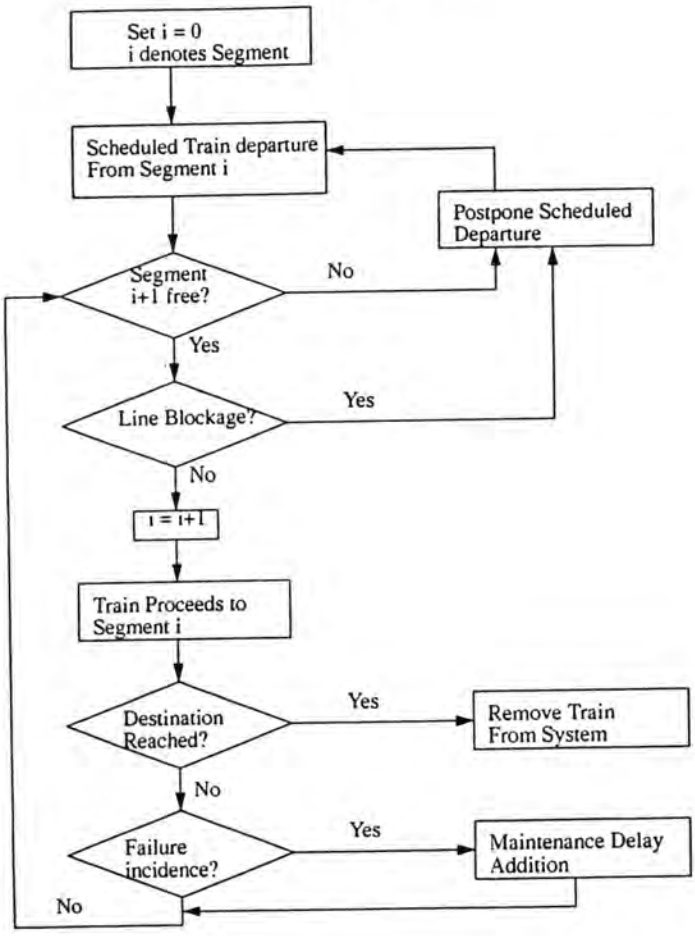
The execution of the model continues until there are no more events to execute in the event list or the total period of simulation has elapsed.

Model logic

A simple train dispatching logic powers the model. Dispatching consists of departing a train from its origin, authorizing it to move from one segment to another, and removing it from the system at its destination. To dispatch a train, the first segment must be empty and there must be no possibility of a line blockage, as discussed below. For an outbound train moving from left to right, the first segment is segment 1. The dispatching logic is explained with reference to figure 1.

Suppose trains are scheduled to depart at 30 min. intervals from alternating yards. Now, consider an outbound train that is in segment i that would like clearance to move to segment i+1. If the segment is not free, then the departure of the train from segment i is postponed until the other train leaves segment i+1. If either the next segment or the siding on the segment happens to be free, the dispatching logic then checks for line blockage problems. If the movement will not create a line blockage problem, then the train is dispatched to segment i+1. If i+1=M, departure from segment will lead to train arrival at its destination. If so, the train is removed from the system, and the relevant statistics are collected. If the destination is not reached, a random variable is drawn to see if a train failure occurs. If a train failure occurs, then a maintenance delay is added to the train data. The train is then delayed on the segment i+1 until the maintenance process is completed. The above process is repeated until the completion of model execution. The procedure remains exactly the same for trains in the other direction.

Movement Of an Outbound Train Through
Single Track Line-Haul
Figure 1



An important component of the dispatching logic is the avoidance of potential line blockage situations, where no trains on the line can move further unless some train (or trains) reverses. Even though a segment is empty, it will not be desirable to move a train onto it without being sure that such a move will not block the line. Although the model does not seek an optimal resolution of line

blockage, it does prevent line blockages by using a concept similar to the simple meetability conditions developed by Petersen and Taylor [1982].

Suppose a train is located in segment i and we would like to move it onto segment i+1. The first rule is that segment i+1 should be free. Given that segment i+1 is free, we perform the following limited look ahead. The look ahead is restricted to segments i+1 and i+2. A counter is created and is initialized to 1. If segment i+1 or i+2 has a siding and both the segment and siding are free, we subtract one from the counter. If one of the segments (namely i+1 and i+2) has a siding and there exists an inbound train on the siding and the corresponding segment is free, we subtract one from the counter. However, if there is an outbound train on segment with a siding with either one of them free, we increment the counter by 1. If either segment i+1 or i+2 does not have a siding and has an outbound train, we increment the counter by 1. In case the train is already on segment M-1 and the segment M is free, we set the counter to zero. The rules are applied until either counter becomes zero or the segments i+1 and i+2 are searched. No line blockages will occur if the counter becomes zero, and the move can be made. On the other hand, if the counter does not reach zero, the train must remain on segment i until one of the segments i+1 and i+2 changes its status. The procedure remains the same for an inbound train, except that the limited look ahead is applied to segments i-1 and i-2 only. The implementation details of this logic can be found in Dontula [1991].

IV. APPLICATIONS OF THE MODEL

We used the model to examine the inter-relationships between engineering and mechanical and operations performance. The results presented in this paper were obtained for a 100-mile line with six sidings, each of which was 2 miles long. The seven single-track segments were each 12 miles long. The ends of lines were in yards. The distinction as to whether a line was inbound or outbound was made based on left yard. The engineering and mechanical performance of a line was represented by a failure rate and the associated repair time. The repair time delay was obtained from an exponential distribution with a mean time of 60 minutes. Train speed was 45 miles per hour, with trains dispatched at regular intervals of the line. The line was simulated under very heavy and medium density traffic conditions.

Case 1: 40 trains/day

In the first case, the line was operating near capacity with 40 trains operating per day (if the trains averaged 5000 tons, this would be 70 million gross tons per year). Trains were dispatched every 36 minutes, alternating between the left and the right yard. To avoid fine-tuning the results to a particular set of train schedules, a five-minute random variation around the scheduled departure time was added. Different rates of failure were imposed on the trains, varying from an average rate of one failure every 500 train-miles to one every 1750 train-miles. The simulation model was run for five weeks duration and the results of the first day and the last three days were not considered in the statistics. The five-week results were compared with model run times less than five weeks and were found to be quite convergent.

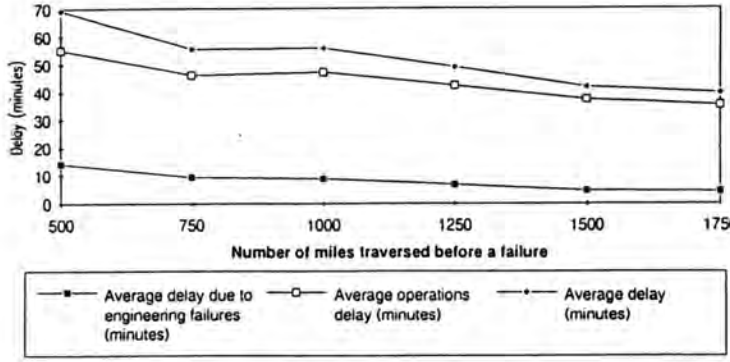
Figure 2 shows the engineering and operating delays as a function of the failure rates. As expected, the engineering delays increased (from 4 to 14 minutes per train) as the failure rate increased from one every 1750 to one every 500 train-miles. In addition, the operating delays also increased with the failure rate. The average delay to a train, when there were no failures, was about 28 minutes for train meets. But, as the failure rate increased to one failure in 500 miles, the operating delays nearly doubled to 55 minutes. The total of operations plus engineering delays, therefore, rose from 28 to 69 minutes.

The effect of engineering failures on train reliability was much higher. From figure 3, the standard deviation of trip time was 15 minutes without any train failures, but it jumped to 72 minutes (more than 300%) as the failure rate increased. The consequences of such increased variance is much higher on the reliability of train operations as compared to the increase in mean running times. (In reviewing these measures of train reliability, it is interesting to note that the standard deviation of trip time observed in earlier empirical studies typically varied from one to three hours [Folk (1972); Martland (1974)].)

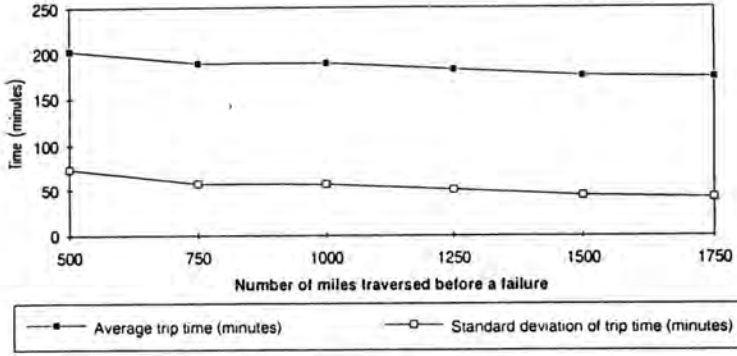
Case 2: 24 trains/day

For a less congested case (approximately 45 MGT per year), we dispatched 24 trains per day at intervals of 1 hour from alternate yards. The same process was repeated, with failure rates, ranging from one failure in 500 miles to one in 2000 miles of train journey. In figure 4, we plot the average train delays to a train due to engineering problems, operations, and cumulative average delays. The

Delay vs Failure Rate
Figure 2



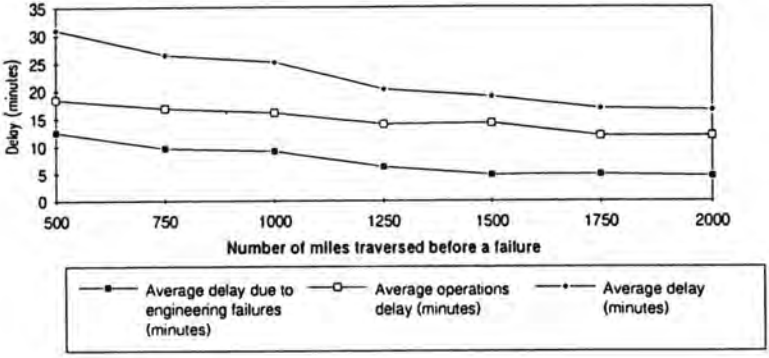
Trip Time, Std. Deviation vs Failure Rate
Figure 3



average operating delay for the base case when there are no failures is 7 minutes. Although the magnitude of the delays are not as extensive as they were in the prior case, the engineering delays now accounts for about one third of the total delay and operating delay accounts for the rest of the delay. On the average, the operating delays ranged from 12 to 18 minutes, and the engineering delays ranged from 5 to 13 minutes. Both engineering delays and operating delays increase as the failure rates

increase. Once again, there is a significant increase in the average delay to trains as the engineering failures occur on the line.

Delay vs Failure Rate
Figure 4



Trip Time, Std. Deviation vs Failure Rate
Figure 5

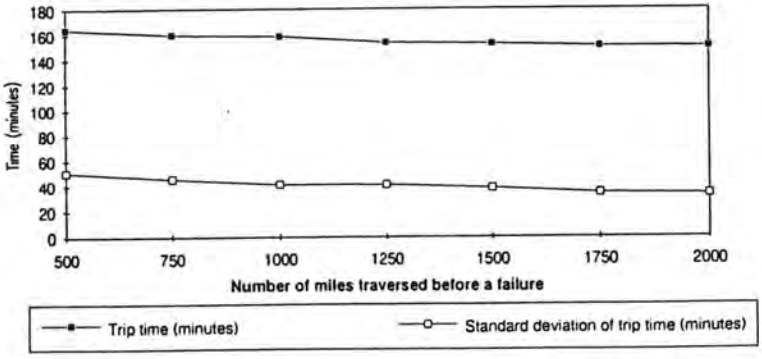


Figure 5 plots the mean and standard deviation of trip time. As the failure rate increases to one failure in 500 miles, the standard deviation of trip time rises significantly, from 6 to 40 minutes.

V. CONCLUSIONS

We used a simulation model to examine the influence of engineering and mechanical reliability on the performance of a single track railroad. A simulation model was needed to compute mean and variance of trip times, taking into account train meets and the probability of mechanical and engineering failures. The results showed important linkages between component reliability and overall line performance. As in the earlier studies of line-haul performance, engineering and mechanical delays were found to account for a small portion of total line-haul time and, on medium to high tonnage lines, a small percentage of total delays. However, as engineering and mechanical failures increased, there was a cascading effect as other trains were delayed and more time was required for train meets. As a result, total train delay rose substantially as the rate of failure increased. Moreover, there was an even greater increase in the variability of train performance.

In summary, as the incidence of engineering and mechanical problems increases, both the capacity of the line and the level of service decline. By using a simulation model, it is possible to relate component reliability to train reliability, which is intertwined with terminal and origin to destination reliability. Significantly, train reliability appears to be more affected by component failures than average travel times.

To the extent that railroad information systems fail to document the relationship between failures and increased operating delays, they will underestimate the importance of engineering and mechanical problems. In fact, as shown in this paper, delays arising from engineering or mechanical problems could be more important than the delays resulting from routine train meets on medium to high-density single track lines, especially in terms of train reliability. This suggests that improving the reliability of track and equipment and providing better coordination among operations and track maintenance activities should be important parts of strategies for improving line-haul performance.

On lines that operate well under capacity, there will be few meets and passes, so that engineering and mechanical delays can be as important as meet and pass delays. This again suggests that more reliable track/vehicle systems will have a higher impact on train performance than will advanced dispatching systems. A similar conclusion applies to the highest priority trains, which are seldom delayed for meets and passes, but which will be subject to mechanical and engineering failures.

The simulation model described in this paper has been used to study line capacity and service as functions of siding configuration and line speed Dontula [1991]. A number of extensions to this analysis are also possible. The model assumes, for dispatching purposes, that all trains are of equal priority. An extension could be made to include varying degrees of priorities. The "limited look ahead" approach of resolving line-blockage could be extended to optimal resolution. Finally, a case study of a real line could be performed after calibrating the model with appropriate functions for failure and repair time distributions.

REFERENCES

Belovarac, K. and J.T. Kneafsey, "Determinants of Line Haul Reliability", MIT Studies in Railroad Operations and Economics, Vol. 3, Cambridge, MA, 1972

Dontula, Rajesh V., "A model for evaluating railroad line-haul performance", MST thesis, Department of Civil Engineering, MIT, 1991

Harker, P.T., and S. Wong, "Two moments estimation of the delays on a partially double tracked line with scheduled traffic", University of Pennsylvania, 1990

Lang, A.S., Reid, R.M., "Railroad car movement reliability: a preliminary study of line-haul operations", Studies in Railroad Engineering, Department of Civil Engineering, MIT, Cambridge, 1970

Manheim, Marvin L., Fundamentals of Transportation Systems Analysis, Volume 1: Basic Concepts, (MIT Press), Cambridge, 1982

Martland, Carl D., "Improving Railroad Reliability: A Case Study of the Southern Railway", MIT Studies in Railroad Operations and Economics, Vol. 10, Cambridge, MA, 1974

Martland, Carl D., P. Little, O.K. Kwon, and R.V. Dontula, "Background on Railroad Reliability", MIT Center for Transportation Studies, Cambridge, 1991

Petersen, E.R., and A.J. Taylor, " A structured model for Rail line Simulation and optimization", Transportation Science, Vol. 16, No. 2, May 1982

Smith, M.E., Train Delay Analysis: Alternative Methods and Implications, Burlington Northern Railroad Report, April, 1990

ECONOMIC ANALYSIS OF LINSEED OIL AS A CONCRETE SEALER

Gabriel R. Toichoa* and Barry E. Prentice**

Salt damage to portland cement concrete is a serious economic problem for highway and municipal street authorities. Rock salt, which is spread on the roads during winter to remove ice, attacks the steel reinforcing rods and damages concrete streets, bridge decks and parking structures. Normally the alkaline concrete environment protects the reinforcing steel from corrosion, but when chlorides penetrate into the structure an electrochemical reaction occurs that causes the steel to rust. Incredibly, the increase in the dimension of the reinforcing steel that is created by the rust produces tensile stresses that are sufficient to crack the concrete and accelerate surface spalling. As a result, salt damage increases the maintenance costs of concrete roads, bridges and parking structures, and in some cases prematurely triggers reconstruction.

Field and laboratory tests have shown that sealants delay the entry of salt solution. As a result, the scaling and spalling caused by the freeze-thaw cycle is reduced and a general improvement in durability is gained. With the introduction of proprietary (silane and siloxane) sealants, engineers are confronted with a range of alternative treatments, as well as linseed oil which has been used traditionally.

Whiting (1990) reports that Canadian and U.S. highway authorities use linseed oil more extensively than other penetrating sealers. Whiting suggests however, that highway agencies are moving away from linseed oil, in favour of silane-based, or siloxane-based, proprietary sealants that are significantly more expensive.

In a market economy, it is usually accepted that higher prices are associated with higher quality, or utility. In the long run, price signals are fairly reliable measures of value. If there is insufficient experience to judge the benefits and costs of alternative products however, consumers can be fooled by price signals. This appears to be the case with respect to new penetrating sealers.

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In Pennsylvania, a five year field test was undertaken to compare the performance of six commercial penetrating sealers versus linseed oil. The study recommended that the Pennsylvania Department of Transportation continue to use linseed oil to seal the new concrete on its bridge decks. "Although all the proprietary sealants were far more expensive than linseed oil, none showed consistently better performance than linseed oil' (Ballew and Highlands, 1989, p.14)

Wright, Shen, and Rizkalla (1991) corroborate Ballew and Highlands' findings with respect to the effectiveness of linseed oil relative to the proprietary sealants. This study used laboratory and field tests to investigate the physical performance of linseed oil versus silane and siloxane concrete sealants. A 1:1 mixture of linseed oil/mineral spirits was shown to provide the same, or in many cases better, protection than other commercially available concrete sealants.

The economic merit of traditional linseed oil, relative to other concrete sealants is clear, and we seem to take it on faith, or as a revealed "fact", that a concrete sealant has a positive cost/benefit ratio. Perhaps the benefit of a single coat is so obvious that no formal analysis is necessary; but, if one coat of a sealant is worthwhile, does it not pay to re-apply a second, or a third coat? "Although it is felt by some that linseed oil should be reapplied every two years to maintain its effectiveness as a concrete sealant, reapplication of linseed oil every two years is not a policy adhered to by all within PennDot" (Ballew and Highlands, 1989, p.12)

An economic analysis is needed to determine the costs-effectiveness of a cyclical reapplication of concrete sealants. Unfortunately, there is a dearth of references in the engineering literature on the long term effectiveness of re-employing sealing materials on concrete structures. The paucity of relevant technical data constrains the scope of this research, and entails the use of existing literature to develop plausible estimates and assumptions. This study examines two typical sites where sealants may be applied: a city street, and a bridge deck.

GENERAL ECONOMIC ANALYSIS

A summary of the costs and benefits of a cyclical sealing program for a city street are described in Figure 1. The costs and benefits are divided into direct and indirect categories, and classified as either tangible, or intangible. The direct categories are those associated with the construction, maintenance, and use of the road. Indirect costs and benefits are incidental to the primary functions of the road. The classification of tangible and intangible are self-explanatory.

The direct and indirect tangible costs of sealing city streets are all municipal outlays. The intangible costs are borne by society. Drivers experience congestion costs as they are inconvenienced by the need to block traffic while the

sealant is being applied. To the extent that noise and odour created by the application of the sealant disturbs nearby residents, some negative externalities may exist. In general, however, the intangible costs of concrete sealants are likely to be very small.

Figure 1 Cost and benefits of a cyclical sealing program with linseed oil on a concrete street.

COSTS

	DIRECT	INDIRECT
TANGIBLE	- Linseed oil procurement - Application costs	- Increased administration for public authorities
INTANGIBLE	- Congestion of traffic during re-sealing	- Odour from process may disturb local residents

BENEFITS

	DIRECT	INDIRECT
TANGIBLE	- Road surface improvement - Extension of useful road life	- Less damage to vehicles and hence costs for car/truck owners
INTANGIBLE	- Better road appearance - Less potholes and scaling	- Support for farm produced natural product in the case of linseed oil

The direct benefits of the sealant program accrue primarily to the municipal authorities. Sealing a city street can defer more expensive maintenance (such as filling potholes), or postpone the need to re-surface the street, and may extend the life of the street (delay re-construction).

The indirect benefits of sealing concrete streets are mainly enjoyed by vehicle owners. If the surface of the street remains smoother, the damage to the tires and suspension of vehicles will be reduced. These costs also vary with the age of the vehicle and its size (Abaynayaka, Hide, Mcrosiuk and Robinson, 1976). Although these costs can likely be estimated, they are so widely spread that they may not have a bearing on the decision to use concrete sealants. The annual

harvest of "spring potholes" that occurs in most Canadian cities may be an embarrassment to municipal politicians, but it never seems to lead to a mass protest of irate drivers at city hall.

The tangible and intangible benefits of using a sealant are difficult to quantify. These benefits are expressed in terms of civic pride and environmental conscientiousness. These may be important, but it is hard to collect any "revenues" that might recompense the civic department for the additional maintenance expenditures.

It is informative to illustrate these potential costs and benefits, but the analysis is confined to the direct tangible costs and benefits. Estimates for the other entries are not pursued in this study because it requires making subjective assumptions that could dilute the overall stability of the results. Moreover the decision making process is essentially confined to how the public transportation authorities view their budget and consequently, their internal costs and benefits.

DIRECT COSTS

Costs are much easier to define than benefits because the engineering relationships with regard to the economic effects of sealants are not well established. Material cost estimates for linseed oil, silane-based and siloxane-based products were obtained from a local industrial products distributor (Specialty Construction Products Ltd.). Application rates and costs were derived from engineering literature (Best, Crany, Gast, and Kubie; Pfeifer and Scali). These data are presented in Table 1.

Table 1: Material cost per unit area.

	(1)	(2)	(1)*(2)=(3)
PRODUCT	PRICE	APPLICATION RATE	MATERIAL COST
	($/GA)	(GAL/FT^2)	($/FT^2)
Siloxane	55.07	1/125	0.44
Silane	35.10	1/125	0.28
Linseed oil	20.00	1/125	0.14

*Application cost is estimated to be $0.03/ft^2 for all materials. This does not include surface preparation, location, and other variable costs.

As illustrated in Table 1, the cost of linseed oil is only 38 percent of the cost of using siloxane, or 55 percent of the cost of silane. Given these cost

differences and the similar efficacy of these products, the remaining analysis considers only linseed oil.

ECONOMIC FEASIBILITY OF LINSEED OIL SEALANT

City Street

Knowledge of the relation between serviceability and age of a city street is needed to develop a benefit-cost analysis for the use of sealants. The estimated life cycle of a road is 45 years with major rehabilitation or resurfacing at 18 and 33 years, Toms (1991). The 45 year life assumes that no sealants are used to protect the surface and that the street is reconstructed at the end of the period. The costs of resurfacing a concrete street is estimated to be $8.83 per square foot for a 150 mm layer, while the cost of re-construction is $18.58 per square foot.[1]

The expected life of a sealant is estimated to be 3 years (Whiting, 1990). It is assumed in this study that the cyclical reapplication of a linseed oil sealant (every third year) can delay the first resurfacing of a concrete street between 2 and 4 years. The use of the sealant is assumed to extend the timing of the second resurfacing from 1 to 2 years beyond the estimate of the theoretical model. The extension of the street's useful life is therefore increased between 3 and 6 years.

The costs and benefits of the sealant are expressed in terms of net present values. For most public investments, a four percent "real" rate of interest is accepted as a reasonable discount rate. The analysis assumes the new concrete is sealed immediately. In the case of the cyclical resealing, the linseed oil is re-applied every third year at $0.17 per square foot.

Seven scenarios are presented in Table 2. The first scenario (18 & 33) is the base case that assumes only the new concrete is sealed. The total costs represent the net present value of resurfacing the street at years 18 and 33. In this case, the street has to be re-constructed in year 45. The subsequent scenarios assume different impacts of using the sealant. For example, the second scenario (20 & 36) estimates the cost of applying linseed oil every three years. The linseed oil treatment is assumed to delay the first resurfacing two years (until year 20), and the time between the first and second resurfacing is delayed one year. As a result, the re-construction of the street is delayed three years (until year 48).

The benefit of delaying re-construction is shown as a "negative cost". In this case, the difference is the discounted value of spending $18.58 in year 48, minus the discounted value of spending the same amount three years earlier (in year 45). At a 4 percent rate of interest, this is worth $0.35.

Table 2 The Economics of Sealing a City Street, Net Present Value based on a 4 percent Real Discount Rate

Scenario	Useful Life	Surfacing Cost	Sealant Cost	Delayed Construction	Total Cost
(years)	(years)	(NPV)	(NPV)	(NPV)	(NPV)
18 & 33	45	$ 6.78	$ 0.17		$ 6.95
20 & 36	48	6.19	1.28	$ -0.35	7.03
21 & 37	49	5.94	1.26	-0.46	6.74
22 & 38	50	5.71	1.25	-0.57	6.39
20 & 37	49	6.10	1.23	-0.46	6.87
21 & 38	50	5.79	1.29	-0.57	6.51
22 & 39	51	5.64	1.29	-0.67	6.26

The results in Table 2 indicate that if the sealant can delay the first re-sealing by three years, and the second re-sealing one year, the authorities are better off to employ a sealant. The benefits of cyclical resealing increase at higher rates of interest (a discount rate above 4 percent), and vice versa. As the effective life of the sealant and resurfacing costs increase so do the benefits. Similarly, if reconstruction costs rise, the benefits of maintenance (resealing) increase.

Bridge Decks

The corrosive effects of salt on concrete bridge decks is a more severe problem than deterioration of city streets. On a road, the new surface can be laid over its old surface, but on a bridge the old surface must be removed to avoid over-loading the structure. In addition, the confined spaces of the bridge make re-construction more difficult. Lastly, the erosion of the bridge deck can expose the remainder of the structure to salt damage, which may also require restoration. Consequently, the costs of resurfacing bridge decks are much higher than road surfaces.

A cost/benefit procedure similar to that conducted for a city street can be undertaken for a concrete bridge. It is more difficult to determine the appropriate cost for this analysis because bridge rehabilitation often entails much more than just re-surfacing. Table 3 presents the cost data for three bridges/highway overpasses that have been rehabilitated recently in the City of Winnipeg. Rather than attempt to define the costs that are exclusively related to

the re-surfacing of the bridge deck, the total cost and the re-surfacing cost are used as an upper/lower range of costs.

Table 3: Historical Cost Data of Three Recent Bridge Rehabilitation Projects in Winnipeg

	Units	Case 1	Case 2	Case 3
Years of Use Before Rehabilitation of Bridge	years	23	31	28
Cost of Concrete Overlay	$/sq. ft	15.15	23.67	27.74
Total Cost of Rehabilitation	$/sq. ft	53.49	105.09	78.58

As in the previous example, the benefits of cyclical resealing are calculated in terms of the additional years of utilization needed (prior to rehabilitation) to offset the discounted costs of the sealant re-application. These calculations are presented in Table 4, for the three case bridges. The data suggest that an extension of bridge deck life between one and four years, is sufficient to pay for the cyclical resealing with linseed oil.

Table 4: Years of Delayed Rehabilitation to Pay for Cyclical (3 year) Re-sealing of Surface with Linseed Oil

	Case 1 (years)	Case 2 (years)	Case 3 (years)
Additional utilization to offset cost of concrete overlay	4	4	3.5
Additional utilization to offset total cost of rehabilitation	1	>1	1.3

DISCUSSION

Field and laboratory tests have shown that the application of sealants increases the abrasion resistance of concrete surfaces and delays the deteriorating effects of de-icing salts. Although it is generally accepted that sealing new concrete is worthwhile, the economics of a cyclical resealing program appear to be unknown. No references could be found in the transportation literature on the cost/benefits of concrete sealants as they relate to the long-term maintenance expenditures of highway agencies.

The results presented in this paper are not definitive due to the lack of field tests to measure the extend to which a sealant can prolong the life of a concrete street or bridge. Given the lower cost of linseed oil, relative to the new penetrating sealants, and its equivalence as a concrete sealant, only linseed oil is considered. Depending on the number of years that linseed oil can extend the life of a concrete street, it is economic to use linseed oil as a sealer. For bridge decks, extending the period before refurbishment by one to four years is sufficient to offset the costs of re-sealing with linseed oil.

It appears that the additional utilization of a street or bridge necessary to make a cyclical resealing program economic using linseed oil is relatively minor. This begs the question, why have cyclical re-sealing programs not become common? The first answer may be the excessively long time-frame for engineering research in the field. Even the most basic relationships regarding the long-term impact of sealants and the deterioration of transportation infrastructure appear to be unknown. Given the value of transportation infrastructure to society, the long term impacts of cyclical resealing of concrete structures should be a research priority of public highway authorities. But when the fruits of such research exceed the life-time of an engineering career, it is easy to understand why this has not been a popular topic.

The second possibility may lay in the difficulty of separating environmental causes of deterioration from those induced by salt. For example, soil conditions in Winnipeg are infamous for the cracks they create in foundations and other structures. When the bridge deck is subject to wide cracks that a sealant cannot span, other methods of protection may be necessary.

A third hypothesis may be that the budgetary pressures placed on road and street administrators tend to discourage maintenance expenditures. When a bridge is declared "unsafe", the politicians must decide either to fund the repairs, or to close this artery. It is unusual for bridges to be closed, and the administrators know this. On the other hand, politicians are always wary of "padded" budgets and administrators may be hard pressed to defend annual expenditures that will forgo large projects later (when both they and the politicians may be cheerfully retired). So given the choice of "Pay me now, or pay me later," the political bias may far outweigh the economic justification for a cyclical resealing program.

REFERENCES

Abaynayaka, S.E., H. Hide, G. Mcrosiuk, and R. Robinson. Tables for Estimating Vehicle Operating Costs on Rural Roads in Developing Countries. Crowthorne, Berkshire: Transport and Road Research Laboratory, Report 723, 1976.

Ballew, Jeffery W. and Keith L. Highlands "Evaluation of Protective Coatings to Reduce Chloride Penetration of Bridge Surfaces." Pennsylvania Department of Transportation. Research Project #83-41, February 1989.

Best, C.H., Crany, J.F., Gast, L.E. and Kubie, W.L. "Linseed Oil Formulations as Curing and Antiscaling Compounds for Concrete", Highway Research Record **504**, pp. 63-69.

Campbel, B. and Humphrey, T.F., "Methods of Cost-Effective Analysis for Highway Projects", Transportation Research Board **142**, 1988, pp. 5-7.

Hare, C.H., "Protective Coatings for Bridge Steel", Transportation Research Board **136**, 1987.

Peterson, D.E., "Life-Cycle Cost Analysis of Pavements", Transportation Research Board **122**, 1985, pp. 4-14.

Pfeifer, D.W. and Scali, M.J., "Concrete Sealers for Protection of Bridge Structures", NCHRP Report No. **244**, Transportation Research Board, Washington, D.C., Dec. 1981.

Ryell, J. and Chojnacki, "Laboratory and Field Tests on Concrete Sealing Compounds", Department of Highways, Ontario. Highway Research Record **328**, 1970.

Toms, D.B. "Highway User Charges: Are Truckers Paying Their Way?" Canadian Transportation Research Forum. Proceedings of the 26th Annual Meetings, May, 1991:111-125.

Specialty Construction Products LTD. 77 Paquin Road, Winnipeg, Manitoba R2J 3V9.

Whiting, D. "Penetrating Sealers for Concrete: Survey of Highway Agencies", Transportation Research Record 1284, 1990:73-84.

Wright, J.R., Shen, Z., and Rizkalla, S.H., "Evaluation of Linseed Oil as a Concrete Sealant", University of Manitoba, 1991.

ENDNOTES

1. Personal interviews: City of Winnipeg, and the Province of Manitoba, Department of Highways and Transportation.

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The Contracting of Highways Maintenance Services In British Columbia

Stuart MacKay
Peat Marwick Stevenson & Kellogg

I INTRODUCTION

In 1988 the Province of British Columbia became the first North American jurisdiction to privatize the provision of highways maintenance services. These services include snow clearance, winter salting/sanding, emergency services, and a wide variety of maintenance activities (surface patching, ditching, shoulder repair, signage, etc.).

The 1988 initiative represented a major change in the framework for providing highways maintenance services. Of approximately 4,100 Ministry of Transportation and Highways employees, about 2,800 became employees of private contractors. Twenty-eight three-year contracts, with a total value of about $800 million, were let. In many Contract Areas, former Ministry employees, with government encouragement, formed a company to provide the services; in other Contract Areas, established construction companies created highways maintenance arms. A variety of ownership and operating styles resulted.

Between 1988 and 1991 a new framework for providing highways maintenance services emerged. A detailed and comprehensive set of standards was developed, specifying performance requirements for all aspects of highways maintenance activities. A "Quality Assurance Program" was implemented by Ministry staff to monitor and rate each contractor's adherence to the performance standards. The Ministry ceased to be a direct provider of maintenance services and instead assumed a contract management role.

In early 1991 the Province began to re-let each of the twenty-eight contracts, using a competitive bid process. Towards the end of this process, a provincial election in October 1991 ousted the administration which had privatized highway maintenance. After reviewing the situation, the incoming administration announced that it would complete the 1991 contracting process, but that the concept of highways privatization is to be critically examined before the 1991 contracts expire in 1994.

The B.C. initiative was a bold experiment in privatization, and is of interest to policy-makers in all North American jurisdictions. The objective of this paper is to review:

- How well has the **contracting and administration process** worked? What were the main operational problems and how were they overcome?
- What have the **impacts and results** been? In particular:
  - How have the levels of service to the travelling public, commercial vehicles and other users been affected?
  - What are the impacts in terms of preservation of the infrastructure, and aesthetics?
  - How effective has the new management framework been?
  - How has the cost-effectiveness of service been impacted? Is the public purse receiving more or less "bang for the buck"?
- What **policy conclusions** can be drawn? In particular:
  - What are the net costs and benefits of privatization?
  - What are the lessons for other jurisdictions and modes? Could the B.C. model (public ownership, private maintenance) be applied elsewhere?

II THE CONTRACTING AND ADMINISTRATION PROCESS

The initial contract-letting process (1987-88)

In 1987, the Government of British Columbia decided to "privatize" a variety of services being provided by public sector entities. One of the key areas selected for privatization was the maintenance of the Province's highway systems, including both roads and bridges. Up to the time of privatization, these services were being provided directly by the Ministry of Transportation and Highways.

The changeover from public sector service service to private sector service was a major one, and involved the following major tasks:

- For purposes of contracting, the Province was divided into 28 separate Contract Areas. In many cases these reflected the operating divisions of the Ministry of Transportation and Highways; in other cases, maintenance regions were combined or delineated on a different basis, to make them more suitable for private sector operations.

- The Ministry was reorganized, and the number of direct employees of the Highways Branch was reduced from about 4,100 to 1,300. The remaining 2,800 employees were identified to become employees of the private contractors, once contracts could be established.

- A comprehensive set of highways maintenance specifications was developed. This proved to be a major undertaking, since it required specification of performance standards for virtually all aspects of highway maintenance including:

  - Winter response time for snow clearance, and maximum allowable build-up of snow for various classifications of highways.

  - Response requirements for emergency situations.

  - Performance requirements for ongoing routine maintenance activities.

  - Performance standards for "annual maintenance plan" activities taking place during the summer. (Quantities of annual maintenance activities were also specified in individual contracts.)

- In each of the 28 Contract Areas, the Ministry encouraged employee groups to perform employee-owned companies to provide the highways maintenance services in each Contract Area. All contracts were let under a competitive bid process, with employees groups in the region receiving a 5% price preference. In some Contract Areas this initiative was well received, and several new companies were formed. In other areas, the level of interest from employees was not as great, and as a result the Ministry awarded many of the contracts to private firms.

- Many of the contractors were granted "local area standards", whereby contractors received exceptions to the general performance standards at specific problem locations. These local area standards were more common in remote areas of the Province.

Managing the initial contracts (1989-91)

The administration of each of the 28 Contract Areas was assigned to a District Highways Manager (DHM), who was responsible for monitoring the performance of the contractor and insuring that the terms and conditions of the maintenance contract were being met. Under the DHM's direction, local area managers performed inspections and enforced the maintenance standards.

One of the problems encountered during the first year of operation was the lack of an objective program to measure contractor adherence to the standards. This situation created problems for the Ministry in enforcing contractor performance. In respect to this problem the Ministry established a "Quality Assurance Program" (QAP) to ensure consistent performance standards were used throughout the Province. This system allows the District Highways Managers and their staff to

rate various aspects of a contractor's performance as above standard, at standard, or below standard. It also includes a system of sanctions leading ultimately towards contract termination.

While the Quality Assurance Program was initially resisted by the contractors, it is now generally conceded that it provided a needed benchmark for monitoring performance. By 1991 it had achieved a high degree of acceptance.

During the first three years of private operations, there was a considerable period of "shaking out", as both the Ministry and its contractors learned more about each others' levels of commitment and expectations. One contract was terminated, while performance problems were experienced in a number of Contract Areas, especially in the first year. However, after the first year, working relationships generally stabilized, as a more cooperative spirit emerged between the contractors and the Ministry.

Negotiating the second round of contracts (1991)

With the contracts in each of the 28 Contract Areas expiring in 1991 and early 1992, the process of re-letting contracts commenced in early 1991. A 21-week schedule for each Contract Area was designed, and the process was initiated in each Contract Area at one-week intervals. A competitive bid process was defined including the following key steps:

- Briefing to contractors, performed in February 1991.
- Call for initial proposals. These proposals included a statement of qualifications and a preliminary business plan, but not a price proposal.
- Evaluation of initial proposals by the Ministry, and shortlisting of qualified contractors to prepare detailed proposals.
- Detailed proposals, including a detailed business plan and price proposal.
- Personal interview and review with each of the qualified contractors submitting a detailed proposal.
- Evaluation and selection of a contractor for detailed negotiations. In evaluating contractors, the technical aspects of the proposal (business and management plan) were assigned 60% of the rating, while the price proposal was assigned 40% of the rating.
- Negotiation with the selected proponent. This process typically involved 1-5 days of negotiations on specific items such as:
    - Consideration of local conditions. One of the Ministry's goals was to reduce (and where possible eliminate) local area standards granted to contractors. This goal was achieved in large measure.

- Any aspects of the business and management plan which required clarification and/or amendment (for example, manpower commitments, equipment plan, accessibility of the contractor to the public).
- Total contract price, and timing of payments by the Ministry.
- Financial and bonding arrangements by the contractor.
- Other aspects of the contract requiring clarification.

- Reaching of a handshake agreement upon resolution of the negotiating points.
- Drafting by the Ministry of an interim written agreement.
- Confirmation of bonding by the contractor and final agreement.
- Mobilization by the contractor (where contracts changed hands) and takeover.

This process was a major undertaking, and involved three project negotiation teams. Each team consisted of a project leader from the Ministry, a team negotiator from an independent consulting firm, the individual District Highway Managers and their Regional Managers, and legal support services. All 28 Contract Areas were re-let, with three-year contract values ranging in size from approximately $7 million to $40 million. In total, about $800 million in contracts were negotiated.

The process was initially scheduled for completion in December 1991, and was on schedule until October of that year. Following the change of government in October, 1991, the process was suspended while the incoming government reviewed the situation. After this review, the new government announced that it would allow the 1991 contracting process to be completed, but also that the concept of highways privatization would be critically examined before the new contracts expire in 1993/94.

Other than the delay resulting from the provincial election, the project proceeded on schedule. The final Contract Area was negotiated in February, 1992.

Outlook for the second round of contracts (1991-94)

The changes introduced with the 1991 process were less significant than the major changes brought about in 1988. Some of the issues to be dealt with include:

- **Collective agreements with employees.** Non-management employees of the contractors are members of the B.C. Government Employees Union (BCGEU), a situation inherited in 1988 by incoming highways maintenance contractors. In most of the Contract Areas, the collective agreements negotiated with BCGEU expired on the last day of the contract. Thus, new collective agreements have been negotiated in an

environment affected by the election of a new government, more oriented towards organized labour than the previous administration. This situation has affected the negotiating environment between contractors and BCGEU representatives.

- **Establishment of a Management Assurance Program.** To complement its Quality Assurance Program, the Ministry plans to introduce a system for monitoring various aspects of contract management by contractors, to ensure continuous quality of service to the public. As of April 1992, details of this program were still under development.

On balance, the outlook for the second round of contracts appears fairly stable at this point. If a government decision is taken to discontinue privatization, this initiative will raise a large number of issues in 1993 and 1994.

III IMPACTS OF PRIVATIZATION

This section briefly discusses some of the impacts of the decision to privatize highways maintenance in four key areas:

- Level of service to the public.
- Preservation of the road and bridge infrastructure.
- Management effectiveness.
- Cost effectiveness.

The reader should be cautioned that the following opinions are those of the author only, and are based on information developed indirectly through involvement in the process, rather than through a structured research program.

Levels of service to the public

Safety

Information regarding the impact of privatization on safety tends to be highly anecdotal. Most highway contractors strongly believe that, under their stewardship, greater levels of overall safety have resulted for the travelling public. There are several examples of contractor employees rescuing travellers caught in hazardous situations.

On the other hand, many Ministry staff are not convinced that safety levels have been improved or maintained, especially in certain Contract Areas. It is not clear that overall levels of safety have been either increased or decreased as a result of privatization.

Responsiveness to the public

With the introduction of locally-based highways maintenance operators, the public profile of the highways maintenance function has increased. Many contractors instituted 24-hour access lines for the public during the first contract period. Toll-free numbers are a requirement for the second round of contracts. Also, the performance and responsiveness of the local contractors has been regularly evaluated in local newspapers. Many contractors point with pride to the favourable local press they have received.

On balance, the author would assess this as an area in which privatization has resulted in improvements in responsiveness to the public.

Ancillary services

One of the benefits of privatization initially forecast was that it would enable highways maintenance contractors to offer related services to the community, using their equipment and manpower resources, during times when these resources were not required for highway maintenance. Some contractors have had success in providing ancillary business and community services that would have not been possible under direct Ministry operations. This aspect has again benefitted the public.

On the other hand, small local contractors have complained that the contractors with highways maintenance contracts have an advantage over them in pursuing outside work.

Preservation of road and bridge infrastructure

This is another area in which limited objective information is available. Many of the private contractors strongly believe that preservation of the infrastructure has been improved by privatization. Contractors tend to characterize the benefits of privatization not in terms of cost savings, but rather in terms of improved maintenance of the roads and bridges.

From the Ministry's viewpoint, the experience has varied by Contract Area. While performance in maintaining the infrastructure has been good in most areas, in about 4-5 Contract Areas the Ministry has not been satisfied with the previous contractor's performance.

In the long run, it could be argued that the separation of the responsibility for doing the work (with the contractor) and for monitoring the work (with the Ministry) should lead to better performance, albeit with higher management requirements. However, in the short run, it is not clear whether the preservation of the road and bridge infrastructure has been affected in either direction by privatization.

Management effectiveness

Management stability

One of the drawbacks of privatization has been the reduced management stability experienced in a few Contract Areas. In a number of situations (involving both existing private firms and newly-formed employee ownership groups), the new management had difficulty in adapting to the operating environment resulting from privatization. While the majority of Contract Areas experienced stable management for the duration of the first contract, the problems occurring in a few Contract Areas were probably greater than would have been experienced had the Ministry continued to provide highway maintenance services directly.

Management innovation

Under privatization, a number of management innovations were introduced that could not have occurred under public operation. For example, winter snow clearing contracts for individual contractors were structured to guarantee a certain number of hours during the winter, in return for guaranteed availability of equipment and operators.

Community relations

Community relations tended to be an area of pride for many of the local contractors, who strongly felt their accountability to the local community. There were some clear exceptions to this general tendency; however, most contractors were proud of their success in community relations.

Labour relations

As a result of the establishment of 28 Contract Areas, each highway maintenance contractor was required to enter into a separate collective agreement with the B.C. Government Employees Union. Partly because of the mix of employee-owned firms and outside owners which emerged, the terms and conditions varied widely among Contract Areas.

The industrial relations performance of most contractors during the initial set of contracts was generally satisfactory, with a few problems where the labour force and management were at odds. This situation contributed to these Contract Areas lagging behind the others in terms of overall performance.

At this point the future implications are unclear, and may depend in part on whether the existing highway contractors continue to negotiate separately with BCGEU, or whether an employers' council emerges to negotiate on behalf of the contractors.

On balance, the uncertainty of the labour relations climate has been a drawback to some extent, but only for a few Contract Areas.

Financial stability

In most of the Contract Areas, financial stability has not been an issue as most contractors have been in a financially stable position. There have been a few exceptions, where contractors have experienced financial stability. A few contractors claim to have lost money on their contracts.

Cost effectiveness

Comparisons of the cost effectiveness of pre-privatization and post privatization operation are complicated by a number of factors including:

- **Accounting methods differ between the public and private sectors.** The Ministry's highways maintenance costs to 1988 were accounted for on a different basis than for payments to private sector operators. To make an appropriate cost comparison, a detailed costing study (with a significant number of adjustments to recorded expenditures) would be required.

- **Inflation effects.** These would also have to be accounted for in any comparative analysis.

- **Evolving changes to the maintenance standards.** The British Columbia highway system is continuously in a state of evolution, with road classifications being changed, rehabilitation work being performed, and new construction and other road works being undertaken. Any comparative cost analysis would have to take these factors into account.

Anecdotally, there seems to be a majority view that privatization has been at least as cost-effective as public operation in more populous Contract Areas. However, there are also a number of specific examples of cost-ineffectiveness, particularly in more remote Contract Areas. Many individuals have questioned whether privatization has been cost-effective in these areas.

IV POLICY CONCLUSIONS

Conclusions on the B.C. experience

In assessing the B.C. experience in privatizing highways maintenance services, three main conclusions are apparent:

- **The concept is workable.** At the outset there was considerable skepticism, both within and outside Government, as to whether the intent to privatize highway maintenance operations could be made workable. Despite a host of complicating factors, the initial process went much more smoothly than many expected. Today the concept is well accepted by both contractors and Ministry staff.

- **The privatization experience has generally been more effective in more populous areas.** As a general rule, ongoing problems have tended to occur in the more remote parts of the Province, which often have a distinct set of requirements and features. Privatization has worked best in more populous areas, where several contractors are familiar with the requirements and have a good understanding of how to fulfill them.

- **"The jury is still out" on net benefits and costs.** A detailed and comprehensive cost-benefit analysis would be required to properly evaluate the net impact of the concept in terms of the public's value for its money.

Potential for other highways/roads jurisdictions

While the net benefits and costs of the B.C. experience remain to be evaluated, the experience provides a useful case study for administrators in other jurisdictions and modes. It demonstrates that private sector contractors have the skills and ability to adapt to the needs of maintaining an extensive road and bridge network, in accordance with externally established standards.

Potential for the railroad

For the rail mode, the B.C. experience provides support for the concept that a public-owned privately-maintained railway system could be achieved operationally. This is not to say that such a system would necessarily be in the public interest; consideration of that issue would require a detailed evaluation. However, the notion of a publicly-owned railbed cannot be rejected strictly on the grounds of operational difficulties.

Summary

The B.C. experience has been a fascinating experiment in privatization. It represents an outstanding case study for policy-makers in other jurisdictions and modes to consider in determining the potential for privatization within their own jurisdictions.

V ABOUT THE AUTHOR

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ENFORCEMENT AND OVERWEIGHT TRUCKING

A. Clayton[1], F. Nix[2], E. Fekpe[3]

1. INTRODUCTION

"Without effective enforcement .. weight limit laws are meaningless" (TRB, 1990 [p. 135]).

"Overweight trucks are a major cause of highway deterioration" (Comptroller General, 1979 [p. 33]).

".. the (Ontario Ministry of Transportation) has a direct responsibility to those road users complying with (Ontario's) laws to detect non-compliance and to take action necessary to bring the offender back into compliance" (Ontario Ministry of Transport, 1989 [p.5]).

These three quotations reflect the raison d'etre for weight limit enforcement programs, namely being that:

(1) not enforcing limits is akin to having no limits
(2) not enforcing limits creates excessive road costs
(3) not enforcing limits advantages illegal operators

While the subject of size and weight limits has received a great deal of attention in many countries for years, the subject of their enforcement has been treated superficially, and for many jurisdictions, not at all. This is evident in the literature from which it can be concluded that few jurisdictions have any objective understanding for how well their limits are complied with, the implications of non-compliance, or how compliance levels can be affected by alternative enforcement efforts.

The objectives of this paper are:

(1) to review key impressions reported in the literature about enforcement and its effects;

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(2) to present an overview of weight enforcement programs in Saskatchewan and Manitoba, and to examine new evidence from these provinces about how the intensity of enforcement at weigh scales affects the amount of overweight trucking;

(3) to provide suggestions as to appropriate directions that weight enforcement programs and related research should take.

2. TERMINOLOGY and CONCEPTS

To put this discussion on an analytical footing, it is important that five key terms and concepts be defined.

Overweight trucking is the operation of a truck at a weight level greater than permitted by the governing limits. A truck can be overweight on tires, on an axle, on a group of axles, or on gross, or on some combination. Whether or not a truck is overweight often depends on some dimensional aspect of the vehicle, such as axle spreads or axle spacings. Trucks may be legally overweight (ie, operating beyond the limits but pursuant to regulatory exemption or permit) or illegally overweight. The concern of this paper is with illegally overweight vehicles.

When an illegally overweight truck is identified, it is considered in-violation if the magnitude of at least one of its "overweight" conditions is such as to cause an action to be taken against its operator/owner which culminates in deeming the condition in-violation. The conditions generating an in-violation status vary among jurisdictions. In Saskatchewan, since 1988, a vehicle or driver is deemed to be "in-violation" where an inspection results in either a charge being laid or a written warning being issued. Prior to 1988, a verbal warning was also considered to be in-violation. In Manitoba, since 1988, a vehicle or driver is deemed to be "in-violation" where an inspection results in a successful prosecution or, in other words, where the vehicle or driver is found by a court to be guilty of overweight operation.

The violation rate is the number of in-violation trucks as a percent of all truck inspected. This depends on two criteria: (i) the basis for labelling a particular overweight event "in-violation", and; (ii) the basis for assigning inspections to the denominator of the calculation. Both of these criteria vary among highway agencies, and may even vary within the same agency over time or among enforcement officers.

Regarding inspections, in Saskatchewan, a "weight and dimension inspection" means one or more of: (i) the weighing of any component of a vehicle on a permanent or portable scale; (ii) comparing a truck's bills of lading and load to determine if a portable weighing should be undertaken; (iii) checking overweight permits and load for compliance with terms of the permit; (iv) measurement of width, length, or height. The definition of a "weight and dimension" inspection has not traditionally included measuring other vehicle characteristics of import to weight issues, such as axle spreads, inter-axle spacings, and wheelbase. At permanent

weigh scales, the vast majority of "weight and dimension inspections" entail weighing one or all components of a truck. In Manitoba, a "weight inspection" means the actual weighing of some component of a vehicle on a permanent or portable scale.

There is one other important point to note about the violation rate - specifically, the rate itself is a function of enforcement activity. That is, truckers' perceptions of the likelihood of being detected operating overweight during the times that trucks are being inspected, and the penalty associated with that detection, will have an impact on the number (and severity) of violations.

The compliance rate is the percentage of all trucks operating in compliance with all aspects of the governing weight limits. The non-compliance rate refers to the percentage of all trucks operating overweight in relation to at least one of the governing weight limits. The non-compliance rate reflects "real" overweight trucking, whereas the violation rate only reflects the ability to issue or impose sanctions and/or warnings. It is not easy to measure "real" overweight trucking, and therefore non-compliance rates. Passive weighing such as that involved with weigh-in-motion equipment produces results generally impossible to compare with the provisions of weight limits; active weighing causes the extent of overweight trucking to be modified, leading to the observation of something other than "real" overweight trucking.

The measure of enforcement intensity used in this analysis is the inspection rate (at a scale, in a year) (IR), defined as:

$$IR = \frac{\text{(trucks inspected for weight at a permanent scale)}}{\text{(trucks passing road section served by the scale)}}$$

3. ENFORCEMENT AND ITS EFFECTS

Key impressions from the literature respecting weight enforcement and its effects are:

- there is little appreciation for the extent of overweight trucking.

The following findings confirm this:

- " .. reliable estimates of the magnitude and frequency of illegal overloads are not available" (TRB, 1990 [p.141]);
- ".. the extent of non-compliance (of weight limits in Ontario in 1979) was not known" (Slocum, 1982 [p. 1]);
- ".. the precise extent of overloads (in Australia) is unknown and there

are not reliable data for recent years" (OECD, 1983 [p. 110]);
- There are significant disagreements in the literature about the number of trucks operating in non-compliance. Estimates of non-compliance with weight regulations range from less than 1% to as much as 32% of trucks; many of these disagreements have their origins in differences in terminology and/or measurement calculations. (Clayton Sparks and Associates Ltd., 1991).

- there is little appreciation for the implications of overweight trucking.

While various research efforts (eg, Walton et al, 1983; Paxson et al, 1982; Euritt, 1985) have given some indication of the costs of overweight trucking, in general estimating the effects of illegally overweight trucks on pavement costs has proven difficult because of unreliable knowledge about overloading (TRB, 1990 [p. 141]).

- there is much scepticism about the effectiveness of permanent weigh scales in detecting overweight trucks.

An American study (Comptroller General, 1979) concluded that permanent scales do not catch many overweight trucks (ie, on average, scale sites experience violation rates of 0.4%, compared to an estimated non-compliance rate of 25% for tractor-semitrailers). It also found that operating a permanent scale that can be readily bypassed, or that operates only a limited number of hours, results in large numbers of legally loaded and empty trucks being weighed. A Manitoba study (IBI Group, 1985) observed that most of the weight violations detected at the permanent weigh stations have been committed unwittingly, and that deliberate violators normally avoid the inspection stations by taking alternative routes. An Alberta study (Thygesen et al, 1991) observed that permanent weigh stations are generally considered ineffective in acting as a deterrent to overweight trucking. An American study (FHWA, 1990) observed that while the enforcement of vehicle size and weight laws requires that vehicles be weighed, it does not logically follow that the more vehicles weighed, the more effective the enforcement program, especially if the vehicles are weighed at a limited number of fixed locations.

- nevertheless, the operation of permanent scale sites does seem to have some effect on the amount of overweight trucking detected.

Grezenback et al (1988) observed that the number of overweight trucks in the traffic stream drops sharply when weigh stations are known to be in operation. The Comptroller General (1979) report observed that a permanent scale is effective only if it is open for prolonged times (eg, 3 to 4 consecutive 24-hour periods) and cannot be easily bypassed. Wyatt et al (1985) studied violation rates at the same scale under conditions of "zero enforcement", "normal enforcement", and "continuous enforcement". They showed that violation

rates for zero and normal enforcement were about 6 and 2 times greater respectively than was experienced under continuous enforcement. They also concluded that as the inspection rate increases to about 5%, the violation rate on weights and dimensions decreases rapidly; increasing the inspection rate beyond 5% has little impact on the violation rate.

- portable scales are generally thought to be more effective than permanent scales at detecting overweight trucks.

  The Comptroller General (1979) report observed that portable scales are particularly effective especially when targeted at sites or circumstances where substantial overweight trucking is anticipated. Thygesen et al (1991) and IBI Group (1985) expressed similar sentiments. While the effectiveness of portable scales appears high compared to permanent sites, their use is much less frequent. For example, Paxson et al (1982) indicated that portable weighing in the United States accounts for less than 1% of total truck weighings.

- off-road enforcement programs (ie, "warning letters", "licence review interviews") are commanding growing attention.

  Stewart (1987) and Ontario Ministry of Transport (1989) observed that off-road enforcement procedures appear quite effective in reducing overweight trucking by repeat offenders. Minnesota is now using the "relevant evidence law" to identify and prosecute overweight operations (eg, by using weigh bills to determine a truck load status).

- the role of weigh-in-motion (WIM) systems in weight enforcement programs has been limited.

  Principal uses to date are: (i) pre-screening trucks for more accurate static weighing; (ii) evaluating the effectiveness of enforcement activities, by collecting data when scales are not open.

4. WEIGHT ENFORCEMENT PROGRAMS IN MANITOBA AND SASKATCHEWAN

Table 1 presents statistics about the number of weight inspections conducted, the number of violations detected, and the violation rates measured, in Saskatchewan and Manitoba in recent years, at permanent weigh stations. Some additional data regarding patrol-based inspections in Saskatchewan are also presented. Based on the terminology outlined in Section 2, the following observations can be made about the enforcement programs in these two provinces:

- Saskatchewan concentrates its weighing programs at permanent weigh scales, and this concentration has been increasing.

  For the 3 year period shown, there have been approximately 20 trucks weighed at permanent scale sites for every 1 truck weighed at a temporary scale. This ratio of enforcement activity at permanent vs temporary scale sites has been steadily increasing since the mid-80s, from 10:1 in 1985/86 to 30:1 in 1990.

- the weight violation rate at permanent weigh scales in both provinces is very low.

  In Saskatchewan, given that only 83% of the "weight and dimension" violations at permanent weigh scales are in fact "weight violations" (the remainder involve dimensions and other violations), the weight violation rate at these permanent sites is about 1.11% (or close to 1 truck in every 100). In Manitoba, the weight violation rate at permanent scales is about 0.25% (or close to 1 truck in every 400). A major reason for this difference is the difference in what is meant by "violation" in the two provinces (ie, charges and written warnings in Saskatchewan, vs successful charges in Manitoba).

Table 1

Inspections, Violations and Violation Rates
Permanent and Temporary Weigh Scales
Manitoba and Saskatchewan

	1988/89		1989/90		1990/91	
	Man	Sask	Man#	Sask	Man	Sask+
PERMANENT SCALES						
No. of insps/month*	n/a	13628	49912	11295	43307	10877
No. of violations*	n/a	167	116	139	107	174
Violation Rate (%)	n/a	1.23	0.23	1.23	0.25	1.60
TEMPORARY SCALES						
No. of insps/month*	n/a	867	n/a	487	n/a	362
No. of violations*	n/a	87	n/a	76	n/a	102
Violation Rate	n/a	10.03	n/a	15.61	n/a	28.18

** monthly averages*
+ based on 9 months data: April - December, inclusive
 # based on 9 months data: April - December, inclusive
n/a not available

- the weight violation rate on patrol in Saskatchewan is high compared to the scale-based violation rate.

  In Saskatchewan, given that only 46% of the "weight and dimension" violations on patrol are in fact "weight violations" (the remainder involve dimensions and other violations), the weight violation rate at these temporary scales is about 7.11%.

5. THE EFFECT OF ENFORCEMENT INTENSITY AT PERMANENT WEIGH SCALES ON OVERWEIGHT TRUCKING

For all permanent scales in Saskatchewan and Manitoba, a measure of enforcement intensity has been developed from records of annual inspection activity and estimates of annual truck traffic flows along the roadway sections served by each scale, for a recent two year period. These measures of (annual) enforcement intensity at each scale are related to the (annual) percent violation rates at each scale in Figures 1 for Manitoba and Saskatchewan. The following observations are relevant:

- the violation rate in both provinces clearly decreases as the inspection rate increases. The resulting relationships can be approximated as follows:

INSPECTION RATE	VIOLATION RATE	
	Manitoba	Saskatchewan
< 2%	< 2%	< 8%
2-4%	< 2%	< 4%
4-6%	< 1.7%	< 3%
6-8%	< 1.6%	< 2%
8-10%	< 0.8%	< 2%
10-20%	< 0.6%	< 0.6%
20-30%	< 0.5%	not observed
> 30%	< 0.2%	not observed

- as the inspection rate increases above 10%, no substantial reduction in the violation rate occurs. Comparatively, Wyatt et al (1985) concluded that an inspection rate of greater than 5% had no significant effect. This suggests that at high levels of inspection, overweight trucking is probably dominated by trucker error (ie, unwitting infraction) rather than intentional circumvention of the limits. It also suggests that little if any reduction in overweight trucking can be achieved from operating weigh scales at higher inspection rates. The implication is that enforcement resources required to achieve high inspection rates with the objective of reducing overweight trucking could be much better utilized in other activities.

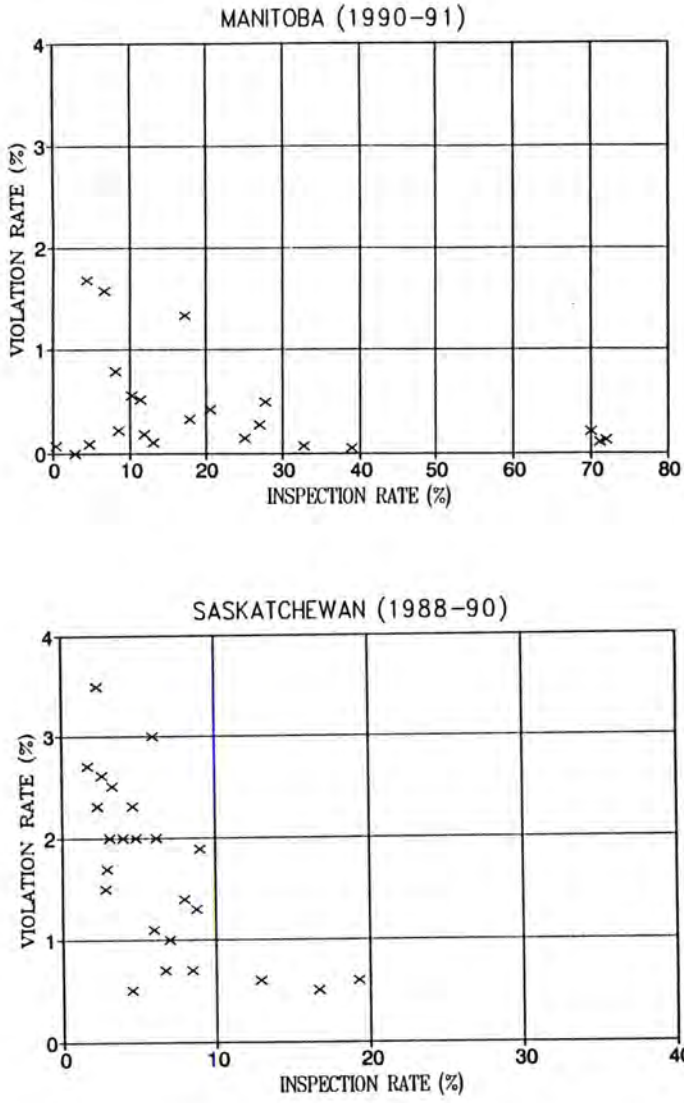


Figure 1. Effect of Enforcement Intensity on Violation Rate

6. SUGGESTIONS FOR WEIGHT ENFORCEMENT PROGRAMS AND RESEARCH NEEDS

Few would argue with the proposition that where weight limits are imposed by statute, they must be enforced. Otherwise, the fundamental rationale for the limits (ie, that road and bridge design and deterioration are functions of weights and dimensions) would seem to be without foundation. Nevertheless, there is little or no data which permits establishing and monitoring the levels of compliance of truck size and weight laws. This fact, coupled with the scarcity and inconclusiveness of past research, makes it impossible to determine meaningful answers to a host of fundamental questions, including:

(1) what are the implications (ie, costs) of non-compliance?

(2) what enforcement resources are justified to address the non-compliance issue?

(3) how can enforcement resources be best allocated among enforcement program types, intensity levels, and in time and in space, to maximize the return from the enforcement dollar?

The reasons for this general state of ignorance include: (a) that enforcement programs have never been a mainstream concern of most transportation agencies, and are seldom under the direct control of those most involved in the research and determination of weight limits; (b) that catastrophic failures (Lundy, 1987) and large out-of-pocket expense rarely occur due to overloaded vehicles, and that as a result many involved in the formulation of policy regarding size and weight regulations often appear to be indifferent to the overweight issue; (c) that the mentality of most enforcement agencies tends to think of and evaluate their efforts - and indeed even allocate their limited resources - more in terms of inputs (eg, number of trucks weighed) rather than outputs (degree of compliance achieved). Bringing enforcement into the mainstream of the size and weight regulatory issue; recognizing the long term nature of the cost implications of overweight trucking; and focusing on the output-end of enforcement efforts; would go a long way to providing a more rational foundation for designing, evaluating and managing enforcement programs.

Based on this review, it is suggested that there is good cause for highway agencies to undertake research into the following weight enforcement-related subject areas:

(1) the design of periodic surveys needed to measure and monitor indicators of weight compliance levels.

(2) the importance of different degrees of "overweightness" in relation to the design and operation of an enforcement system.

Thus, for example, it is probably much more beneficial to detect and act on the few, more severe, overweight conditions, than many, minor, overweight conditions.

(3) appropriate compliance level "targets" to guide enforcement programming.

(4) the productivity of different enforcement types and intensity levels.

Of particular interest here is the subject of the value of continuing to weigh far too many knowingly underweight trucks at permanent weigh scales. This "overweighing of underweight trucks" is done at the expense of identifying and addressing important non-compliance problems.

Such knowledge is a prerequisite to effective enforcement, and to paraphrase the opening sentence, "effective enforcement is a prerequisite to meaningful weight limit laws".

ACKNOWLEDGEMENTS

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REFERENCES

1 Clayton Sparks and Associates Ltd. "Enforcement Levels Study". Report for the Transport Compliance Branch, Saskatchewan Department of Highways and Transportation. 1991

2 Comptroller General of the United States. "Excessive Truck Weight: An Expensive Burden We Can No Longer Support". Report to the Congress, No. CED-79-94. 1979.

3 Euritt M.A. "Overweight Truck Operation in Texas: Developing Effective Fines and Penalties to Deter Violators". Professional Report, Faculty of Graduate School, University of Texas at Austin. 1985.

4 FHWA. "Overweight Vehicles - Penalties and Permits: An Inventory of State Practices". US Department of Transportation, Federal Highway Administration. Publication No. FHWA-MC-89-015. 1988.

5 Grenzeback L., Stowers J., & Boghani A. "NCHRP Report 303: Feasibility of a National Heavy Vehicle Monitoring System". TRB National Research Council Washington D.C. 1988.

6 IBI Group. "Motor Carrier Regulation Enforcement". Final Report to the Manitoba Department of Highways and Transportation. 1985.

7 Lundy J.R. and McCullough B.F. "Efforts to Reduce Illegally Overweight Truck Operations in Texas". Proceedings of the 2nd N. American Conf. on Managing Pavements, Canada. 1987.

8 Ontario Ministry of Transportation. "Transportation Regulation Compliance Program: Objectives and Strategies". Ontario Ministry of Transportation, Downsview, Ontario. 1989

9 Ontario Ministry of Transportation. "Compliance with Safety Laws in Ontario". Ontario Ministry of Transportation, Downsview, Ontario. 1989.

10 Organisation for Economic Cooperation and Development. "Impacts of heavy Freight Vehicles". OECD France. 1982

11 Paxson D.S. & Glickert J.P. "Value of Overweighing to Intercity Truckers". Transportation Research Record 889. 1982

12 Slocum R. "A Synopsis: The Truck Inspection Study". Report No. TRE-82-01. Ontario Ministry of Transportation and Communications, Downsview, Ontario. 1982

13 Stewart D. "Promoting Motor Carrier Safety and Fitness in Saskatchewan". Proceedings of the 22nd Annual Meeting CTRF. St. John's. 1987.

14 Thygesen C., Khalil S., Bedi I. & Keown L. "Alberta's Weigh Enforcement Program and Its Impact on Pavement Costs". Alberta Transportation and Utilities. 1990

15 Transportation Research Board. "Truck Weight Limits: Issues and Options". Special Report 225, TRB, National Research Council, Washington D.C. 1990.

16 Walton C.M. & Yu C. "Truck Size and Weight Enforcement: A Case Study". Transportation Research Record 920. 1983

17 Wyatt J. & Hassan M. "Some Tentative Findings about the Effect of Level of Enforcement on Compliance with Truck Weight Regulations". Saskatchewan Department of Highways and Transportation. 1985.

Les expéditeurs québécois et la déréglementation économique de l'industrie du camionnage

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1. INTRODUCTION

Depuis le début de 1988, l'industrie du transport routier au Québec et au Canada évolue dans un nouveau cadre réglementaire. Dans ce contexte, l'étude que nous avons réalisée pour le ministère des Transports du Québec avait pour objectif d'évaluer les effets de ces changements auprès des usagers de service de camionnage, de même que le degré de satisfaction de ces derniers relativement à l'offre de services de camionnage. Par la même occasion nous en avons profité pour tenter de mieux connaître les pratiques et besoins des expéditeurs en matière de camionnage. Nous vous présenterons dans cette communication certains résultats de cette étude.

Les expéditeurs auprès desquels l'enquête a été menée sont ceux des secteurs manufacturiers et du commerce de gros de l'ensemble du Québec. Certains résultats sont présentés selon la localisation géographique des expéditeurs. A cette fin, les établissements sont regroupés en trois régions:

- la région de Montréal: Montréal, Laval, Rive-Sud;
- les régions centrales: Québec, Mauricie-Bois-Francs, Estrie, Outaouais, Chaudière-Appalaches, Laurentides, Lanaudière et Montérégie (sans la Rive-Sud);
- les régions périphériques: Bas-St-Laurent, Gaspésie, Iles-de-la-Madeleine, Saguenay-Lac-St-Jean, Abitibi-Témiscamingue, Côte-Nord, Nord-du-Québec.

La taille de l'expéditeur servira également dans la présentation de certains résultats, grâce à une distinction entre les petits et moyens établissements et les grands établissements. Cette distinction repose sur le nombre d'employés et établit un seuil différent dans les secteurs manufacturiers et du commerce de gros, soit:

- secteur manufacturier:
  petites et moyennes entreprises: 1-199 employés;
  grandes entreprises: 200 employés et plus;
- secteur du commerce de gros:
  petites et moyennes entreprises: 1-49 employés;
  grandes entreprises: 50 employés et plus.

La méthodologie reposait d'abord sur une cueillette de données auprès d'un échantillon de 2 910 établissements parmi les 28 790 établissements que comptait la population totale. Un

questionnaire leur a été envoyé par la poste en juin 1991. Environ 700 questionnaires furent reçus et de ce nombre 665 ont été retenus pour l'analyse finale. Ces données ont été complétées par des entrevues auprès de 23 expéditeurs.

2. NIVEAU DE CONCURRENCE ET NIVEAU DES TARIFS

La réforme du cadre réglementaire a pour première conséquence d'augmenter le niveau de concurrence dans l'industrie du camionnage. Cela devrait se traduire par une offre de services accrue pour les expéditeurs. Le tableau 1 porte sur cette question pour différents segments de l'industrie. De façon générale on peut dire qu'une forte majorité d'expéditeurs considère que le nombre de transporteurs offrant leur service est soit en hausse ou est stable, et qu'une minorité variant entre 8,0% et 19,6% selon les segments de marché, considère que l'offre a diminué.

Si on compare les résultats sur les différents segments de marché, on remarque que sur les six segments de marché la proportion de ceux qui pensent qu'il y a eu une hausse de l'offre est assez semblable, soit entre 29,3%, sur le marché des charges partielles internationales, et 35,6%, sur le marché des charges complètes interprovinciales. Au niveau des baisses de l'offre, le marché qui se démarque est celui des charges partielles internationales où seulement 8,0% des expéditeurs observent cette situation, comparativement à des pourcentages variant entre 15,4% et 19,6% sur les autres marchés. Cette situation est cependant contrebalancée par un plus grand nombre d'expéditeurs observant une stabilité du nombre de concurrents sur ce marché, soit 44,4%. Sur les marchés intraprovincial et interprovincial, on peut noter un nombre légèrement moins élevé d'expéditeurs observant une baisse de la concurrence sur le marché des charges complètes que sur celui des charges partielles. Cela va dans le sens de la tendance que l'on attendait, soit un niveau de concurrence plus élevé sur le marché des charges complètes, mais la tendance est loin d'être aussi significative qu'on ne l'aurait crû.

Dans le rapport remis au ministère des Transports nous avons regardé cette question au niveau des régions et de la taille des établissements. On constate alors que les établissements de la région de Montréal sont moins nombreux à constater une hausse de l'offre. Cela se vérifie sur cinq des six marchés étudiés. Pour le sixième marché, charges complètes/international, les établissements des régions centrales ne les dépassent que de 3,3%. A l'opposé, les régions périphériques sont celles qui ont le moins noté une baisse de l'offre. Les différences entre la région de Montréal et les régions périphériques sont parfois assez importantes. C'est particulièrement le cas sur les trois segments de marché de charges partielles. Sur ces marchés il n'y a jamais plus de 23,3% des établissements de la région de Montréal qui considèrent que le nombre de transporteurs a augmenté. Dans les régions périphériques, il n'y a jamais moins de 45,5% des établissements qui considèrent que le nombre de concurrents a augmenté. Compte tenu des craintes qui avaient été avancées selon lesquelles le service allait se détériorer dans ces régions, cela représente une certaine surprise. Par ailleurs la taille des entreprises ne semble pas avoir d'effet sur le niveau de concurrence, quel que soit le marché considéré.

Dans ce débat sur l'offre de services de camionnage, la présence accrue des transporteurs

américains fait l'objet d'une grande préoccupation. Est-ce que cette présence est réelle ou exagérée? Le tableau 2 pose la question à l'expéditeur de façon générale et de façon plus spécifique pour ses propres expéditions. Un nombre important d'expéditeurs ne peuvent répondre à cette question, surtout lorsque la question porte sur la présence des américains de façon générale (46,0%). Mais ce qui est le plus frappant c'est le grand nombre qui constate que leur présence a augmenté. Cela est même vrai pour les expéditions de l'établissement, où 39,9% ont remarqué une augmentation du nombre de transporteurs américains offrant leurs services. Un infime 1,4% ont noté une baisse de leur nombre alors que 31,0% parle de stabilité. Cette présence des transporteurs américains n'est donc plus perceptible seulement à un niveau général. Elle est ressentie par une majorité des expéditeurs comme étant réelle et offrant une alternative qui leur est maintenant offerte.

Le questionnaire s'est ensuite attardé à la question des tarifs. Le tableau 3 présente l'évaluation que font les expéditeurs des modifications à leurs coûts unitaires moyens de transport depuis janvier 1988. Ces résultats sont présentés pour le transport en charge complète et partielle, et pour les destinations intraprovinciales et extraprovinciales. Ce qui ressort au niveau de l'ensemble des expéditeurs ce sont les hausses modérées que la plupart des expéditeurs ont connues. En effet, pour l'ensemble des établissements entre 76,5% et 86,0% des expéditeurs, selon les marchés, ont connu une augmentation de tarifs inférieure à 10% sur une période de plus de trois ans. Environ 20% des expéditeurs ont même connu des baisses de leurs coûts unitaires de transport pendant cette période. Si on compare les charges partielles et les charges complètes, on constate que ces dernières ont connu une évolution légèrement plus favorable, surtout au niveau du transport extraprovincial.

De plus, le tableau 3 fait ressortir que les hausses très modérées de tarifs sont généralisées dans toutes les régions. En fait, la région de Montréal semble avoir connue une évolution des tarifs de transport légèrement moins favorable que les autres régions du Québec. Compte tenu des craintes que pouvaient faire peser la déréglementation sur les régions périphériques, cela constitue une surprise. Les subventions croisées auraient-elles été dans le sens inverse que l'on croyait, i.e. que les expéditeurs en région auraient subventionné les expéditeurs montréalais dans la période réglementaire? Cette hypothèse reste à vérifier, mais on peut au moins conclure que les régions périphériques n'ont pas souffert de la déréglementation au niveau des tarifs. La conclusion est semblable en ce qui regarde la taille des établissements. Le tableau 3 indique cependant que sur le marché des charges complètes, les grandes entreprises ont profité d'une situation plus favorable. Mais globalement, l'évolution des tarifs demeure très favorable pour l'ensemble des établissements, PME ou grands.

3. ÉVALUATION DES SERVICES ET DU CONTEXTE RÉGLEMENTAIRE

Regardons d'abord le jugement global posé par les expéditeurs sur la qualité des services offerts présentement par les transporteurs avec qui ils font affaires. Le tableau 4 montre un niveau de satisfaction tout à fait étonnant. En effet,pour l'ensemble des établissements, si on additionne les 27,3% de très satisfaits au 66,3% d'assez satisfait, on obtient 93,6% comme niveau de satisfaction. A l'opposé il n'y a que 5,8% de peu satisfait et 0,6% de pas du tout satisfait. Notons par ailleurs que la satisfaction est très élevée, et qu'il n'y a pas de différences notables ni au niveau des régions, ni au niveau de la taille des établissements.

On peut ensuite regarder si cette satisfaction s'est accrue depuis le début de 1988. Une question demandait en effet aux expéditeurs s'il y avait eu une amélioration ou une détérioration dans la qualité des services offerts par les transporteurs pour compte d'autrui. Cette question, dont on trouve les résultats au tableau 5, était par ailleurs posée pour quatre segments de marché, les charges complètes et partielles intraprovinciales et extraprovinciales. Or il semble effectivement que cette satisfaction soit en hausse. En effet, environ 50% des expéditeurs constatent une amélioration mineure ou significative sur chacun de ces marchés, alors que la grande majorité des autres expéditeurs constatent qu'il n'y a pas eu de changements. Il reste en définitive toujours moins de 8% des expéditeurs pour déplorer une détérioration mineure ou significative.

Une étude plus poussée des données nous a permis de constater que la taille des établissements ne fait pas de différence sur aucun des quatre segments de marchés. Au niveau des régions, on peut constater que les régions centrales notent l'amélioration la plus significative, en particulier pour le transport en charge partielle. Ces deux éléments viennent encore une fois contredire la crainte de ceux qui s'attendaient à une détérioration des services dans les régions périphériques.

Il reste finalement la question des modifications à la réglementation économique comme telle. Notons d'abord qu'environ la moitié des expéditeurs se sont dit au courant des changements apportés. On a ensuite demandé à ceux qui étaient au courant, leur opinion quant aux modifications apportées à la réglementation dans l'industrie (tableau 6). Un certain nombre n'a pas d'opinion, soit 27,1%, mais parmi ceux qui ont une opinion, ceux qui sont en accord sont six fois plus nombreux, avec 62,2%, que ceux qui sont en désaccord (10,7%). On peut donc parler d'un appui très majoritaire des expéditeurs à ces modifications. Dans le contexte où ceux-ci sont plutôt satisfaits des services reçus, dans la mesure où ils ont vu leurs tarifs augmenter très légèrement, et dans la mesure où ils jugent que les services se sont plutôt améliorés, cet appui n'est pas surprenant. Évidement on ne peut conclure que la déréglementation est seule responsable de cette situation, mais il serait surprenant qu'elle n'y soit pour rien. Par ailleurs, le tableau 6 montre qu'il n'y a presque pas de différence entre les régions, si ce n'est un accord légèrement moins grand dans les régions centrales. Au niveau de la taille des établissements, ce sont les grands établissements qui montrent l'accord le plus élevé, bien qu'il soit très élevé pour l'ensemble des répondants.

4. MARKETING ET DISTRIBUTION PHYSIQUE

La situation de concurrence accrue a certainement changer certaines habitudes et pratiques des expéditeurs. Le premier exemple de cela est la grande infidélité des expéditeurs à leurs transporteurs. Le tableau 7 indique que plus de 76% des expéditeurs ont changé certains des transporteurs avec lesquels ils font affaires sur une base régulière. Le nombre de transporteurs avec lesquels les expéditeurs font affaires n'a pas changé, mais ils ont abandonné certains transporteurs au profit de leurs concurrents. Pour quelle raison ont-ils posé un tel geste? Deux raisons sont principalement invoquées, soit pour des raisons de tarifs (50,7%) et pour améliorer le service obtenu (42,6%).

Une autre question interrogeait les établissements sur les modifications qu'ils auraient

apportées à leur façon de gérer les stocks. Le tableau 8 indique qu'un pourcentage étonnant de 61,3% des établissements auraient apportés des modifications depuis le début de 1988. Il s'agit d'une situation tout à fait exceptionnelle dans un si court laps de temps. Dans notre enquête nous avons cherché à savoir quelles étaient les raisons qui ont motivé ces changements. Une raison domine complètement les autres, c'est la volonté de diminuer le niveau des stocks, qui a été cité par 67,2% des répondants. A l'inverse, seulement 3,3% des répondants affirment vouloir accroître le niveau des stocks. Les autres raisons qui sont fréquemment citées sont également reliées à la volonté de réduire les stocks, soit l'augmentation de la rotation des stocks (47,8%) et la nécessité de s'adapter à un système de production "juste-à-temps" (32,7%). Les raisons liées à la conjoncture externe de l'entreprise et susceptible de l'affecter, soit la baisse ou l'augmentation de la demande de ses produits, apparaissent dans 11,3% et 18,0% des cas respectivement. C'est non négligeable, mais c'est insuffisant pour expliquer la véritable révolution qui semble affecter la fonction distribution physique dans l'entreprise au niveau de la gestion des stocks. Lors des entrevues, il est apparu clairement que la concurrence entre les entreprises ne leur laissait aucune alternative à ce niveau. L'objectif de réduction et de rationalisation des inventaires explique cette grande mobilisation quant à la façon de gérer les stocks.

Une question portait sur l'existence d'un réseau informatisé de communication entre l'expéditeur et certains clients. Il s'agit précisément d'une technologie qui peut permettre une meilleure synchronisation des différents éléments de la fonction distribution physique. Le tableau 9 nous apprend d'abord qu'un nombre appréciable de 21,9% des établissements sont reliées à de tels réseaux. De plus les établissements qui sont reliés à ces réseaux les utilisent de façon plutôt intensive, puisqu'en moyenne 43,5% de leurs commandes arrivent par ce moyen. On pourrait ajouter que ce phénomène est relativement récent, car 59,7% des établissements reliés à ce type de réseau l'ont été depuis 1988. Nous pouvons par ailleurs constater que les grands établissements sont plus nombreux à être reliés à de tels réseaux, soit 32,5%, alors que ce taux n'est que de 21,6% pour les PME. Au niveau des régions, ce sont les établissements des régions périphériques qui sont nettement en dessous de la moyenne avec 12,0%. Le pourcentage d'utilisation du réseau, lorsqu'il est présent, est cependant le plus élevé dans les régions centrales (55,9%), puis dans les régions périphériques (47,0%).

5. CONCLUSION

Cette enquête nous a permis de mesurer un fort niveau de satisfaction des expéditeurs quant à la qualité des services qu'ils reçoivent des transporteurs publics. Ils sont généralement d'avis que ces services se sont même améliorés depuis le début de 1988. Ils ont dans le même temps pu profiter d'une situation très avantageuse au niveau des tarifs de transport. Cette situation ne peut être expliquée uniquement par les changements dans le cadre réglementaire, mais il est certain que les modifications ont favorisé ce mouvement. C'est certainement l'avis d'un bon nombre d'expéditeurs qui expriment en même temps leur accord aux modifications apportées à la réglementation.

En fait, la situation créée par la nouvelle réglementation a permis l'apparition d'un niveau de concurrence que l'industrie n'avait jamais connu auparavant. Les expéditeurs ont profité au maximum de cette conjoncture, comme en fait foi leur grande infidélité à leurs

transporteurs réguliers. En effet, plus de 75% d'entre eux ont changé certains de leurs transporteurs réguliers depuis le début de 1988. Il est difficile d'imaginer une situation où la concurrence est plus vive. Par ailleurs ils ont continué de profiter d'une conjoncture très favorable en termes de taux de transport. Les informations recueillies indiquent même que la dépression des tarifs de transport s'est légèrement accentuée au cours de la dernière année, sans doute à la faveur de la récession.

Il faut par ailleurs noter que la fonction distribution physique semble faire l'objet d'une grande rationalisation chez les expéditeurs. Les changements dans la façon de gérer les stocks, dans les habitudes d'entreposage, l'implantation de système de production "juste-à-temps", l'implantation de système informatisé d'échanges de données, sont des phénomènes qui ne sont plus marginaux. Dans le cas de la réduction des inventaires, il y a vraiment un effort presque généralisé dans ce sens. Face à ces changements, l'industrie du camionnage a su répondre en offrant des services de qualité.

Finalement y a-t-il des perdants parmi les expéditeurs? Certains pouvaient faire l'hypothèse que les régions périphériques seraient défavorisées par rapport à la région de Montréal, par exemple. D'autres prévoyaient une dégradation de la qualité des services pour les PME. Or, rien de cela ne semble s'être produit jusqu'à présent. S'il y a des perdants se sont probablement les transporteurs qui se trouvent dans une situation où la concurrence très vive et les tarifs de transport très bas ne leur laissent que peu de marge de manoeuvre.

Référence

BIGRAS, Y. (avec la collaboration de D. Pettigrew), Étude des effets de la déréglementation auprès des usagers de services de camionnage, Québec, Ministère des Transports, 1991.

Tableau 1
Modification depuis janvier 1988 du nombre de transporteurs offrant leur services (% des établissements)

	Hausse	Baisse	Stable	Ne sais pas
TL/intraprovincial	33,1	16,5	39,2	11,3
TL/interprovincial	35,6	18,4	35,4	10,6
TL/international	32,9	15,4	38,0	13,7
LTL/intraprovincial	34,5	19,2	34,5	11,9
LTL/interprovincial	33.9	19,6	35,0	11,6
LTL/international	29,3	8,0	44,4	18,4

Tableau 2
Changements depuis janvier 1988 dans le nombre de transporteurs américains offrant leur services (% des établissements)

	Hausse	Baisse	Stable	Ne sais pas
De façon générale	38,7	1,7	13,6	46,0
Pour les expéditions de l'établissement	39,9	1,4	31,0	27,7

Tableau 3
Proportion des expéditeurs dont les coûts unitaires moyens de transport ont augmenté de moins de 10% depuis janvier 1988 (% des établissements)

	Charge complète		Charge partielle	
	Intraprovincial	Extraprovincial	Intraprovincial	Extraprovincial
Rég. Montréal	65,1	74,4	78,0	77,6
Rég. centrales	85,4	94,8	75,2	83,2
Rég. périphéri.	83,2	98,7	72,7	86,1
Grands établis.	91,2	91,0	75,6	71,2
PME	76,9	85,7	76,4	80,0
Tous les établis.	78,5	86,0	76,5	81,1

Tableau 4
Satisfaction par rapport aux services offerts par les transporteurs
(% des établissements)

	Très satisfait	Assez satisf.	Peu satisfait	Pas satisfait
Région de Montréal	27,7	64,2	6,8	1,3
Régions centrales	27,5	67,9	4,6	0,0
Régions périphériques	23,5	69,7	7,5	0,0
Grands établissements	23,3	75,5	1,2	0,0
PME	27,5	66,0	6,0	0,6
Tous les établissements	27,3	66,3	5,8	0,6

Tableau 5
Évaluation des changements survenus depuis janvier 1988 dans les services de camionnage pour compte d'autrui (% des établissements)

	Charge complète		Charge partielle	
	Intra-provincial	Extra-provincial	Intra-provincial	Extra-provincial
Amélioration significative	24,9	21,0	22,3	15,6
Amélioration mineure	32,5	34,3	31,3	31,5
Aucun changement	37,0	37,1	42,0	45,7
Détérioration mineure	3,1	4,3	3,9	5,8
Détérioration majeure	2,6	3,3	0,5	1,5

Tableau 6
En accord avec les modifications apportées à la réglementation économique
(% des établissements)

	Oui	Non	Pas d'opinion
Région de Montréal	66,1	11,6	27,1
Régions centrales	59,3	10,6	30,1
Régions périphériques	65,1	8,9	26,0
Grands établissements	71,1	9,9	19,0
PME	61,8	10,8	27,4
Tous les établissements	62,2	10,7	27,1

Tableau 7
Changements depuis janvier 1988 de certains des transporteurs avec lesquels l'expéditeur fait affaires sur une base régulière (% des établissements)

	Oui	Non
Région de Montréal	78,0	22,0
Régions centrales	76,1	23,9
Régions périphériques	65,9	34,1
Grands établissements	72,8	27,2
PME	76,5	23,5
Tous les établissements	76,3	23,5

Tableau 8
Modifications dans la façon de gérer les stocks depuis janvier 1988 (% des établissements)

	Oui	Non
Région de Montréal	62,6	37,4
Régions centrales	58,7	41,3
Régions périphériques	67,8	32,2
Grands établissements	76,3	23,7
PME	60,8	39,2
Tous les établissements	61,1	39,2

Tableau 9
Liens existant avec certains clients par un réseau informatisé de communication (% des établissements)

	Oui	Non	Pourcentage d'utilisation
Région de Montréal	22,9	77,1	30,7
Régions centrales	22,8	77,3	55,9
Régions périphériques	12,0	88,0	47,0
Grands établissements	32,5	67,5	46,4
PME	21,6	78,4	43,3
Tous les établissements	21,9	78,1	43,3

Diesel Engine Emissions and Intercity Trucking

Fred P. Nix

Emissions from diesel engines in large trucks give rise to or are part of the cause of ozone, acid rain, global warming, and substances believed to be carcinogenic. As a result, governments have adopted -- or are in the process of adopting -- policies to deal with heavy-duty diesel engine emissions and fuel quality. This paper discusses these policies and examines the potential impact on intercity trucking. The purpose is to explore the following questions: (i) What is the magnitude of the problem associated with diesel engines used in intercity trucking and, in particular, long-distance intercity trucking? (ii) What policies can be used to control these emissions? and (iii) What are the implications for intercity trucking?

1. DIESEL ENGINE EMISSIONS

Diesel engines are the main method of propulsion for intercity trucking. Although more expensive than heavy-duty gasoline engines, they rose to prominence in the 1970s when fuel prices were rising, as their greater inherent efficiency became important. On highway operations, a diesel engine converts 40% - 42% of available energy to kinetic energy whereas a gasoline engine only converts about 30%. Although more fuel efficient, diesel engines emit certain pollutants:

Carbon monoxide, *CO*, in high concentrations is known to be a hazard to health. Emissions of CO generally increase with the age of the engine.

Hydrocarbons, *HC*, including volatile organic compounds (*VOC*), are the result of unburnt fuels in the exhaust. They are considered a health hazard and are also involved in the formation of ozone.

Nitrogen Oxides, NO_x, are involved in the formation of ozone and, when they combine with water vapour, are one of the causes of acid rain. The level of NO_x can be reduced by lowering the temperature of diesel engines and there are a number of ways of doing this.

Particulate matter, *PM*, consists of several substances: soot or carbon, a soluble organic fraction which contains polynuclear aromatic hydrocarbons (*PAH*), and sulphates (SO_4). Particulate matter, and the PAH associated with it, is of concern as the particles are small enough to breathe and, therefore, probably associated with chronic lung disease. Further, according to the best evidence, it is a probable

human carcinogen. It is estimated that diesel particulates make up 2.8% to 14.6% of the total inhalable particulates in the air ([3] p 7).

Carbon dioxide, CO_2, is responsible for roughly half of all global warming. The UN is now looking at ways to stabilize or reduce CO_2 levels. Unlike other emissions, CO_2 is proportional to the amount of fuel used. There is no engine or after treatment technology which can reduce CO_2 levels; the real control measure is to limit the amount of fuel used (less driving or more fuel-efficient driving).

Sulphur Dioxide, SO_2, is produced from the sulphur in diesel fuel -- about 97% of the sulphur is converted to SO_2 ([3] p 20). Some of the SO_2 emitted is transformed in the atmosphere into sulphate particulate (*secondary particulate* formation) and some into sulphuric acid (acid rain). The most direct way of controlling SO_2 is by regulating the sulphur content of diesel fuel.

There are no measurements of the quantity of these emissions produced by large trucks.[1] Instead, models are used to estimate annual tonnes and the emission rate (grams/litre or /km). These models use assumptions about such things as the duty cycle of typical engines, the vintages, etc, and it is not known how accurate these assumptions are. Table 1, based on these models, compares estimates for 1985 (1987 for CO_2).[2] More recent figures suggest that HDDVs (*heavy-duty diesel vehicles*) in 1992 will produce about 140 kt of CO -- up 40% from 1985; 31 kt of HC/VOC - up marginally from 1985; and 253 kt of NO_x -- down significantly from 1985 and, presumably, a result of the tighter NO_x standards.[3]

TABLE 1: Emission Inventory, circa 1985 (kilotonnes)

		CO	HC/VOC	NO_x	PM	CO_2
1	PRODUCTION in Canada (kt)	10 780	1 854	1 885	2 200	435 180
2	- of which, HDDV	104	30	270	23	23,819
3	- percent	1.0%	1.6%	14.35%	1.0%	5.5%

As shown, large trucks (and other diesel vehicles) are, with the exception of NO_x, a relatively small part of the overall problem. One qualification to this is that, although the total production of particulates is small (1%), there is a special concern about diesel particulates given the health risk associated and given that diesel particulates are small enough to be inhaled (this, presumably, accounts for the difference between the 1% shown in the table and the 2.8% - 14.6% given earlier).

2. EMISSION LIMITS AND FUEL STANDARDS

The current emission limits for diesel trucks, in Canada and the US (Environmental Protection Agency), in grams per brake horsepower hour, *g/bhp-hr* are shown below. There are also plans to lower the NO_x emission level to 4.0 g/bhp-hr in 1998. This may require that the aromatic content of diesel fuels be limited ([3] p 11).

	Can. 1990	US EPA Standards 1991	1994
CO	15.5	15.5	15.5
HC	1.3	1.3	1.3
NO_x	6.0	5.0	5.0
PM	0.6	0.25	0.10

To meet the 1994 EPA limits, in particular, the reduction of particulates to 0.1 g/bhp-hr, US engine manufacturers and fuel suppliers came up with a plan involving both modifications to engines and the use of low-sulphur fuel. Diesel fuel in Canada has, perhaps, an average of 0.18% of sulphur by weight although it may sometimes be as high as 0.5%[4] The planned standards in the US will limit this to 0.05% The new 1994 engines will meet the requirements for NO_x, while the low-sulphur fuel in combination with an after-treatment device -- a particulate trap or a catalytic converter -- will meet the limits on PM emissions.

The situation in Canada is more confused. Transport Canada, which regulates emissions under the Motor Vehicle Safety Act, has plans to adjust standards to those of the EPA. However, the implementation date has been delayed. To adopt the US standards requires that fuel quality also be regulated. The power to do this is held by Environment Canada under the Canadian Environment Protection Act. Accordingly, Environment Canada, in June 1990, published a Notice of Intent to do so. The problem is that the petroleum industry is balking at the cost involved and has asked the government to delay implementation of the standard until 1998 or later. It is not clear, then, if or when fuel-quality standards will be introduced.[5]

Whatever happens with Canadian regulations, US-based engine manufacturers will be exporting to Canada EPA certified engines -- currently the 1991 standards but, starting in October 1993, the new 1994 limits. This means, then, the Canadian trucking industry will be using new engines on any equipment they purchase after October 1, 1993. There have been concerns raised that there may be problems if new engines are used and there are no regulations on the sulphur content of fuel.

3. SOURCE OF DIESEL EMISSIONS

This section presents three estimates of emissions by the trucking industry. There are weaknesses in all three methods; however, one of them is good enough to indicate the relative importance of intercity trucking in terms of air-borne pollution.[6]

The first estimate ("A"), is developed from data used in Environment Canada's model estimating total inventories. These are the figures for the 1991 fleet average in Ontario:[7]

HC	1.86 grams/mile
CO	8.38 "
NO_x	16.46 "

These can be converted to grams/litre on the basis of an estimate of fleet average fuel consumption -- where *fleet* includes some non-diesel vehicles -- using Statistics Canada's 1988 trucking surveys (StatsCan #53-222): 7.06 billion kilometres and 3.19 billion litres equals an average of 2.21 km/L.

The second method ("B") is based on the regulated limits and a separate estimate for CO_2 ([15]). Trucks actually in use will have emission levels below and above these levels. The emission rate per unit of distance is calculated as the product of the mean load and the brake specific emission rate where,

$$\textit{Mean Load} = \frac{\textit{Fuel Density}}{\left(\begin{matrix}\textit{Brake Specific}\\ \textit{Fuel Consumption}\end{matrix}\right) x \left(\begin{matrix}\textit{Route Specific}\\ \textit{Fuel Consumption}\end{matrix}\right)}$$

The critical variables are the brake specific fuel consumption (assumed to be 181 g/bhp-hr) and the brake specific emission rate (EPA 1991 levels).

TABLE 2 Estimated Sources of Emissions, circa 1988

		CO	HC/VOC	NO_x	PM	CO_2
	EMISSION RATES (g/l)					
1	estimate "A" - '91	11.52	2.56	22.62	--	--
2	estimate "B" - '91	75.00	6.29	24.19	1.21	2 650
3	estimate "C" - '89	22.81	5.48	48.65	3.30	--
	EMISSION RATES x DIESEL FUEL SALES (kt, 1988)					
	road ($5.7 * 10^9$ l)					
4	A)	65.7	14.6	129.0	--	--
5	B)	427.6	35.9	137.9	6.9	15 110
6	C)	130.1	31.2	277.4	18.8	--
	trucking ind. ($2.7 * 10^9$ l)					
7	A)	31.1	6.9	61.1	--	--
8	B)	202.6	17.0	65.3	3.3	7 158
9	C)	61.6	14.8	131.4	8.9	--
	long distance trucking ($0.4 * 10^9$ l)					
10	A)	4.6	1.0	9.0	--	--
11	B)	29.7	2.5	11.6	0.5	1 049
12	C)	9.0	2.2	19.3	1.3	--

The third method ("C") is the simplest: In 1989, Environment Canada estimates that all diesel vehicles produced 135.4 kt of CO, 32.5 kt of HC/VOC, and 288.8 kt of NO_x. Assuming these vehicles are the same as those accounting for the 5.9 billion litres of diesel fuel where a road-use tax was paid ([5] Table 3.2), emissions per litre are as shown on the third line of Table 2. For primary particulate emissions per

litre (on line #3), it is estimated that all on-road diesel engines in 1989 produced an average of 3.3 grams/litre ([3] p 21).

A total of 7.0 billion litres of diesel fuel is consumed by the transportation sector, other than rail, marine, and pipeline.[8] Some of this appears to be for uses other than road transportation as sales of diesel fuel where a road-use tax was paid is only 5.7 to 5.9 billion litres (1988/1989) ([5] Table 3.2, or StatsCan #53-218). The trucking industry itself, at least the surveyed portion of the for-hire and private trucking industry, accounted for 2.7 billion litres.[9] (StatsCan #53-222) The surveyed intercity bus and urban transit industry accounts for another 0.4 billion litres and, presumably, the non-surveyed trucking industry -- primarily the private carriers with fewer than 15 vehicles -- accounts for most of the remaining 2.6 billion litres.

Some assumptions have to be made to estimate the share of this fuel accounted for by long-distance trucking. As only 17.5% of the tonnes hauled by for-hire truckers move more than 500 kilometres[10] and assuming the same amount of fuel is used per tonne in hauls over or under 500 km, then only 17.5% of for-hire fuel is accounted for by long-distance for-hire truckers. *Long distance* here is arbitrarily defined as over 500 kilometres as this is often used as a cut-off point where trucks and rail compete. Only 8.5% of the tonnes hauled by private trucks are interprovincial. The published statistics do not give tonnages in distance blocks as they do for for-hire trucking so here *interprovincial* is used as the demarcation for long distance. Therefore, it is assumed that only 8.5% of the fuel consumed by private truckers is accounted for by long-distance truckers. Together, these estimates suggest 0.4 billion litres of diesel fuel being used by long distance truckers in 1988.

Although these are all tenuous estimates, they suggest a number of things. First, diesel trucks are producing considerably less carbon monoxide than the regulated limits -- compare lines #1 or #3 with line #2 on the table. Second, in terms of hydrocarbons, there is not a lot of difference between method "B" and "C" suggesting, perhaps, that trucks are producing close to the regulated limits. The high amounts of NO_x suggested by method "C" is, presumably, a function of the age distribution of trucks (there are still many pre-1990 trucks in the fleet). The difference between method "B" and "C" for particulates -- 1.2 versus 3.3 g/l -- is presumably a reflection of the difference between engines built to the new 1991 EPA limits and the typical engine in use as of 1989.

The other thing that can be said on the basis of the figures is that long-distance trucking is a minor player in terms of the total production of emissions. Using the results of "C" for the first four emissions and "B" for the last one, the following are the percentage of (a) total and (b) HDDV emissions produced by long distance trucking (this mixes data from various years, but the error is not large):

	CO	HC/VOC	NO_x	PM	CO_2
a) Total Emissions	0.08%	0.12%	1.02%	0.06%	0.24%
b) HDDV Emissions	8.65%	7.33%	7.14%	5.65%	4.40%

Even if these are in error by a factor of two or three, the point is that long-distance intercity trucking is not a major source of pollutants. This ties in with two other observations. First, most trucking activity in Canada is still a relatively short-haul affair (for example, the biggest commodity hauled is sand and gravel). Second, during the 1980s, the growth area in the market for diesel engines has been in the medium to mid-sized trucks used in urban or local areas.

4. GOVERNMENT POLICIES

A number of policies can be used to control emissions, with emission limits and fuel quality regulations being the two most obvious examples. However, others include carbon taxes (for CO_2), alternative fuels, encouraging fuel efficiency, and perhaps such things as controlling the demand for transportation or even encouraging the use of one mode of transportation over another. Some of these, such as emission limits and fuel-quality standards, are inter-related. Policies designed to encourage efficiency are closely related to policies such as a carbon tax or other policies which increase the price of fuel (assuming the demand for diesel is relatively elastic).

Engine Emission Limits: This is the policy of choice in both Canada and the United States and, more recently, in Europe ([11]). It is suspected that this is because regulated limits can be quite precise in terms of the pollutants controlled. Further, there is a belief that such controls work. Witness, for example, Environment Canada's forecast for total HDDV NO_x emissions in Canada in 1989 and 1999 -- 288.8 kt versus 188.0 kt -- a drop of 35% over the decade.[11]

From a Canadian perspective, it is difficult to see how Canada can do anything on its own in this area. All heavy-duty diesel engines are imported, almost all from the US, and US manufacturers build only to EPA standards. Canada only accounts for 10% - 15% of the market. Further, given the size of the transborder trucking industry (approaching one-fifth of for-hire revenues in Canada) and the increasing corporate links on both sides of the border, the industry is too integrated to imagine that it is feasible for Canada to have polices significantly different than American policies. In terms of the actual mechanics of implementing the policy, however, there is a problem in Canada in that it has proved difficult to coordinate engine emission limits with the required fuel-quality controls. How serious this is -- ie, having 1994 engines and, possibly, two types of diesel fuel -- is not known.[12]

From a broader perspective, two other comments can be made. First, as long as there are no actual programs of testing emission levels on the road or, perhaps, of testing vehicles for compliance once they are in use, it is difficult to see how governments can be so confident about the success of this policy.[13] For example, a 1987 American study of light-duty vehicles found that 19% and perhaps as many as 31% of the vehicles had emission control equipment that had been illegally modified ([13] p 36). While it is not known if the heavy-duty diesel emission technologies are susceptible to tampering, it is known that any number of problems (such as high-sulphur fuel in one of the 1994 engines) will result in a situation where emission rates are not those assumed in Environment Canada's models. Further, given that

the relationship between engine emission rates based on what engines do in the lab under a prescribed duty cycle and what engines do when in actual use on the highway is not well established ([4]), there must be some question marks surrounding the forecasts of emission levels.

Second, a point raised by others: "The key disadvantage of the new diesel technology is that it is inflexible with respect to future changes in the emission standard. A much reduced NO_x standard would require an entirely new exhaust treatment technology to be developed" ([16] p 9).

Carbon Tax: As concerns over global warming have increased, there have been calls for carbon taxes on fuels. According to a UN report, stabilizing CO_2 levels will require a 60% reduction in the production of CO_2 by the year 2005 -- that is, a 60% reduction over the "business-as-usual" levels by that time ([7] p 16).

An American study suggests that the gasoline tax will have to increase from 9¢/gal (US measures) to $1.55 by the year 2010 to hold the production of CO_2 constant and to $4.75 a gallon to reduce production by 20% ([7] p 17). A study in Ontario suggests that a carbon tax "of an additional 31% by the year 2000" will be required to improve fuel efficiency by 16% and stabilize CO_2 production. To reduce CO_2 production by 20% by the year 2005, a carbon tax of 109% would be required ([7]). In both cases, measures other than carbon taxes were assumed to reach these targets. These taxes (31% and 109%) amount to about 17¢ and 59¢ per litre. The authors who report these studies continue on to point out that there are only small differences in average fuel consumption figures (for cars) from one county to another even though fuel prices vary considerably.

The point of all this evidence is that carbon taxes may have to be very high to have the desired effect on fuel consumption and, as a result, the emission of CO_2. While most of this evidence concerns gasoline, the same point may hold for the level of carbon taxes on diesel (unless there is a great difference in demand elasticities). It is not known here how much freedom governments in Canada have in this area given the existing problem with the level of fuel taxes. At a certain level above American taxes, it becomes increasingly difficult to keep fuel buyers on this side of the border.[14] Canadian provincial taxes on diesel fuel -- ranging between 7¢ and 16¢ a litre -- are already considerably higher than taxes in the US.

Alternative Fuels: Alternative fuels are now seen as a policy option for environmental issues. For large trucks, the three most likely are propane, methanol, and compressed natural gas (*CNG*). Engines running on these all offer a considerable improvement over existing diesel engines in terms of particulate emissions ([16]). They also offer some improvements in terms of NO_x, and other emissions. CNG and methanol engines, however, are not as good as existing diesel engines in terms of carbon monoxide and all three alternative-fuel engines offer only small improvements in terms of the greenhouse effect. Significantly, the new 1994 diesel engines match or exceed the performance of these alternative-fuel engines for all emissions ([16] Exhibit 6). For these and a variety of other reasons (eg, fuel

availability) most people think that diesel will be the primary fuel for long-distance trucking for some time to come. (Alternative fuels may be a viable environmental policy for local or short-haul trucking where fuel supply is not such a problem.)

Fuel Efficiency: Encouraging fuel efficiency is, perhaps, one of the most effective policies. Several provinces do have programs designed to either educate, teach, or encourage truckers to be more efficient and, on a broader level, the Canadian Management Plan for NO_x/VOCs includes a recommendation for either more effective speed-limit enforcement or a lowering of the speed limits (ie, to boost fuel efficiency).

Whether or not there are specific government policies in place to encourage fuel efficiency, the prospects of improved efficiency (hence, lower emissions) appear good. It has been estimated that, for the US, there will be a fleet average diesel truck fuel consumption rate of 8.2 mpg (3.5 km/l) by the year 2000 ([12]). While this number may not be directly applicable to Canada where trucks are heavier and operating conditions harsher, it is still a long way from the 2.2 km/l fleet average estimated previously.

Other Policies There are a range of other possibilities. Some have suggested demand management; others have suggested modal switches. These suggestions are usually made within the context of passenger transportation -- for example, encouraging off-peak commuter traffic or encouraging the use of transit -- but they sometimes spill over into the realm of freight transportation.[15] It is not immediately obvious how or to what extent governments could adopt policies which would change the demand for freight transportation in such a manner so as to reduce emissions (encourage less JIT deliveries? encourage more centralized manufacturing?) Governments can and do implement many policies which influence the decisions on modal choice for shippers. Whether any of these can or should be used as a means of controlling emission levels is debatable. Certainly the numbers given previously -- the extremely small proportion of emissions resulting from long-distance intercity trucking -- suggest that such policies are not going to have much of an impact on the total level of pollutants.

5. IMPACT ON INTERCITY TRUCKING

The prime impact of the emission limits, of course, is that the trucking industry is buying (1991 EPA) and will be buying (1994 EPA) new technology. Whatever the cost, and the consequent increase in tractor prices, there appears to have been some off-setting savings in that the new engines are both more fuel efficient and use less oil than the engines they replace. The full impact on trucking costs -- higher equipment prices, possibly better fuel and oil consumption, and possibly higher or lower maintenance costs -- is not known.[16] Figures that have been mentioned suggest, perhaps, increases of $3,000 for the new electronic engines and anywhere from $5,000 to $10,000 for after treatment technology.

As a preliminary estimate of what this all means in terms of costs, the following numbers -- all at the high end of the range of estimates made[17] -- are used. The increase in engine prices themselves are ignored on the assumption that improvements in fuel usage will off-set these.

after treatment technology	$10,000
low-sulphur fuel	+2.9¢/l
low-sulphur fuel and reduce aromatics	+7.0¢/l

Without considering other factors (including new depreciation rates), the following figures show what these amounts mean in terms of 1990 trucking cost ([114]) in three situations (using Ontario costs): a 5-axle tractor semitrailer hauling dry freight; a large 8-axle B-train hauling bulk products; and a small 2-axle diesel truck.

	Increase in Operating Costs		
Truck:	5-axle	8-axle	2-axle
Freight:	dry freight	bulk	dry freight
Annual Km:	160 000	240 000	40 000
after-treatment	+0.7%	+0.4%	+1.5%
low-sulphur fuel	+0.9%	+0.9%	+0.3%
after-treatment + low-sulphur, high cetane fuel	+2.8%	+2.2%	+2.7%

At the high end of the range, then, and assuming the aromatic levels of diesel are also limited some day (to meet the 1998 NO_x limits), there appears to be a possibility of increasing trucking costs by something less than 3%

The only other point to add here is the possible problems that may occur if Canada has 1994 EPA engines starting in October, 1993 and a dual-fuel situation. There is a possibility of increased costs (where more storage tanks are required), increased administrative and operational problems, and serious problems if the high-sulphur fuel manages to find its way into one of the new engines. (Motor Truck, April 1992) According to some: "Misfuelling could damage the catalytic aftertreatment device and will void the emission components warranty on the engine. Misfuelling a new technology vehicle will also increase the particulate emission" ([31] p 9).

In terms of the carbon tax, and assuming such a tax would be quite high, a recent study may be relevant as it has looked at the impacts on trucking of doubling or tripling the level of road-user taxes. Briefly, what it found was that a doubling of road-user taxes (fuel and registration taxes) would increase trucking costs in Canada by 9% and a tripling of taxes would increase costs by 17% This, in turn, would shift a small amount of freight from the trucking industry to the railways ([8]). However, since a carbon tax will increase fuel prices for all modes, a consideration of the cross-elasticity of demand is not relevant here, unless, of course, one mode is more or less energy efficient than the other. This is a controversial subject, not only because there is disagreement over current efficiency levels ([111]) but also

because in this instance it is really each mode's ability to adopt new, fuel-efficient technology in a rapid manner which is important. Perhaps the simplest way of dealing with this subject is to look at both modes at an aggregate level. Fuel expenses for both account for roughly the same share of total operating expenses. Assuming a carbon tax increases the price of fuel for both in an equivalent fashion, then, there may not be any freight shifting from one mode to another ([9] p 144).

Policies designed to encourage the use of alternative fuels will have an impact on costs. One recent estimate suggests that the engine and fuel-tank requirements for propane, methanol, and CNG-powered equipment are all higher than the current diesel engines (from $6,500 to $15,000), but that the fuel costs per kilometre -- primarily because of the different tax levels -- are all lower than diesel (from 13.5¢ to 19.6¢ per kilometre versus 20.7¢ for current diesel engines).(Motor Truck, March 1992) As noted above, however, these costs may be more relevant to local or short-haul trucking than to long-distance, intercity trucking.

Policies designed to improve fuel efficiency could have a large impact on trucking: an industry-wide improvement of even 5% represents over 150 million litres of fuel, almost $66 million in operating expenses, and an improvement in operating ratios of about 0.5 (these figures are based on StatsCan's surveyed for-hire and private carriers only). A 5% improvement is probably quite feasible simply through driver training or education. The difficulty is knowing whether or not government policies are effective in this area or whether the best policy is simply higher fuel prices. One writer has observed that, in the US, the only recent period during which average fuel economy for Class 8 trucks (ie, the largest trucks) improved was between 1977 and 1982 when real energy prices were increasing. "Since 1982, there has been little change in their average fuel economy despite increased penetration of improved technologies . . . " ([12] p 1). The evidence in Canada suggests that fuel consumption did improve during the 1980s, but then this was also a period of rising fuel taxes.

6. SUMMARY

Since this paper is concerned with transportation issues -- that is, it is not an environmental analysis -- it is taken as a given that diesel engine emissions are a problem and that government action is required to limit or control the pollutants. From the rough evidence assembled, two points can be made about the source of diesel emissions. First, HDDVs in total account for a small part of all emission inventories in Canada. Second, considering just intercity trucking activity, the evidence suggests that it accounts for a small share (4% - 9%) of HDDV emissions. None of this reduces the need for government action, that is, limiting or controlling emissions, but it does provide an insight as to where these actions need to be focused.

The main policy used to control emissions is a reliance on engine emission limits, which, in turn, requires or is related to a requirement for fuel quality controls. Several points about this policy emerge from the material reviewed. First, it is

difficult to adopt a policy independent of American policy and, having made the decision not to do so, there has been the problem in Canada of implementing a coordinated policy. (Our legislation, apparently, is more cumbersome than that under which the EPA operates.) Whether or not this leads to problems after 1994 is not really known. Assuming there are none (low-sulphur fuel supply, misfuelling, administrative costs, etc), the preliminary evidence is that these emission controls will not have a significant impact on trucking costs.

There are a range of other policy options for controlling diesel engine emissions that, except for some discussions, demonstration projects, training-educational initiatives, and other forms of moral suasion, have not been pursued with much vigour in Canada. One of the reasons may be that there are some large question marks as to the precise form of these policies should take and their effectiveness (how high a carbon tax? are alternative fuels really viable? is shifting freight from one mode to another significant in terms of total emissions? what is the most effective way to encourage fuel efficiency?). While this paper has not provided the definitive answers, it has, perhaps, laid the groundwork.

REFERENCES

[1] Berry, J.M., 1989, "Vehicle Engineering Legislation, Including the Implications of 1992," Proceedings, Institution of Mechanical Engineers, International Conference on Managing the Vehicle on the Road.

[2] Blevins, W.G., Gibson, A.W., 1991, "Comparison of Emissions and Energy Use for Truck and Rail," TAC annual conference, Winnipeg.

[3] Caple, J., Guerette, C., 1991, "Assessment and Control Background Report on the Proposed Diesel Fuel Quality Regulation," Environment Canada, Ottawa.

[4] Dietsmann, H.E., Warner-Selph, M.A., 1985, "Comparison of Emissions From Heavy-Duty Engines and Vehicles During Transient Operation," Energy Sources and Technology Conference, Dallas.

[5] Energy, Mines and Resources Canada, 1991, Transportation Energy Data Book, Edition 5, TE 91-11, Ottawa.

[6] Harmelink, M.D., Colavincenzo, O.M.S., 1991a, A Review of the Provincial Transportation Impacts of the Canadian Management Plan or NO_x/VOCs: Ontario Perspective, TTE-91-01, Transportation Technology and Energy Branch, Ministry of Transportation of Ontario, Toronto.

[7] Harmelink, M.D., Colavincenzo, O.M.S., 1991b, "Transportation, Energy and the Environment, Things are Heating Up," draft, presented to TAC Workshop, Winnipeg, Sept 18, 1991.

[8] Jones, J., Nix, F., Schwier, C., 1990, The Impact of Changes in Road User Charges on Canadian Railways, CIGGT Report #90-1, Queen's University, Kingston

[9] Kahn, A.M., 1991, Energy and Environmental Factors in Freight Transportation, TP 10942, Economic Analysis, Policy and Coordination, Transport Canada, Ottawa.

[10] Lockwood, R., 1990, "The 1991 Engines: Changes All Over," Today's Trucking, V 6, # 8.

[11] Nix, F.P., 1991, "Trucks and Energy Use," for the Ontario Trucking Association, Québec Trucking Association and the Canadian Trucking Association

[12] Sachs, M.H., DeCicco, M.L., Mengelberg, U., 1992, "Heavy Truck Fuel Economy: A Review of Technologies and the Potential for Improvement," TRB, Washington.

[13] Saricks, C.L. 1989?, "Review of Technological and Policy Options for Mitigating Greenhouse Gas Emissions from Mobile Sources," TRB Record 1267, Washington.

[14] Trimac Consulting Services Ltd., 1990, Operating Costs of Trucks in Canada - (various years), TP 921, Transport Canada, Ottawa.

[15] Willis, C., Soots, V., 1990, "The Role of Technology, Fuel Substitution and Conservation in Minimizing Emissions and Their Impacts on the Environment," Proceedings, Vol 4, RTAC annual conference, St John's.

[16] Vespa, S., Webb, R.F., 1991, "Trends in Heavy-Duty Vehicles and Their Fuels," TAC annual meeting, Winnipeg.

ENDNOTES

1 Environment Canada wrote (in a letter to the author) the following: ". . . there is not a substantial amount of information on heavy duty vehicle emissions as the federal exhaust emission standards . . . relate to engine testing not vehicles." (July 17, 1991)

2 The data is from [9] Table 2.8. The CO_2 shown is only that produced from the burning of fossil fuels. In 1989, there was an estimated 55 kt of primary and 127 kt of primary and secondary particulates in Canada ([3] Table 5) from all diesel engines (ie, not just the HDDVs shown).

3 These most recent numbers were obtained by telephone from Environment Canada.

4 An average of 0.18% is used in [3]. Today's Trucking, Oct., 1990, reports some sources are as high as 0.5%.

5 "Environment Canada still intends to regulate diesel fuel to a maximum sulphur level of 0.05% and a minimum cetane number of 40. Effective October 1, 1995 the regulation will apply to all diesel fuel used in on-road vehicles" ([3] p 8). This was written in April 1991. Barry Holmes, Motor Truck, April 1992, writes that the Canadian Petroleum Producers Institute has asked the minister to defer the ban. The industry prefers a "dual fuel/voluntary phase-in" program.

6 The weakness in the first method is that it combines data from one source with data from another source even though they apply to the different populations. Further, there may be weaknesses in the Environment Canada figures themselves. As for the StatsCan data, there are several problems with the calculation made in the text for fleet average fuel consumption rate -- one of these is discussed more fully in [11]. The weakness in the second method is that it assumes regulated emission levels are the actual levels. Second, the method assumes that emission levels are the same for an engine transient cycle and that same engine when placed in a specific vehicle pulling a specific load. As [4] has shown, this is a weak assumption. There is

really only one weakness with the third method: not knowing the difference between the reported 7.0 billion litres on diesel sold to road users versus the reported 5.9 billion sold where road-tax was paid. If 7.0 billion is the current denominator (as [3] Table 5 seems to suggest) the estimated grams/litre would be lower than those shown in the text.

7 By telephone, Environment Canada, March, 1992. There is not much variability from one province to another.

8 [5] Table 2.10 (the source being StatsCan #57-003). These are the terajoules consumed by the "road transport & urban transit" and the "retail pump sales" sector. Using 36.48 to 38.65 terajoules per megalitre, these amounts can be converted to 6.7 to 7.1 billion litres (1988) and 6.6 to 7.0 billion litres (1989).

9 This is lower than the 3.2 billion reported earlier in that it excludes fuel purchased in the US and non-diesel fuel.

10 This is domestic tonnes only of the Class 1 & 2 carriers for 1988.

11 Numbers are from Environment Canada by FAX.

12 Manufacturers are now testing the prototype 1994 engines with fuel that has a sulphur content higher than 0.05%. The results of these tests are not known. In the meantime, there are some strongly-held opinions on the possible problems associated with a dual-fuel situation (see Motor Truck, April 1992).

13 The NO_x\VOC Management Plan recommends a program of inspection/testing ([6] p 5).

14 In the case of commercial vehicles using diesel this should not matter as tax is collected on the basis of distance driven in each province or state. Whether this tax collection policy is "leak proof" is not known.

15 ". . . modal shifts from truck to rail offer the most significant and realistic opportunity for saving energy and improving environmental quality" ([9] p v). This is also the implicit message in [2]; and [6] (p 12) implies that shifting freight from trucks to the railways might be one way of dealing with CO_2. Even more explicitly, this suggestion of shifting freight to the railways was the gist of a resolution passed at the last convention of the provincial NDP in Ontario.

16 According to [10], the new engines and, after 1994, the after treatment technologies will cost more than the power plants they replace. Off-setting this, are the improvement in fuel consumption that is possible, the better diagnostics capabilities, and the ability to control the engine work load (engine idling can be controlled, progressive shifting can be programmed, road speed can be governed).

17 A figure of $10,000 for traps is used in [6]; Today's Trucking, (Oct., 1990) suggests a cost of anywhere from $2,400 to $10,000 for traps; several people, including [3], use a figure of 2.9¢ per litre for the cost of low-sulphur fuel; and [16] suggest a cost of 7¢ per litre for low-sulphur and high cetane (low aromatic) diesel.

The Ports of Seattle and Vancouver: Some Competitive Differences

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ABSTRACT: This paper reviews issues critical to understanding the competitive position of the port of Vancouver in the 1990s. Attention is focused on the container trade of the ports of Seattle and Vancouver, and set in the context of interport competition for container traffic. Specific competitive aspects that are reviewed include the coupling of intermodal technologies with traditional spatial advantage, new infrastructural investment, and innovative marketing strategies employed by west coast port authorities. Particular attention is paid to the Canadian container traffic leakage to the American pacific northwest. By using secondary data sources, the size of container traffic leakage between the Seattle port region and the port of Vancouver is described. In turn, the difficulties of trying to measure Canadian container traffic leakage from existing data sources is briefly examined. In the end, it is suggested that the port of Vancouver is uniquely poised to gain a larger share of the Asian-North American container trade.

INTRODUCTION

Seattle/Tacoma[1] and Vancouver lie on opposite sides of a common border just 115 nautical miles from each other. Both ports are located on a portion of heavily crenulated coastline overdeepened by glacial action in successive ice ages. As a result, both cities are endowed with superior natural harbours and offer excellent port facilities conducive to international marine commerce on a year round basis.

Historically, the ports of Seattle and Vancouver have followed similar evolutionary paths. Functionally, the economic convergence of the two cities was influenced by their proximity and the export of a similar mix of commodities produced by their regional hinterlands. In addition, the 'Pacific Gateway' role performed by each city in the development of their national economies has, over time, been similar.



Figure 1. *Location of the ports of Seattle, Tacoma, and Vancouver.*

In the past two decades, the specialisms pursued by the ports of Seattle and Vancouver have diverged [1][2]. In an environment of borderless trade, changing intermodal transport technologies, and over-capacity within the Pacific shipping industry, Seattle has managed to become a formidable load centre which dominates the lucrative Pacific Northwest trade in container goods. This fact is readily confirmed; in 1990, Seattle enjoyed a six-fold container throughput advantage over the port of Vancouver (see Table 1).

Table 1. Container Throughput, Principal West Coast Ports 1985-1990, in '000s of TEU's

Year	Vancouver	Seattle	Oakland	L.A.	Long Beach	Portland	All Ports
1985	178	1,127	856	1,104	1,444	111	4820
1986	223	1,517	900	1,325	1,394	125	5484
1987	281	1,723	925	1,580	1,460	140	6109
1988	305	1,806	1,000	1,660	1,528	165	6464
1989	305	1,966	1,070	2,057	1,575	184	7157
1990	317	2,013	1,134	2,036	1,610	202	7315
Throughput Five-Year Total	1,612	10,152	5,885	9,762	9,011	927	37,349
Average	269	1,692	981	1,627	1,502	155	6,225

Note: Throughput for Vancouver in 1991 was 384 thousand TEU's. The figure for Seattle includes Tacoma.

Seattle's ascendancy as a load centre dates to the early 1970s, when it consolidated its traditional advantages over other Pacific Northwest ports and began to compete with the ports of California. By definition, load centres are points in space where all of the transportation modes associated with intermodal movement become focused. Besides Seattle, two other west coast container ports - Los Angeles, and Long Beach - have come to represent 3 of the 5 busiest container ports in North America. On the Atlantic coast of North America, the only city that handles comparable levels of containerized cargo is New York-New Jersey port region. In the presence of North America's container port giants, the port of Vancouver can only be described as a small player, whose competitive entry into the container scene has been characterized as tardy [2].

Table 2. Average per Annum Change in TEU Throughput at Principal West Coast Ports, 1986-1990 (Years where port growth exceeded group mean are in bold)

Year	Vancouver	Seattle	Oakland	L.A.	Long Beach	Portland	Mean
1986	**25**	**35**	5	**20**	(3)	**13**	**14**
1987	**26**	**14**	3	**19**	5	**12**	**11**
1988	9	5	8	5	5	**18**	6
1989	0	9	7	**24**	3	**12**	**11**
1990	5	2	6	(1)	2	**10**	2
Average	12.9	12.9	5.8	13.4	2.2	12.8	8.8

The figure for 'Seattle includes Tacoma.

SEATTLE

In the case of Seattle, the port vies with Los Angeles and Long Beach for first containership port of call status on the North American west coast. Historically, Seattle developed as a first port of call in the 1960s, after pioneering the idea of freight consolidation as a strategy meant to offset locational and agglomeration advantages enjoyed by Southern California ports (see Table 3). The pooling of cargo led to competitive rates on rail transport to the American industrial heartland, providing an overall transport cost advantage to Seattle [3].

Table 3. Historic Call Rotation of West Coast Ports

Port City	Import or Export Orientation	Port of Call Status
Los Angeles	Import	First
Long Beach	Import	First
Oakland	Export	Last
Portland	Export	Last
Seattle/Tacoma	Import	First
Vancouver	Export	Last

As a regional load centre, Seattle built on its initial intermodal advantages, and developed minibridge services to the U.S. midwest and Atlantic coast cities during the 1980s. Vancouver, Portland and Oakland did not challenge Seattle's role as an intermodal nexus, given the latter's superior inland rail connections and dockside services [3]. For Seattle, the initial development of a healthy mix of inbound and outbound high value container traffic has served to entrench the city's position as a first port of call.

Table 4. Share of TEU Throughput, Principal West Coast Ports 1985-1990, by Percent
(Note: Year over year gains are underlined)

Year	Vancouver	Seattle	Oakland	L.A.	Long Beach	Portland	All Ports
1985	3.7	23.4	17.8	22.9	30.0	2.3	100.0
1986	4.1	27.7	16.4	24.2	25.4	2.3	--
1987	4.6	28.2	15.1	25.9	23.9	2.3	--
1988	4.7	27.9	15.5	25.7	23.6	2.6	--
1989	4.3	27.5	15.0	28.7	22.0	2.6	--
1990	4.4	27.5	15.5	27.8	22.0	2.8	--
Average	4.3	27.0	15.9	25.9	24.5	2.5	

The figure for Seattle includes Tacoma

The success of Seattle as a load centre has not been achieved without some penalties. Most notably, Seattle is physically constrained, and the inability to meet burgeoning container traffic demands led to diseconomies of scale in the mid-1980s [2]. Thus, Tacoma benefitted from Seattle's congestion, and managed to induce Sea-Land and

Maersk container lines to relocate by extending lower regional rail rates, cheaper container terminal charges, and reduced drayage (*eg.* dockside handling) costs [2]. In this paper, the issue of internal competition in Puget Sound is avoided, as both ports are treated as a common threat to Vancouver's future as a load centre.

VANCOUVER

For Vancouver, the long term competitiveness of the port as a loadcentre is shaped by four key forces; borderless economics, the impact of new transport technologies, trade liberalization, and the proximity of the Seattle port region. It is a truism that the viability of any container port is dictated by the size and range of the market it serves and the potential for achieving economies of scale within this environment.

To create a self-sustaining container export flow, a minimum demand would include performing a distributive role for a highly diversified, spatially diffuse manufacturing base. As a nation characterized by a thin ecumene and highly focused manufacturing belt, Canada lacks the basic pre-requisites for generating a viable export trade in high value containerized goods. This contention is borne out by existing Canadian containerized exports which are made up of bulk commodities; one 20 foot Canadian container typically weighs as much as a 40 foot American container [4].

On the import side, Vancouver has traditionally lacked the presence of a large domestic population capable of consuming large volumes of containerized goods. As an export oriented port, Vancouver's overall success relies on strong demand for unfinished bulk commodities on the global marketplace (see Table 5). Because of the high weight and low value of bulk commodities, Vancouver has had difficulty capturing container traffic. Taken together, these two basic constraints have impeded container trade growth at Vancouver. By contrast, Seattle, with a large domestic population and a steady export trade, can be described as having a circulation geography that is conducive to the transport of container traffic.

Table 5. Ten Largest Import and Export Markets of the Port of Vancouver, 1990.

NATION	bulk arrivals	NATION	bulk departures	NATION	container arrivals	NATION	container departures
U.S Pac.	1607	Japan	22433	Japan	344	Japan	810
Togo	760	S.Korea	6573	Taiwan	170	S. Korea	254
Japan	535	P.R.C.	3661	Hong Kong	141	Cameroon	147
Mexico	307	U.S Pac.	2490	S. Korea	92	U.S Pac.	107
U.S. At/Gulf	171	Taiwan	1879	F.R.G.	37	P.R.C.	90
U.S. Alaska	138	U.K.	1834	Netherlands	31	Australia	70
Australia	131	Brazil	1572	Italy	29	Iraq	49
Spain	122	C.I.S.	1567	France	29	U.K.	45
Brazil	97	Australia	1189	U.K.	17	Taiwan	29
Total	3868		43199		889		1603
Market %	87		77		90		84

Source: Statistics Canada Marine Database. Figures are in '000s tonnes.

Given these limitations, it has been suggested that the chances of capturing larger shares of international container traffic at the port of Vancouver were slight. However, the ability of the Vancouver to gain access to the large American market under the Free Trade Agreement should help the port gain a larger share of containerized goods produced wholly in the United States or Canada for export abroad. Unfortunately, the Free Trade Agreement does not provide any incentive for Asian shippers to use Vancouver as a distributive node for servicing the United States. Because no value can be added to finished Asian exports, the rules of origin clause in the Free Trade Agreement prevents preferential tariff treatment available to goods manufactured in North America [5]. Estimates suggest that one-third of Asian-Canadian container trade is conducted through American loadcentres serving as distributional nodes for the whole Canadian market. In the long term, these practices threaten to relegate Canada's only full-service west coast port to feeder port status.

North America's West Coast: Land of Intervening Opportunities

As a functional abstraction, the west coast region represents a collection of vertices and nodes with a compact geometry. In reality, the west coast of North America can be described as an assembly of related cities, each having several transportation linkages that connect each city nationally and globally.

Among the six largest cities with good harbour facilities along the west coast (Table 3 above), any one could support intermodal operations capable of servicing the entire North American market for several Asia-Pacific container liners. Factors which prevent this from happening include between port competition, and circumscribed port facilities. In effect, the west coast ports presented in Table 3 each exert locational and administrative influences over one another. In isolation, each city represents a part of a common west coast spatial structure.

Besides being the only Canadian loadcentre on the west coast, the port of Vancouver is also furthest from the epicentre of west coast shipping activity. Thus, Vancouver finds itself in a position of mixed market opportunities. As a peripheral player, Vancouver would not benefit from a smooth attenuation of shipping activity along the length of the west coast.

Fortunately, containerized shipping activity does not decay at a constant rate along the length of the west coast. Instead, there are pockets of port activity - spread effects - that exceed what local markets might be expected to sustain. Therefore, Vancouver's proximity to Seattle and Tacoma enhances its ability to benefit from container industry spread effects and economies of agglomeration. Moreover, the port of Vancouver, lying outside the jurisdiction of the other west coast ports, can couple its spatial advantages with innovations in transport technology (so-called seamless intermodal transfer) and administrative efficiencies (electronic data interchange and minimal customs disruption). As a region characterised by several attractive port opportunities, the port of Vancouver has to make every locational advantage counts.

Container Leakage

The success of Seattle as a port region has had a demonstrable effect on the growth of other Pacific Northwest ports, including Vancouver. To Vancouver's detriment, Seattle has managed to capture diverted Canadian container cargo that might otherwise have been handled in Canada. Conversely, Vancouver has not offset the loss of Canadian container traffic transhipped via Seattle by diverting American sourced or destined cargo.

In the early 1980s, the issue of port competitiveness was addressed by the Economic Council of Canada:

> The vital importance of B.C. ports to Canada's trade with the Pacific Rim requires that continuing attention be paid to adequate port facilities, infrastructure, and operating conditions [6].

While the ability of the Seattle port region to divert Canadian container trade is well known, the level of container cargo leakage is difficult to verify empirically. At best, existing data sources available at Statistics Canada use manifest and customs documents to provide detailed coverage of a wide range of international and domestic commodity movements by ship. Unfortunately, attempting to determine leakage levels by using this database is very difficult, as it does not provide coverage of the movement of Canadian container traffic across transport modes. Besides linking data elements covering other transport modes by an as yet unwritten series of algorithms, only one potential sources of information which might track Canadian container leakage exists. The privately operated PIERS system (Port Import and Export Reporting Service) provides expensive tabulations based on manifest information compiled at 62 seaports across the United States [7]. Besides PIERS, the United States Bureau of the Census does measure Canadian marine import data by reciprocal agreement with Statistics Canada, it does not cover Canadian containerized goods moving intermodally or in bond across the United States.

Secondary Evidence

Given a dearth of primary data sources, it becomes necessary to use secondary evidence of Canadian container traffic leakage to examine Canadian container leakage. Understandably, the reliability of secondary data sources cannot be easily verified. Specifically, no sense of how much 'educated guesswork'(imputation), or port boosterism underlies a published statistic is conveyed to the user of the statistic; rather, container leakage figures are presented without substantiation. Despite this, published figures provided by the Canada Ports Corporation estimate that nationally, the diversion of Canadian container traffic via the western U.S. minibridge system is offset by the capture of eastern American container trade transhipped at the port of Montréal. In 1990, the volume of American container trade diverted to Montréal was estimated as being between 250 and 300 thousand TEU's [8]. Whatever the extent of the leakage problem really is, the aggregate picture suggests that between na

container leakage occurs, and that regional leakage inequalities are not well documented.

For the port of Vancouver, the effect of container traffic diversion is felt more immediately than at any other Canadian port. Estimates suggest that some 270 thousand TEU's (2.2 million tonnes) of Canadian containerized trade was handled via the United States western minibridge system in 1990 [8]. Of this diverted Canadian traffic, four-fifths of the captured benefit is thought to have been captured by ports in the U.S. Pacific Northwest [8]. In turn, the majority of leaked benefit (upwards of four-fifths of the total) is thought to have accrued to the Seattle port region. Reflecting global trade patterns, nine-tenths of the diverted Canadian west coast container traffic is thought to have been sourced or bound for the Asia Pacific region.

VANCOUVER'S VIABILITY IN THE 1990'S: CANADIAN DOUBLE STACK SERVICE

Besides improving the state of container market monitoring, long term container growth at the port of Vancouver will depend on the port's ability to shed its image as a final port of call. In early 1992, two large marine carriers, China Ocean Shipping Company and the European consortium CGM (made up of Hapag-Lloyd, Générale Maritime et Financiere, Atlantic Container Lines, and Nedlloyd Lines), increased the Port of Vancouver's profile by adding capacity and conferring first port of call status on the Canadian city [8] [9]. Enticing carriers away from traditional port of call rotations is not an easy achievement. One aspect of the port of Vancouver's marketing strategy included offering shippers rate inducements for making the port of Vancouver their first port of call [10]. However, the key factor involved in enticing container shippers to Vancouver is the provision of double stack rail service between Vancouver and eastern North America.

At dockside, the ports of Vancouver and Seattle both offer shippers so-called six over one container stacking service, with lifting capabilities that exceed the needs of the largest post-Panamax vessels. While onload efficiency is important to containership operations, offloading requires a smooth ship to shore transfer. At both Vancouver and Seattle, double stack rail service enables standard twenty and forty foot equivalent container units to be stacked one atop the other, on a railroad flatcar at dockside. After leaving the dockside railyard, containerized goods moving in this high cube configuration provide shippers with twice the inland cargo movement capacity for a slight increase in labour and fuel costs [11]. Thus, double stacking results in new economies of scale, particularly on long-haul or high density routes. According to some studies, double stacking generates a savings of nearly half per container-kilometre versus movements by truck [12].

Because of the rugged physical geography of British Columbia, the initial cost of building an all-Canadian double stack rail system is very high. From this perspective, infrastructural investment involves lifting bridges for clearance requirements, new tunnel expansion projects at the eastern and western ends of the journey, and railyard expansion at dockside in Vancouver and at inland industrial loadcentres [13].

Despite these infrastructural costs, both CP and CN have commenced reliable and efficient double stack service between Vancouver and the North American industrial heartland. Canadian National has gone so far as to customize its schedule to suit individual carrier needs. Thus, Orient Overseas Container Lines demanded, and received, double stack service to the Canadian heartland [14]. At Canadian Pacific, the use of the spine car was abandoned in favour of proven double stack technology, with container trains routed via CP's Soo subsidiary line terminating at Chicago [15]. From there, the massive Vaughn inland container yards, just north of Toronto, unload inbound and reload outbound container traffic. Eastbound transit time for the CP service is a very competitive 72 hours [16].

Minibridging Versus the Panama Canal Option

Currently, the double stack railcar maintains an economic balance with the largest containerships still using the Panama Canal as a transport route. To maximize economies of scale, containerships will continue to grow; hence, the appearance of the post-Panamax vessel. Inevitably, post-Panamax vessels will become the container ship standard in the 21st century; barring the revival of Nicaraguan Canal schemes or the expansion of the Panama Canal system, shippers will expand their use of land-based bridging systems. Evidence that this scenario is well under way is suggested by the magnitude of Pacific to Atlantic movement by intermodal bridging; in 1990, west to east flow was nearly 10 times that of the reverse flow.

Rail intermodalism is the driving force behind new patterns in ocean shipping, with entire trains dedicated to serving only container load centres. With the growth of post-Panamax container shipping, double stack rail connection will focus on fewer load centres. For the port of Vancouver, the co-operative pursuit of superior double stack infrastructure can lead to faster handling times for post Panamax containerships. Because of the negative effect that time spent idling in port represents to these vessels, the integration of intermodal services at Vancouver is critical to port competitiveness [17].

International Sea-Air Linkage, SeaTac and Vancouver

Sea-air linkage is a small, but lucrative trade that is growing at a rapid pace. In Vancouver, sea-air container traffic has increased about 70 percent since Canada Customs changed its freight sufferance rule, which held that freight forwarders couldn't take containers to warehouses for destuffing within 80 kilometres of Vancouver [6] [18]. Sea-air linkage seeks to reduce the transit time of high value items -electronics - exported from Asia to North America from 30 days to half that. Thus, a portion of the sea voyage is replaced by an air link, resulting in shipping costs that are about 50% cheaper than all air shipments. Canada Customs sufferance warehouse licensing policy for freight forwarders (see above). Some estimates place sea-air volumes moving through the Sea-Tac complex at 30,000 tonnes in 1988, compared to Vancouver's 10,000 tonnes. Like rail intermodal movements, sea-air movement is difficult to monitor. The challenge becomes how to measure this high-

value, low coverage area.

Vancouver offers sea-air intermodal the following advantages:

- Superior air connections to Europe compared to Seatac.
- New runway capacity which will allow Vancouver to handle the largest wide-body aircraft technology currently in use or development
- Proven ability to divert sea-air cargo for uplift from Seattle; increased tonnage uplifts result in economies of scale. [18]

TRANSPACIFIC CONTAINER RATES AND OVERCAPACITY

One prominent feature of the Pacific basin container market is its chronic overcapacity. With too many shippers chasing too few goods, the development of backhaul economies and low overall handling costs at loadcentres is important. In the 1980s, attempts were made to control the supply of containership capacity available on the Pacific market. The most notable cartel, the *Transpacific Stabilization Pact*, has 12 signatories who monitor capacity and set price levels for the industry. In 1987, these 12 carriers accounted 10 of the twenty largest container carriers in the world. Of the ten Transpacific Stabilization Pact signatories who are among the top twenty global container operators, some 603 thousand TEU's were under their control in the late 1980's. This figure amounts to one-fifth of the total capacity of the world's containership fleet [19] [20].

Among west coast ports, both Long Beach and Vancouver have openly acknowledged the negative effects of moves towards lowering capacity among Pacific Basin container lines [21]. Currently, estimates of container ship over-capacity on the Pacific are placed at between 25 and 35 percent. As such, competition between west coast loadcentres will continue to be fierce, as container lines try to find ways to control their costs [22].

INTANGIBLES

Three administrative practises currently impede the ability of the port of Vancouver to compete more effectively with the Seattle port region.

- Destuffing

The practise of destuffing, which insists that containerized movements shared among several consignees must be unloaded at dockside unnecessarily impedes the smooth circulation of container traffic. At Vancouver, the destuffing rule applies within a radius of 80 kilometres of the port. Thus, each of the container facilities of Lynnterm, Vanterm, and Centerm are prone to the effects of this rule.

- Local Tax Base

Unlike the ports of Seattle and Tacoma, the port of Vancouver cannot levy a port development or maintenance tax on the regional population. Despite the benefits that the port of Vancouver bestows on the regional economy, its sole source of revenue is from operations. As a result, Seattle and Tacoma are less likely to face the same impediments for raising capital to improve port infrastructure [16].

- Threat of Cost Recovery

In the mid-1980s, the Federal Government considered the implementation of a cost recovery program for navigational services extended to vessels by the Canadian Coast Guard. Under the proposed formulation of chargeable fees, each tonne of cargo travelling a nautical mile of Canadian water with coast guard assistance would be charged according to the value of goods carried [14]. Containerized cargo, as a high value shipment, would be charged at the rate of 0.16¢ tonne/kilometre (four times the rate of bulk cargo). For the port of Vancouver, with 110 nautical miles of chargeable distance in each direction, the toll on a fully loaded post-Panamax container might be enough to divert container traffic south of the border.

- Container Handling Charges

Recently, the Vancouver Port Corporation began to levy charges on a per length basis with one rate applying to containers measuring 40ft or longer, and a separate rat for containers less than 40ft. Lower rates are also now applied to containers carrying export cargoes - and charges apply only to loaded containers [14]. By charging a lower price for empty containers and export cargo, the port of Vancouver is actively participating in the development of backhaul economies.

- Computainer

Earls Industries, a Vancouver-based engineering firm, unveiled a high-bay warehouse lift and store system that it has dubbed Computainer. The computainer system would accommodate up to 2000 forty foot containers at a given time, in a structure that is 45m high by 137m long by 61m wide (370,000 m^3 of enclosed space), with 8 drive through lanes for handling truck traffic [23]. While the computainer project has been put on hold by the Vancouver Port Corporation, such a system would offer enormous gains in the efficient use of space - 1500 TEU's per acre compared to about 300 TEU's per acre at present - at a port with limited container expansion space. Besides computainer, the development of new container handling facilities at Robert's Bank, an offshore bulk loading facility, represents the only other container expansion alternative currently receiving consideration by the Vancouver Port Corporation.

CONCLUSIONS

The port of Vancouver is uniquely poised to capture a larger share of the Asia-North

America container trade. By exercising its traditional locational advantages and offering shippers efficient intermodal access to the North American industrial heartland, the port of Vancouver should begin to redress the problem of Canadian container cargo leakage to the U.S. west coast. As a port city, Vancouver is notable for its proximity to Asia, fast access times to the whole North American market, and containerized shipping services that are comparable to other west coast ports. As North America's busiest port, Vancouver offers container shippers proven backhaul economies by rail. By lowering export handling charges, the port of Vancouver has created an opportunity for shippers to containerize specialty grains, foodstuffs, and manufactured goods produced in the North American interior. In the near future, the port of Vancouver will have to overcome several administrative irritants that impede its ability to aggressively pursue Asia-Pacific container trade from an equivalent competitive position. If unfettered access to the American marketplace can be retained, the port of Vancouver is capable of providing the entrepreneurial drive and infrastructural support needed to achieve full-fledged loadcentre status.

NOTES

1. For comparative ease, the ports of Seattle and Tacoma are combined and presented as one continuous port region termed 'Seattle'. Similarly, 'Vancouver' includes traffic at the ports of Vancouver and New Westminster.
In Tables 1, 2, and 4, data for the port of Vancouver are from *Statistics Canada* and the *Vancouver Port Corporation.* Data for all other ports were compiled from various the following sources: 1. *Containerisation International,* various issues from 1987 through 1990. 2. *Port Development International,* January/February 1991. 3. The Port of Vancouver News, 1989 vol. 13 no. 2 and 1990 vol. 14 no. 2.

In Table 3, information was gathered from *Containerisation International Yearbooks,* 1985-1990, and Smith, D.S., Port Planning for Intermodal Growth, *Journal of Transportation Research Forum,* 22(2), 1989. Port of call status is based on import/export orientation between 1985 and 1990.

REFERENCES

1) Yeates, Maurice and Barry Garner *The North American City.* New York: Harper and Row, 1980.
2) White, C. Langdon, E.J. Foscue and T.L. McKnight *Regional Geography of Anglo-America.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1985.
3) Hershman, M.J. (ed.) *Urban Ports and Harbor Management: Responding to Change Along U.S. Waterfronts.* New York: Taylor & Francis, 1988.
4) Nix, Fred P. Potential Impact on Canada of New Container Standards, *Transportation Research Forum,* Vol. 31, No. 1, 1990, pp. 109-118.
5) *Pacific Shipper,* Vol. 65, No. 44, p. 46.
6) Economic Council of Canada *Western Transition.* Ottawa: Ministry of Supply and Services, 1984.

7) PIERS/Journal of Commerce *Vessel Manifests in the European Maritime Trades*, April, 1991.
8) *Seaports and Shipping World*, February, 1992.
9) *Seaports and Shipping World*, September 1991.
10) *Harbour and Shipping*, April, 1992.
11) Ircha, M.C. Canadian Container Ports: Shipping Trends and Policy Issues, *Canadian Public Administration*, Vol. 31, No. 1, 1988.
12) Chadwin, Mark L., James A. Pope, and Wayne K. Tally *Ocean Container Transportation: An Operational Perspective*. New York: Taylor and Francis, 1990.
13) Containers at the Crossroads *Port of Vancouver News*, Vol. 13, No. 2, 1989, p. 5.
14) Vancouver on the Attack *Port Development International*, Vol. 7, No. 3, 1991.
15) Competing for the Long Haul *Port of Vancouver News*, Vol. 14, No. 4, 1990. p. 8.
16) Vancouver's Box Gamble *Port Development International*, Vol. 6, No. 4, 1990.
17) Archambault, Michel Intermodalism and Liner Shipping Intermodal Approaches, *Transportation Practitioners Journal*, Vol. 56, No. 2, 1989. pp. 151-163.
18) Sea-Air Shipping: Vancouver's Ship Comes In, *Transportation Business*, Vol. 10, No. 2, pp. 11-12.
19) Asian Carriers Dominate Top 20 Rankings *Containerisation International*, November, 1987.various issues from 1987 through 1990.
20) Transpacific Stabilization Pact Sets Rate and Capacity Goals for Coming Year, *Pacific Shipper*, Vol. 66, No. 44, 1991. p. 50.
21) Whose Cut of the Double Stack Deck?, *Port Development International*, Vol. 5, No. 4, 1989. p. 20.
22) *American Shipper*, Vol. 29, No. 6, 1987. pp. 34-35.
23) Now Computainer, *Ports Development International*, Vol. 7, No. 3, 1991.

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INTERNATIONAL COMPETITIVENESS—ASSESSING AND EXPLOITING COMPETITIVE ADVANTAGE BY OCEAN CONTAINER CARRIERS

by

Mary R. Brooks*

Introduction

Container shipping is a mature but not yet declining global service industry.[1] The profitability of the industry can hardly be described as attractive. Of the last ten years on the North Atlantic, for example, in only two have most carriers done well. The trans-pacific has been plagued by overcapacity and low rates as well. Although carriers often possess an optimism about what the future will hold, the return on investment is questionable, with transport entities in general not matching the returns possible from manufacturing. Most carriers know that this is cyclical business in which one has to make money when possible and have deep pockets the rest of the time. In order to meet the demand for international trade, there must be transport in some form.

The competitive pressures of the past several years and the current recession have triggered a re-examination of competitive strategy by most container carriers. As an industry matures, its offerings tend to be viewed more homogeneously by its customers and cost leadership is the strategy desired by many but which can only be acquired by a few. The same is happening in the ocean container transport industry. Dealing with the perception of homogeneity is the focal point of many carriers' current activities and the strategies being discussed are service differentiation and total quality management. But will these and other efforts provide a carrier with a firm-specific competitive advantage which is also sustainable? This paper provides an examination of the sources of competitive advantage for firms within the industry and further describes how these sources may be used by carriers to ensure survival in the coming decade.

An Industry Analysis

Before firms can identify potential sources of competitive advantage or disadvantage, they need to develop a deep understanding of the industry in which they operate and the trends within that industry. This section provides a brief summary of the industry and its environment using a framework based on Porter's five competitive forces—the entry of new competitors, the threat of substitutes, rivalry among competitors, the bargaining power of buyers, and the bargaining power of suppliers.[2]

The threat of entry of new competitors

Ever since the 1870s and the formation of the first liner shipping conference[3] on the UK/Calcutta trade, the existence of shipping conferences has served to limit capacity and raise the barriers to entry. Typically carriers who wished to enter the market quickly (the only way to get in given the capital investment) usually entered as a non-

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conference operator and then, once established, were co-opted into the conference to stabilize rates at a higher level, leaving the market susceptible to a new low priced entrant. Since the promulgation of the US *Shipping Act of 1984*, service contracts and independent action have further eroded the power of conferences to establish the premium rates needed to ensure the continuing long-term profitability of conference operators. Now carriers may increase capacity on a particular route to act as a barrier to entry or as a pre-emptive grasp for market share.

The largest barrier to entry is the requirement for matched or nearly matched ships in order to serve a particular route. In early 1990, a medium-sized container ship cost upwards of US$50 million at a Far East shipyard. As it may require three or four similar ships to adequately service a particular route structure, the capital cost of providing this injection of capacity is both lumpy and massive, leading to the growth of slot charters and other strategic alliances in the industry over the past several years. In addition, the specialization of the asset (container ship) serves as a barrier to exit. There is a saying in the industry that, "Every carrier has the right of entry and the right to go bankrupt."

Some carriers can boast of being in the shipping business since the days of sail and, over the years, have developed strong customer relationships, which can also serve as a barrier to entry. However, many carriers can no longer rely on these relationships as, increasingly, shippers view the old lines as stodgy and, in seeking competitive advantage for themselves, are will willingly try a new carrier showing a fresh modern face thereby leaving the industry more exposed to the threat of new competitors.

The threat of substitutes

The conference structure initially meant that the buyer had few, if any, price options if a high quality service was desired. Buyers now are finding it increasingly difficult to perceive the differences between conference and non-conference carriers—they switch to non-conference operators for price reasons and then often comment that the service differences are insufficient to encourage their return. Some buyers view the container transport services available on the major trade routes to be homogeneous.

Although switching costs for buyers are low, the routine nature of the purchase, however, makes it easy for carriers to benefit from buyer complacency. In cases where the value of the goods is quite high, shippers have often shown that they prefer to deal with the known operator rather than risk shipping with an unknown one. Carriers too have become complacent in good markets but, in the past few years, they have lost market share to air cargo at the high value end and, in the case of coastal routes, to modal switching at the low end. In the early 1980s, interest rates and the cost of capital increased the buyer's predilection for evaluating the carrying costs associated with inventory in transit in assessing supply options and these costs have contributed to tremendous growth in the air cargo industry. Air's share of total trade moved in 1985 was 13.7% and is forecasted to be 18.2% by the year 2000.[4] Additional development of sea-air links expected in the near future will further erode the top end of the ocean container market.

In addition, carrying costs led to the growing importance of transit time as a criterion by which carriers were judged and, ultimately, to the competitive necessity of acceptable transit times by container carriers by the end of the 1980s.[5] Once minimum standards are met, there is little incentive for buyers to use one carrier over another—whichever ones are convenient to use (this is a phone and facsimile business) will get a share of the business. Splitting business over a number of carriers is one way in which shippers diversify their risk, and further evidence of the homogeneity of the container

shipping market. It also provides a partial explanation of the intense rivalry between carriers in the industry.

Rivalry among competitors

The conference structure exists to limit rate-based, and in some cases capacity-based, competition. The presence of non-conference operators on a route raises the level of rivalry to one which can only be described as intense. The high barriers to exit lag capacity reduction and leave the industry in an almost perpetual state of capacity oversupply. Even among conference members and those participating in slot charters and other equipment or ship-sharing alliances, the competition is extremely healthy in spite of mutual dependency,[6] and made even more so by poor buyer loyalty and the diverse cultural backgrounds of the participants. Over the past several years, new forms of strategic alliance have developed—equipment- and chassis-sharing agreements, joint marketing entities, and so on—to complement the range of co-operative agreements previously existing, such as slot charters and consortia. However, allegiance to one's partners in this industry seldom runs deep and competition intensity is very high. The capital investment required to support EDI development or vertical integration will encourage greater cooperation on some routes and between some carriers in future.

The bargaining power of buyers

The strength of the buyer in any negotiation with a carrier is related to the route and the volume on it. Where significant cargo imbalances exist, buyers on the well-utilized leg have less clout. Where significant excess capacity exists, buyers have more power. Some buyers are blessed with a strong position even in an intense market; they have enough volume in fact that carriers may give away value-added services to retain their custom. Most carriers would prefer to service the large shippers and freight forwarders rather than to take the effort required to service small buyers; many carriers believe that their margins cannot support servicing this segment of the market leaving a large number of buyers with little if any clout.

Buyer power is also product-specific as most carriers operate on a commodity-based tariff rating system. Large volume buyers shipping high value goods are better able to protect shipment space while, at the other end of the continuum, small shippers of relatively low value goods are often shut out. For example, New Brunswick peat moss producers shipping into Europe are often shut-out as the Canada-Europe eastbound leg is close to capacity and carriers will make room for a higher revenue product at the expense of the low-rated peat moss. On the other hand European shippers of low value goods have little difficulty finding space westbound.

The bargaining power of suppliers

For the carrier, the power of the suppliers of ships, fuel, labour, capital, ship management services and flags of registry have been critical in the past to securing temporary competitive advantage. The sorry state of the shipbuilding industry throughout the early 1980s dampened prices for new vessels. Lack of differentiation in bunker fuel has led to fuel hedging as a means of cutting cost inputs but this alternative is available to all carriers in scheduled service and so becomes a competitive necessity for all but those with expertise in fuel price forecasting. On the labour side, the supply of seafarers has been likened to a "Dutch Auction" for those carriers buying on cost, although this situation is changing; the carrier that wants quality seafarers to protect its investment in the ship, as is more common in this end of the shipping business, is facing a growing shortage of well-trained seafarers.[7] None of these factors has been able to provide a sustainable cost advantage for the carrier because the advantage is

easily replicated by a competitor. The same can be said of efforts to secure lower costs through reflagging; the cost advantages of a flag of convenience as easily exploited by other carriers and are therefore short-lived and not sustainable in the face of intense competition. The power of suppliers is limited, except in the area of inland transport.

The provision of land-based elements in the international door-to-door movement of goods is one area where not all container carriers have equal access to supply inputs. In many instances, ocean carriers have vertically integrated into land-based activities in search of competitive advantage through control of the door-to-door service. Where inputs are sought through negotiation, the bargaining power of the trucking and rail transport industries varies widely throughout the world; in some cases the carrier holds the balance of power while in others it is the inland transport operator. One might speculate that the reason for so many strategic alliances in this area is because the power is often balanced and both parties can benefit from the arrangement.

Sources of Competitive Advantage

> *Competitive advantage grows fundamentally out of value a firm is able to create for its buyers that exceeds the firm's cost of creating it.*[8]

With this philosophy in mind, this section will examine where container carriers can find firm-specific competitive advantage by examining their strengths in context with today's market and industry environment.

Cost containment and asset utilization

Facilities, ships, labour, equipment, flag of registry, as seen from the previous discussion, all offer the potential for some cost savings. Of these, however, ships and equipment offer the greatest opportunity for cost leadership as the others, for the most part have already been fully exploited. The quest for the lowest slot cost[9] through new orders from subsidized yards has led to a massive infusion of new ships which carry more TEU and use less fuel. However, with the rising price of ships at source in the late 1980s, this opportunity has faded. Further advantage is possible by rationalizing ports of call and careful attention to asset utilization, both in terms of vessel deployment and container deployment.

This attention to slot costs has also led to the increased use of slot charters,[10] the advantages of which are detailed in Exhibit 1. Technology also offers significant potential for improvement in asset utilization, with bar-coding and computer tracking, and for capacity management[11] in the next few years. The endurance of such advantages may be questionable depending on how easily they may be imitated by those with the capital to do so.

Services

The narrower the selection of equipment types, the cheaper the container supply element in the total cost profile of the company. On the other hand, some carriers' broad range of equipment available enables them to service niche customers with a premium priced product; for example temperature-controlled containers attract a premium over standard dry containers and can offer a profitable niche to carriers. Over the years, the core service available on the major container trade routes—North America/Europe, Europe/Far East and Far East/North America—has improved. On these routes weekly fixed day departures and fast transit times are a competitive necessity and carriers must now look to new ways to secure a competitive advantage. The result is increased interest in EDI and other value-added services as a means of

improving their ability to serve the customers in ways that meet the customers' needs. This is the area where differentiation efforts are focused and will be examined later.

Agency networks

Agency networks, in addition to serving as a barrier to entry, can provide the carrier with a major competitive advantage—customer service with a personal touch. Although this is largely a phone and facsimile business, buyers' loyalties are channeled to some degree by personal relationships, the depth of knowledge of the sales personnel and their efforts to solve the buyers' logistical problems. Both telephone and sales personnel are the carrier's primary contact with the customer; effective implementation of a service strategy and astute management of customer service elements can secure a competitive advantage which serves as a barrier to entry and which often can be sustained through a period of price-cutting, although seldom through one of deep discounting.

Exhibit 1
Cost Comparison Between Two Trans-Atlantic Service Alternatives

	Alternative "A"	Alternative "B"
Fleet	4 X 500 TEU	1 X 2,000 TEU
Annual Vessel Capital and Operating Costs	$14,100,000	$8,000,000
Annual Port Charges	$3,600,000	$1,800,000
Annual Fuel Consumption	$5,100,000	$1,810,000
Annual Total System Costs	$22,800,000	$11,300,000
Total Capacity Offered	52,000 TEU	52,000 TEU
Slot Cost Per Leg		
at 100% Utilization	$438	$223
at 85% Utilization	$515	$263

"A": 4, second hand, 500 TEU cellular vessels with a 28 day round-trip, an 8 year life expectancy. Price: $6 million each. Fuel consumption: 45T/day, at $90 /T.
"B": 1, new 2,000 TEU cellular vessel, with a 28 day round-trip, depreciated over 10 years. Price: $40 million for the ship. Fuel consumption: 70T/day, at $90/T.
Annual Interest Rate: 10%. All $ are US$.

Source: Louis J. LeGendre, Compagnie General Maritime, Presentation: "Partnerships in Liner Shipping: CGM–French Line's Perspective," Halifax, September 10, 1990.

Access to capital

Some ocean container carriers are part of a much larger diversified business entity. As the transport industry is not particularly noted for high returns on investment, the ability of some carriers to secure funding for expansion and service improvements from diversified parent companies provides them with a competitive advantage over pure transport entities. The international nature of the business also makes the shipping industry in general a target for companies desiring a venue for money laundering although, for the most part, this source of capital has steered clear of the major container trades preferring the greater anonymity possible in the tramp market.

Vertical integration into input supply

Control of the inland connection is one source of competitive advantage for carriers with access to capital. This is based on the premise that if a particular carrier controls the door-to-door move and does it well, then the buyer differentiates this service from

those offered by competitors. In the past decade, railways in North America and trucking companies in Europe have been the target of mergers or strategic alliances initiated by ocean carriers. In some cases carriers now have equity interests in stevedoring companies, port terminals, inland trucking or rail connections and even in forwarding and warehousing businesses.[12] For example, Nedlloyd has moved to gain greater control of their total service package by expanding into the business of port operations; through their control of stevedoring and Europe Combined Terminals they are seeking control of container operations at Europe's largest port, Rotterdam.[13]

Sources of Competitive Disadvantage

In addition to identifying its strengths and abilities in exploiting opportunities in order to determine possible sources of competitive advantage, each carrier must also explore its weaknesses and the threats it faces to ascertain the specific competitive disadvantages which must be overcome. Some of these disadvantages are temporary and may be overcome, the bleeding of managerial talent from the firm by competitors or more lucrative industries for example, while others may result in the eventual demise of the firm, as in the case of insufficient access to capital or the deterioration of route-related volume. Two specific competitive disadvantages which are problematic and, because they are not always recognized by the carrier, sometimes fatal are discussed below.

Loss of market identity

Today's container operators depend on brand awareness for consideration by shippers. The easily recognized logo of ACL or the CAST blue box remind shippers of their options. But, in seeing an ACL box in an advertisement, does the buyer know about or trust Compagnie General Maritime (CGM), one of the ACL partners prior to the restructuring of the consortium? Although CGM has been in the container transport market for a long time, it lost its market identity through its participation in the ACL consortium[14] and this was cited as one of the major reasons that CGM now, in partnership or alliance agreements, retains its own marketing structure.[15] The need to maintain a market identity for long-term success is one of the reasons why slot charters have been a popular means of market entry and reducing costs; the vessel actually used is not obvious but the identities of the sales representative and the booking agent are. The problem with slot charters is that they blur the identity of those carriers involved, and the carrier with the differentiated service may find that it has negotiated the advantage away to its competitors.

Service homogeneity

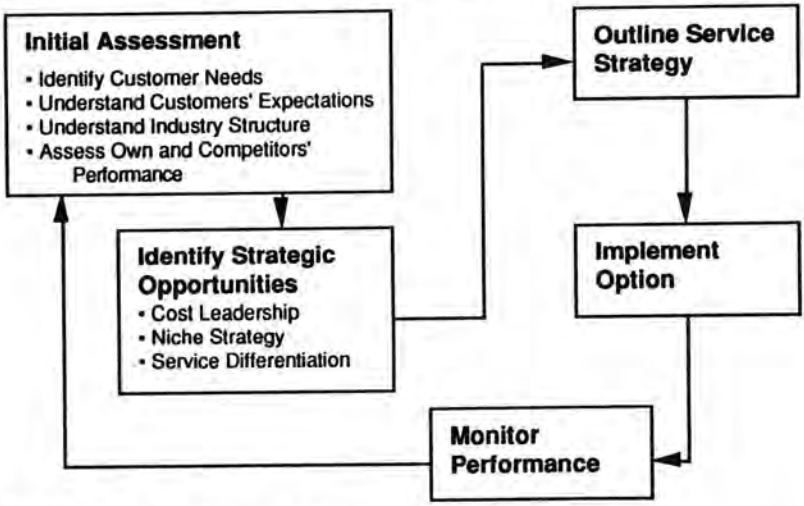
More than anything else, the buyer's perception that one carrier differs very little from the next is a major competitive disadvantage for many firms. Many shippers do not distinguish the performance of one carrier from another except on a few dimensions, which may or may not be determinants of choice. In a mature market, this usually leads to discount pricing—an option not available to members of a shipping conference except through independent action or service contracts. It is extremely tempting for conference carriers to respond to non-conference price-cutting by reducing terminal charges or other price elements in order to circumnavigate conference rules. The deep discounter intensifies industry rivalry and leaves carriers with less capital available for strategic initiatives which would exploit their competitive advantages and counter perceptions of service homogeneity.

The next section of the paper examines what strategies are available for carriers which wish to minimize their competitive disadvantages and maximize their advantages so as to seize the initiative and acquire a lead on their competitors.

Process for Identifying and Exploiting Advantage—A Company Specific Approach

The key to exploiting competitive advantage is knowledge—knowledge of the sources of such advantage, knowledge of the company's specific strengths and weaknesses, knowledge of the market and, most of all, knowledge of the company's performance vis-à-vis that of its competitors. Each carrier must map its competitive strengths and weaknesses, and align its performance capabilities with the customers' expectations. Once this initial assessment of the firm's position is undertaken, the firm needs to identify those strategies available to exploit the advantage the firm holds. The process is charted in Exhibit 2. While the first part of the paper focused on industry structure and the possible sources of competitive advantage a firm might identify from its initial assessment, the balance of the paper discusses the strategies available to the ocean container carrier which might be profitably exploited.

Exhibit 2
Identifying the Carrier-Specific Strategy



Strategies for Exploiting Competitive Advantage

Doz (1986) defines the multinational firm's strategic choices in terms of the corporation's control over and centralization or diffusion of decision-making responsibility; the three choices are (1) an *integration* strategy, (2) a *national responsiveness* strategy which allows autonomy at the national level or (3) a *multifocal* strategy, one in which the firm avoids a clear choice and combines the other two in an ad hoc way.[16] This approach offers little assistance in strategic planning for the ocean container transport firm as the mobility of its capital assets requires an integration strategy. Asset mobility is this industry's unique feature and precludes all but feeder operators (in markets

where cabotage is legislated) from considering the second strategy, and by default the third.

Noting that international ocean transport firms must follow an integrative approach, what other frameworks have been proposed as identifying suitable strategies? Bhide (1986) notes that service firms have considerable difficulty in developing service strategies which will provide sustainable competitive advantage.[17] He illustrates this premise with evidence collected from the financial services sector, one in which new products offered by innovating firms are quickly copied by competitors; he concludes that service firms, therefore, often only have one strategy—hustle, always being one step ahead of the competitor in innovative service offerings. Perhaps the strategy of hustle is appropriate but are customers always seeking some variation on the basic transport service? Or is it the excellent implementation of the strategy, the performance of the core service, that they really want? I suspect the latter.

Porter provides an excellent framework for examining the strategic choices available to today's container shipping firms.[18] His strategic choices are cost leadership, differentiation or focus strategies, with geographic focus as one type of niche strategy. It should be remembered that even if the ocean carrier formulates the best strategy, implementation will determine its success.

Cost leadership

Economies of scale, the quest for the lowest TEU slot cost through new ships purchased at the bottom of the cycle (or astute purchases of second-hand vessels or bottom-of-the-market charter fixtures), competitive interest rates or charter prices from parent companies can all offer short-term cost leadership potential. Some, like transfer prices or rates from parents or innovative capacity management, can offer long-term cost leadership. Moreover, some carriers seek cost advantages through investment in value-added cost reducing activities. For example,

> *Cost reductions are significant when integration permits major cost savings such as occurs when cargo booking and ship's manifest information can be transferred to connecting carriers and final consignee without re-keying. (Conservative estimates put labour savings at 8-10 percent while the National Industrial Transportation League in the U.S. has forecast savings in the order of 30 percent.)*[19]

A second example can be found when the effective of data about customers' shipments results in the development of a capacity management system which makes the most profitable use of the available capacity on offer. Such investment in technology, as implied in both examples, has two benefits—defraying costs and enabling the carrier to exploit the service benefits of such technology.

The problem with cost leadership is that only one firm can lead (or a few depending on the number operating on a route) and, according to Porter, the leader(s) must achieve "proximity" in the bases of differentiation.[20] Finding the capital to do both in the face of intense competition is difficult. But without that effort, the container transport industry will continue to have the problems so well-documented for other mature industries in a recent *Fortune* article.[21]

Niche Strategies

Niche strategies in this industry focus the firm's activities in its choice of geographic market or core service offering. Most niches tend to be geographic—developing a route that has insufficient volume to attract carriers looking for global domination on the main trades. The niche-seeking firm pursues domination of the route and the strategy can be

profitable as long as the niche is well-served. The greatest fear of the geographic niche player is that the profitability of the segment will attract attention leading to new entrants who might segment the market further.

Containerization developed because of the economies of scale possible by handling a standard unit on more than one mode. This standardization makes it hard to develop a niche strategy globally by means other than equipment choice. Even so, most carriers seeking to service this niche do so regionally rather than globally. As an example, ACL offers its North Atlantic customers a wide range of equipment and ro-ro service in addition to the standard container service available from its competitors. For shippers with an unusual product to be shipped or with a mix of cargo requiring a diverse range of equipment types, ACL is the natural choice. ACL has also opted for a regional rather than global position, and this strategy has sustained it through a number of years of losses on the route, losses often attributed in the 1980s more to its cumbersome consortium structure than its service.[22]

In Europe, CGM has also followed an equipment-focused niche strategy. It now has a large share of the over-the-road reefer business in its efforts to control more of the door-to-door move. The eventual strategy is intended to build up intermodal container operations in niches ignored by the bigger lines rushing for global domination.[23]

Equipment-based niche strategies have proven to be successful for some small and medium-sized carriers. Once the strategy has become established, buyer loyalty is generally stronger than found in the standard container market raising barriers to entrants who might consider segmenting the market further.

Service differentiation

The fundamental element in service differentiation is knowing what customers' want and what meets that expectation. It is not sufficient to ask them what they want; this must be assessed in conjunction with what they receive.[24] Lessons from the airlines' experience are not transferable—cargo and passengers are quite different in their demands of the system. Still ocean carriers need to identify possible service strategies by starting with their customers—shippers who book the container and the booking agent—the front line person who will ultimately sell the service to the customer. Once the needs and expectations of both the internal and external market are known, the shape of the carrier's particular service strategy can be explored and defined.

Some container transportation companies seek to integrate their distribution networks vertically in an effort to better meet emerging customer needs and achieve competitive advantage over rivals, either through expanded company owned networks or strategic alliances. These efforts may also include value-added services like warehousing, customs clearance, and other logistical support activities. Where door-to-door service once offered competitive advantage, the concept of a shelf-to-shelf service[25] strategy is now being explored by some carriers and door-to-door service has become a competitive necessity on all the major trade routes. It is how the firm implements its door-to-door strategy that holds the promise of competitive advantage.

Carrier-shipper alliances provide the opportunity for both parties to enhance their respective competitive advantages. Carriers who are willing to work as part of the shipper's team in servicing the shipper's customer will gain the benefits which flow from the shipper's competitive advantage. Carriers interested in pursuing these forms of partnerships are able to sustain this significant advantage in the face of excess capacity as this buyer sees the service as differentiated and is willing to pay a premium for it because it makes his/her company competitive globally.

In the era of globalization of markets and of Just-in-Time production and delivery systems, shippers competing globally must have highly integrated systems capable of rapidly moving cargo and instantly tracing shipments. Any firm that can take bookings electronically or trace cargo continuously has a competitive advantage over rival firms when seeking a shipper's patronage. Many carriers thus view Electronic Data Interchange (EDI) as the value-added service which will differentiate them from the others. But if too many carriers try to dominate this service segment, it will be the new battleground in the search for competitive advantage.

But while carriers search for such an advantage, rate wars are possible in the current marketplace. Porter warns that,

"A sustained period of price cutting can undermine differentiation."[26]

This raises the question about whether or not each firm will be able to capture the value created for its buyers through the development of a competitive advantage or whether this value will eventually be competed away. Many carriers have embarked on EDI systems to provide a value added service for customers as a differentiation strategy (that also should ultimately yield cost advantages as well). However, unless this system is easy to use, buyers will be inclined to reject the system as it moves some of the services purchased into their domain. In the past, the shipper called the carrier's agency office to make enquiries which were hopefully followed by a booking order. If they now must use a proprietary system, learning a different one for each carrier and typing in their own details, they will probably consider this an unacceptable division of labour. Far easier to fax or telephone a request and receive the paperwork from the carrier who has taken care of the details. This may mean that carriers will invest in EDI systems only to find that buyers want it supplied for free.

The establishment of in-house market development services with the capability of putting buyers and sellers together and thereby creating new business for the firm is another service strategy possible. The advantages of such a service bureau can only be measured in terms of the value it creates for the buyer and seller, value that may ultimately bypass the carrier once the buyer-seller relationship is cemented.

In contrast to cost leadership as a strategy, there can be many differentiators each with a unique base of service offering. There is room for more than one service leader if different segments of the market value different attributes and, in seeing a difference, shippers are willing to pay a premium for it. In the case of conference carriers not able to exploit niche strategies, differentiation must be the strategy of choice, as the conference rate tends to be the price ceiling on the route rather than the floor. With little room for price competition, each conference line must somehow distinguish itself or lose market share to those who can. And the service considered for differentiation must provide a unique advantage, not easily imitated, in order to ensure that the advantage created is not eroded in the short and medium term.

Sustaining Competitive Advantage

Ocean carriers look to the air carriers and see that Computer Reservation Systems (CRS) and Frequent Flyer Programs were innovations that initially promised sustainable competitive advantage. In addition, both paved the way for air carriers to manage demand and therefore minimize the need to alter capacity.[27] (In the liner shipping industry, the commodity tariff (pricing) system introduced by conferences in the 1800s served a similar purpose.) The benefit of both innovations was that, once eroded, they continued to be competitive necessities and thereby served as barriers to entry. Such advantages are enviously sought by ocean carriers but cargo does not much

care where it is located on the ship and so variations on these capacity management programs remain to be discovered, explored and, hopefully, exploited.

Cost leadership is difficult to sustain in this industry and has led to a number of firms being neither the lowest cost carrier nor the provider of a differentiated service. Experience has shown that the lowest cost per TEU slot is a short-lived position. Equipment tracking or deployment technology will eventually be imitated. The market currently differentiates the carriers only minimally, and tends to view them as homogeneous. Such homogeneity is deadly for conference operators, which have come under intense price pressure from non-conference operators, and face a credibility problem when they talk "quality" service.

Sustainability for the conference carrier requires a uniqueness which is difficult to imitate. Ghemawat (1986) identifies three categories of sustainable advantage—size in the targeted market, superior access to resources or customers, and restrictions on competitors' options.[28] Dominating a market niche is the strategy which is the most easily sustainable of all. In shipping, economies of scale in a geographic niche can be easier to establish as a sustainable advantage than economies on a global basis. The global carriers appear unable to retain position as leader in market share for long; they keep tripping over each other as they jockey for position.[29]

As for access, switching costs are low and so buyers' loyalty needs to be secured by other means. Efforts tend to be focused on ensuring that contestable advantages are not converted by competitors into competitive disadvantages. The majority of conference carriers at this time are flirting with two major initiatives which they hope to convert into sustainable competitive advantages—vertical integration or alliances to secure participation in inland transport and EDI systems to link themselves with their major customers.

The attraction of EDI is powerful. It offers the carrier the opportunity to build an integrated service, market and marketing, and competitor intelligence system, which will enable the firm to forecast trends and develop pre-emptive strategies in future.[30] The investment in EDI is substantial but, once in place and effective, like CRS will raise entry barriers. It enhances the firm's capability to differentiate service efforts, particularly if keyed to customer requirements and its information potential is exploited. Finally, if the system is placed in the hands of empowered and well-trained front-line staff, the service enhancement potential is very high.

Sustainability is clearly difficult in an industry demonstrating such cyclical profitability. There are two bright spots on the horizon—strategies aimed at dominating a niche and service differentiation. For those with access to capital and managerial skills in the operations areas, control of inland transport and hence the door-to-door operation through vertical integration or strategic alliance offers the opportunity to control service production. For those with access to the capital and marketing expertise, raising buyer's switching costs through proprietary EDI systems and/or carrier-shipper alliances with full monitoring systems are attractive strategies for service differentiation; both lead to carriers who are viewed by shippers as partners, and the loyalty engendered by instituting such a program(s) will provide the holy grail—sustainable competitive advantage.

References

1 As a global industry (meeting Porter's definition of global), it does not have the option of following any strategies focusing on national responsiveness; the nature of the industry renders these inappropriate for all but companies engaged in feeder services domestically, a minute sector of the

industry. (Porter, Michael E. (1986), *Competition in Global Industries*, Boston: Harvard Business School Press; p. 18.)

2 Porter, Michael E. (1980), *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, New York: The Free Press.

3 Conferences are voluntary associations of container lines which agree to abide by fixed rates for a particular trade route in order to stabilize service on the route. They normally require some form of government approval.

4 Sclar, Michael L. and David L. Blond (1991), "Air Cargo vs. Sea Cargo Trends," DRI/McGraw-Hill Conference *World Sea Trade Outlook*, London: 25 September.

5 Brooks, Mary R. (1990) "Ocean Carrier Selection Criteria in a New Environment," *The Logistics and Transportation Review*, Vol. 26, No. 4, p. 339-55.

6 Brooks, Mary R., Robert G. Blunden and Cheryl I. Bidgood (1993 forthcoming), "Strategic Alliances in the Global Container Transport Industry," *Multinational Strategic Alliances*, Refik Culpan, ed. Haworth Press examine the competition within the container transport industry on a co-operation competition continuum for conference members.

7 Moreby, David (1990), "Survey", *Seatrade Business Review*, May/June, p. 29-33.

8 Porter, Michael E. (1985), *Competitive Advantage: Creating and Sustaining Superior Performance*, New York: The Free Press; p. 3.

9 A slot is a measure of ship space; one slot will accommodate one TEU, or twenty foot equivalent container (20' x 8' x 8').

10 A slot charter is an agreement whereby one line agrees to charter a fixed number of TEU slots (or spaces) on another line's vessels.

11 For an excellent evaluation of capacity management in service industries see Armistead, C. (1985), "Capacity Management" in *Operations Management in Service Industries and the Public Sector*, C. Voss, C. Armistead, B. Johnson and B. Morris, eds., New York: John Wiley and Sons.

12 Brooks, Blunden and Bidgood (*Op. Cit.*) provide five case studies of major container operators and their strategies to illustrate this point.

13 *World Wide Shipping*, December/January, 1989, p. 23-4 at p. 23. For other examples, see Brooks, Mary R. and Robert G. Blunden (1990), "Strategic Alliances vs. Ownership in the Container Transport Industry: An Exploration of the Issues," Canadian Transportation Research Forum *Proceedings*, Saskatoon, p. 1-13.

14 Helmut W.R. Kreis of the Commission of the European Communities Directorate General—Competition has defined consortia as specialized joint ventures encompassing many different arrangements. He notes that the industry has "no common views ... even on the definition of what constituted a consortium—except that the shipping industry claimed antitrust immunity for them." (*The Journal of Commerce*, January 2, 1990, p. 1A.)

15 Brooks, Blunden and Bidgood (1993); *Op Cit.*

16 Doz, Yves (1986), *Strategic Management in Multinational Companies*, Oxford: Pergamon Press.

17 Bhide, Amar (1986), "Hustle as Strategy," *Harvard Business Review*, September/October, p. 59-65.

18 Porter (1985), *Op Cit.*

19 Brooks and Blunden (1990), *Op Cit.*

20 Porter (1985), *Op Cit.*, p. 13.

21 Saporito, Bill (1992), "Why the Price Wars Never End", *Fortune*, March 23, p. 68-78.

22 See Brooks, Blunden and Bidgood (1993), *Op Cit.*, for a company profile of ACL.

23 *World Wide Shipping*, December/January 1989, p. 23-4 and *Journal of Commerce*, April 24, 1989, p. 8c.

24 See Heskett, James L. (1986), *Managing in the Service Economy*, Boston: Harvard Business School Press, p. 36.

25 The concept includes retrieval from the shelf at origin and stocking the shelf at destination to provide a total logistical support service to the shipper and consignee.

26 Porter (1985), *Op Cit.*, p. 7.

27 Armistead, C. (1985), *Op. Cit.*

28 Ghemawat, Pankaj (1986), "Sustainable Advantage," *Harvard Business Review*, September-October.

29 Bidgood, Cheryl I. (1991), *Megacarriers: Strategies, Marketing and Fleet Profiles of Seven Megacarriers 1979/80-1989-90*, Dalhousie University: Unpublished graduate paper.

30 This concept is developed further by MacMillan, I.C. (1984), "Seizing Competitive Initiative", in *Competitive Strategic Management*, Robert B. Lamb, ed., Englewood Cliffs, NJ: Prentice-Hall Inc., p. 272-96.

Education and Training For a Competitive Marine Transportation World

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Experience from loss control principles proves that most of the mistakes people make are caused by factors over which only management has control. Most loss control experts put this factor as high as 80%. This leads to the conclusion that safety -control of accidental loss - is primarily a function of management control. In the maritime environment, this means shipboard and onshore management.

Sten Bengston
Vice-President
Det Norske Veritas[1]

INTRODUCTION

Two major components of competitiveness in the marine transportation world are safety of life at sea and the prevention of marine pollution.[2] Ships, lying on the ocean floor, surrounded by mangled bodies do not compete. An environment reeking with oil and chemical pollution from ships means a waste of valuable resources and a contribution to the loss of the competitive edge. To compete with any hope of gaining that edge implies that these two major components are managed with the utmost of skill. Being competitive recognizes that such management skill comes only with experience and the finest of management education and training. Our sea-going managers do not receive such education and training. They never have nor are they likely to in the near future unless Canada undertakes a major revision of its marine education and training policy. Perhaps I should say the formulation of a coherent maritime education and training policy that stresses the importance of maritime management education that those involved so rightly deserve.

What follows describes the present situation and puts it into perspective by answering the following questions:

- When is a manager not a manager?
- What group of would-be managers have immense responsibilities but little authority?
- What group of would-be managers receive most of the blame in the event of loss of life at sea or a pollution incident?
- Who is responsible for this state of affairs?
- Why is it allowed to continue?

These questions will be addressed in the context of where we are in maritime management education, what the situation should be and what strategy we should pursue in order to achieve the necessary maritime management education for a competitive marine transportation world.

THE TRAGIC REALITY OF TODAY

On 21 September 1991 Bob Wylie of the *Globe and Mail*[3] reported on a ship called *Peace*. To summarize, it was a ship without a home or a hope. There was no food or wages for the crew, no medical care and a mind-bending boredom that only sailors without a sea can know. This ship had been in port for a year when the article was written and the future held only misery and broken promises. The *Peace* was, and is not now, a unique situation. From Halifax to Helsinki[4] ships may be found having similar conditions - living and working conditions that would be totally unacceptable to any other self-respecting profession on earth.

The *Peace* symbolizes most of what is wrong with our marine transportation industry. It points to an ethic devoid of content, to human exploitation on a global scale, and to a way of doing business that could only have its roots in the Dark Ages. It speaks volumes on the way we pursue profit at sea, how our sea-going enterprises are mismanaged, and the helplessness of those whom we charge with the responsibility of operating our maritime enterprises. The crew in this case were Bulgarian and African. They could have been Canadian or any other nationality. Maritime mismanagement and exploitation knows no geography or nationality.

On 6 April 1991, the *Scandinavian Star*[5] left Oslo bound for Denmark. At 0145 on the seventh a fire was detected in a passenger corridor and extinguished. Although it was probably incendiary, no extra measures were taken. At 0200 another fire started in a corridor and this one claimed 158 lives. The crew were Norwegian and Portuguese. The Portuguese could not speak Scandinavian or English. The Master was found at fault because he left the ship while there were survivors onboard.

The person responsible for closing the bow-doors of the *Herald of Free Enterprise*[6] was asleep when she left the dock. He awoke only after the vessel capsized minutes after leaving Zebrugge harbour killing 188 persons.

The Master of the *Exxon Valdez*[7] was in his cabin when his vessel ran aground spilling thousands of tonnes of crude into a previously pristine environment. The third officer in charge of the bridge was suffering from fatigue.

The Master of the *Amoco Cadiz*[8] wasted hours of valuable time while his vessel headed for disaster. He was trying to determine what his company would have him do. Two hundred thousand tonnes of crude oil washed upon the beaches of France.

A Philippine vessel, the *Donna Paz*[9], collided with the tanker *Vector* killing up to 4 000 people. It was one of - if not the worst - peace time marine accidents on record. The vessel was badly overcrowded and confusion reigned.

The above are only a few of the disasters that have befallen our maritime industries. The litany of woe is endless. All however, have a common thread. The enterprises were mismanaged. Some would say, and quite rightly, that they were not managed at all. Lord Justice Sheen in the *Herald of Free Enterprise* inquiry; Justice Hickman[10] in the *Ocean Ranger* Commission; Lord Cullen in the *Piper Alpha*[11] occurrence; and the National Transportation Safety Board inquiring into the *Exxon Valdez* accident have all pointed to management shortcomings resulting in disaster. In these four occurrences alone some 450 persons died.

WHY?

Over one hundred and fifty years ago, Samuel Plimsoll[12] pleaded for the life of British seafarers who were being sent to their deaths onboard "coffin ships." In a Danish harbour in 1988, I helped inspect a vessel that was ready, long since ready, for the scrap yard. It was no better than Plimsoll's "coffin ships." The one item that has remained fairly constant from Plimsoll's time to the present is the way we educate and train our sea-going managers. It is an education almost totally dominated by technical content and nearly totally devoid of anything resembling management education. It is realized that there must be technical education to deal with the realities of the sea, ships, and cargo. We have, however, forgotten, or perhaps never knew, that the most important element onboard any vessel is its crew and that the only way anything can be achieved is through them.

Furthermore, where there is the human element, their must be a management process which highlights human potential, excites human motivation, and realizes that the sea-going enterprise must be managed. Such a management process is proactive and dynamic. It is a leadership process that believes a safe and clean enterprise is prerequisite to becoming profitable. It is a process managed

by competent well-educated individuals who know, through their education experience, that the major elements leading to competitive safety of life at sea and pollution prevention are indeed management processes.

This must be a top-down process. It begins at the top levels of management and is demonstrated in word and deed. Sea-going managers (the Ship Officers) must know through direct interaction what is expected of them. They must realize and be taught that they are an integral part of the management chain and that they have the requisite authority in order to help manage the enterprise. One of the top management's key roles is the motivation of their sea going managers who, in turn, motivate all to greater competitiveness through "safer ships and cleaner oceans."

The International Maritime Organization (IMO)[13], the major Shipmanagers[14], the Classification Societies[15], and professional associations such as the Nautical Institute[16], all recognize that the operation of sea-going enterprises is a management exercise. All have published documentation outlining what must be done in order to assure safety of life at sea and the prevention of marine pollution. They are also leading the way in showing just what is meant by a quality management process and what has to be done in such a process. It becomes quite obvious from reading their publications that the day when technical standards and enforcement of prescriptive regulation which stood for the management of safety and marine pollution prevention is mercifully coming to an end. A key feature of each and every one of those documents mentioned is the education and training of our sea-going managers. It is to that which I now turn.

MEANINGFUL MARITIME MANAGEMENT EDUCATION

A brief study of a document called the EXN 1[17] (Canadian Syllabus for Masters and Mates Examinations) indicates the depth of our problem. The syllabus for Marine Engineers is just as barren of anything resembling management studies. (Keep in mind we educate and train for the international market. Also bear in mind that many other countries follow the same type of syllabus.) Every certificate is dominated by technical subjects. Navigation, Stability, Rule of the Road, and on it goes through all levels. At the highest level, i.e., the Master Mariner level, there is a little Shipmaster's Business. This is the extent of management education for Canadian Merchant Seafarers. To add insult to injury, the only mandatory education and training is in sea-survival and electronic navigational aids. (Excerpts from the EXN 1 are available at the Registration desk). I stress there is no mandatory education and training in Canada beyond what I have mentioned above. The individual seafarer can study anywhere, under any conditions, and then sit the examinations as many times as is necessary to pass. If and when they receive their Certificate of Competence, they are off to manage our sea-going enterprises in the merchant marine (including Canadian Government Ships), oil and gas, and fishing industries. These personnel will be found not only in national and international waters but in the pilotage services, the maritime colleges, and filling jobs ashore

in our maritime industries. Is it any wonder that if one captain refuses to take a rusting death-trap to sea there are those lined up behind him who surely will.

WHAT IS TO BE DONE?

Management processes are dynamic and proactive. The processes involve the setting and achieving of objectives through people, budgeting, controlling, guiding, planning, communicating, empowering, coaching, and delegating. These are very human processes that require motivating individuals to peak performance in meeting the modern world's competitive agenda. There is no doubt that the key to marine transportation competitiveness involves the motivation of our sea-going managers. This raises the question as to how we do indeed motivate such individuals.

There are many ways to motivate people. Through monetary rewards and promotion, or the threat of the loss of bonus or status, we may attain a degree of motivation. I believe, however, that one of the most effective motivating factors in the world is the valuing of the individual. There is no stronger motivation I know of in life than to value what persons achieve in their lives, what it is they are doing, and to what it is they aspire. These very personal concerns must be recognized and valued.

VALUING

We start the valuing process by giving our sea-going managers excellent education and training designed to meet the needs of competitive global marine transportation. Their education and training would contain the following elements:

- Organizational Psychology
- Organizational Sociology
- Statistical Analysis
- Problem Solving
- Ethics
- Communications and Computers
- The Business of Shipping

in addition to the very important technical subjects that are vital to the management of a modern sea-going enterprise. By providing such ***mandatory education,*** our national and provincial governments, as well as industry, would be sending an immediate message to maritime professionals that we do indeed value them and what it is they might bring to a most competitive industry.

Enshrined within this idea of valuing is a philosophy which expresses as one of its guiding principles the belief that students of marine transportation be given the opportunity for meaningful education through active participation. This

approach recognizes the wealth of experience, optimism and energy brought to our institutions by all those to whom we would entrust the leadership of our marine transportation industries. Furthermore, it recognizes that the students of our industry have such incredibly diverse experiences and that these diverse experiences are a major educational resource. Such human resources should be given the fullest prominence and can be in a world where students guide themselves and other students as well as teachers guiding students and teachers learning from students. With this approach we just might hear the teacher say: "... but I feel as if my teaching is being celebrated.", or the student: " The *Course Guide* asked us to supply input and feelings - I loved it! If every class had something like this, I think I would like school better."[18] Indeed!

The buzzword today is empowerment. And what exciting possibilities it opens up for all. It says in effect that I recognize you as being capable of accepting responsibility for your own learning, that you have the will and capacity to accept such responsibility, and that in the process you are demonstrating and living a leadership which in fact is the ultimate goal of the exercise. The means and the end are one. What an exciting foundation on which to build our competitive marine transportation!

Once such valuing becomes part of an organizations culture, we must continue to value our people by recognizing and rewarding efforts that lead to a safer and cleaner condition. Such recognition includes monetary rewards, symbolic gestures such as plaques and certificates as well as awards for innovative thinking and stewardship. It must be stressed, however, that valuing in the context in which it is used here, indicate a management tool which first and foremost recognizes the importance of people to an organization, that without the initiative and enthusiasm that such individuals bring to the job nothing would be accomplished, and that such a philosophy must be a cornerstone of the culture of the organization if it is to be truly competitive.

As our people progress, we could continue to value them by offering every opportunity for professional and social development along lines which they themselves have helped to draw. This would not only include the upgrading of professional qualifications but the opportunity to expand their horizons in related fields of transportation. This could be achieved through attendance at specialized courses and, national and international conferences and seminars.

A NATIONAL STRATEGY FOR COMPETITIVE MARINE EDUCATION

First and foremost, the Canadian Government ***must make marine education and training mandatory for ship's officers and ratings seeking Canadian qualifications.*** Also, they should remove themselves from direct involvement in the marine education examination system. Under the Canada Shipping Act[19] the Federal Government has the responsibility for providing facilities for the

preparation of ship's officer to sit their professional examinations, and for issuing certificates. Except for providing some radar simulator and sea-survival training equipment, the Federal Government has little control over marine education and training since this comes under provincial jurisdiction. They do, however, set the syllabus. This has already been identified above as being a major part of the problem. Since they have no control over education and training on which the examinations are based than the examination process should be passed to the provincial institutions. (It is also realized that the Coast Guard is involved in just such a process at the present time. As will be spelled out later, I believe that this should be done within a national standards scheme which is somewhat different from the approach we are now taking. What are the guiding principles and who has formulated them?) It is my belief that the role of the Federal Government in marine education and training is the setting of a national policy containing national objectives. They must also continue to issue Certificates of Competency as they are bound to do under international law.

In setting national standards, the Canadian Government should utilize a transportation studies standards board. There is a Canadian precedent in the form of the Canadian Transportation Accident Investigation and Safety Board. It is believed that the maritime industries have much to learn from the air, railway, and commodity pipeline industries especially with respect to the way they educate and train their professionals. Such a board would set the stage for a common approach to transportation education and training. It doesn't necessarily have to be a new board. It could be an arm of the Transportation Safety Board since a major preoccupation of that Board is transportation safety, including maritime safety.

This Board would set the maritime educational objectives which define the standard for the nation. There would then be a common standard and everyone would know and teach to the same standards. An integral part of the Board's work would be the upgrading and revision of its educational objectives with input from both Federal and Provincial governments, the industry, and the educational sector.

In this scenario, there would be no such thing as a so-called challenge examination process (present set up) except for a very brief transition period. Education and training to become a maritime professional would be ***absolutely mandatory*** with no possibility of exemption from the required classes.

AN INTERNATIONAL STRATEGY

It is recognized that we live in a global village and that Canada has obligations under international treaties with respect to maritime education and training. This is only how it should be since we do provide personnel for the international market and our ships sail in international waters. In 1988, Canada acceded to the International Convention on Training and Certification of Seafarers

(1978) - commonly known as STCW. These, however, are minimum standards of marine education and training and are a far cry from what is outlined above. Yet, when it was adopted, it was a giant step in marine education and training, especially for countries with no standards at all.

We have, however, moved on. The technological and social world of the 1990s is very different from the world of the 1970s. (Ships of the future, one man bridges and crews consisting of up to 28 nationalities are becoming more and more common.) Canada should take every opportunity to have the Convention updated and modified to meet modern-day needs by incorporating the topics outlined above. Canada is a very active member of the International Maritime Organization (IMO) which is the depository for this Convention and should exert its best efforts to bring about change.

In addition it would be beneficial if the World Maritime University in Malmö, Sweden (a child of the International Maritime Organization) adopted this philosophy in teaching it's post-graduate programs. It would be a major advance in marine education and training because students involved in marine transportation from all over the world attend the University and there is a particular focus on marine education and training as well as several other courses.

CONCLUSION

Being competitive in our marine context implies safety of life at sea and pollution prevention. These two major components must be managed and those entrusted with such management must have the requisite education and training. This, however, is not enough. Such individuals need to be motivated to peak performance through a valuing process which continues throughout their career.

Such a course of action is today's thinking manifested. However, it is expensive. Furthermore, should you believe that safety and pollution prevention, and, hence, competition in marine transportation are expensive try an accident such as the *Exxon Valdez* which at last count involved costs exceeding 2 Billion dollars US. Also, you might try existing non-competitively in a most competitive marine transportation world.

While some of the ideas outlined above may appear novel as well as expensive, we at the School of Maritime Studies of the Newfoundland and Labrador Institute of Fisheries and Marine Technology believe that this is the route we must follow. We are doing so by upgrading and modifying existing courses in our Diploma Programs in Maritime Studies, by adding new courses, by encouraging the Coast Guard to move its examinations to the colleges and by promoting discussion of the subject by taking part in conferences such as this.

Finally the answers to the questions posed in the introduction can now be answered:

- When is a manager not a manager? — When he/she is a ship's officer.
- What group of would-be managers have immense responsibilities but little authority? — Ship's Officers.
- What group of would-be managers receive almost zero management education? — Ship's Officers.
- Who is responsible for this state of affairs? — All of us.
- Why is it allowed to continue? — Because we allow it to continue.

I applaud the theme of this conference and I thank you for the opportunity to present my views on a most important topic.

NOTES AND REFERENCES

1. *Lloyd's List*, 11 June 1991, "Classification Societies can improve safety say Bengston."

2. These are the two main objectives of the International Maritime Organization (IMO) which are incorporated in its slogan "safer ships and cleaner oceans".

3. Bob Wylie, "The last sad voyage of the bad ship *Peace" Globe and Mail*, 21 September 1991, p. D5.

4. For more information on the abuse of seafarers see the various volumes of *The Seafarers Bulletin* issued by the International Transport Federation.

5. Per Svennar, "*Scandinavian Star* Aftermath", IMLA International Workshop - *Marine Casualty Investigation*, Singapore 11 - 15 November 1991.

6. UK, DTp, The Merchant Shipping Act 1894, *Report of the Court No. 8074 (Herald of Free Enterprise)* London, 1987.

7. National Transportation Safety Board, Marine Accident Report - *Grounding of the Tankship Exxon Valdez on Bligh Reef, Prince William Sound near Valdez, Alaska March 24, 1989.* (Washington, 1990)

8. Interim Decision of The Commissioner of Maritime Affairs, R. L. and Interim Report of the Formal Investigation by the Marine Board of Investigation in the matter of the *Loss by Grounding of the VLCC Amoco Cadiz, ON 4733* (Monrovia, 1979)

9. *Sydsvenskn*, (Swedish Newspaper) 13 February 1988, p. 3.

10. Royal Commission on the *Ocean Ranger* Disaster Report One: *The Loss of the Semisubmersible Drill Rig Ocean Ranger and Its Crew* (St. John's, Newfoundland 1984).

11. UK Department of Energy, *The Public Inquiry into the Piper Alpha Disaster, Volume Two*, (London, 1990)

12. Samuel Plimsoll, *Our Seamen - An Appeal*, London 1873.

13. *IMO Guidelines on Management for The Safe Operation of Ships and for Pollution Prevention (1989).* Resolution (A) 647 - 16.

14. Group of Five, *Code of Shipmanagement Standards,* Cyprus, 1990.

15. See for example Det Norske Veritas, Safety and Quality Management in Shipping - The role of the Classification Society, (Hovik, Norway 1991)

16. Nautical Institute, *The Management of Safety in Shipping - Operations and Quality Assurance,* (London, 1991)

17. *The Examination of Masters and Mates, Publication EXN 1 Revised July 1981,* (Ottawa, 1981)

18. *Innovation Abstracts,* Volume XIII, Number 27, 8 November 1991 - "ALC: Activating Learning in the Classroom"

19. *Office Consolidation, Canada Shipping Act , Section 127,* p. 75. (Ottawa, 1990)

UNE FACE CACHÉE DE LA RÉVOLUTION DU CONTENEUR

1. Côté pile: une révolution véritable et pleine de promesses

Au début de 1990, le parc mondial de conteneurs s'établissait à 4,3 millions d'unités, représentant environ 6 millions d'E.V.P.[1]; en 1989, il y aurait eu 78,5 millions de mouvements d'E.V.P. dans les ports à travers le monde.

Depuis la fin des années '60, le transport des marchandises a subi une véritable révolution du fait de l'avènement et de la généralisation de l'usage du conteneur. En effet, ne se contentant pas d'être seulement une technique évoluée de transport et de manutention, cette "boîte" constitue en elle-même un système possédant une logique d'organisation propre; initialement destiné à augmenter la productivité des navires et des ports, le conteneur a, bien vite, imposé une restructuration du transport maritime de ligne, de même que l'intégration de différents modes, donnant ainsi tout son sens à l'intermodalité. Cette évolution se traduit, entre autres, par l'élargissement du champ d'action des transporteurs de lignes maritimes, lesquels intègrent, désormais, les divers services de transport intérieur, surtout ferroviaires et routiers. La notion de chaîne de transport est donc devenue réalité au plan international tout en forçant les opérateurs, qu'il s'agisse d'armateurs ou de N.V.O.C.C.[2], à pénétrer et à maîtriser les marchés intérieurs pour la distribution des conteneurs. Les clients se voient offrir un service intermodal intégré, passant du "port-à-port" au "porte-à-porte", couvert par un seul contrat (connaissement unique et direct), et ce moyennant un coût de fret unique également. Les chargeurs vont alors exiger de plus en plus cette sorte de prestation de services, ce qui explique les progrès considérables de la conteneurisation des points de vue du tonnage transporté et du nombre d'E.V.P., des navires porte-conteneurs et des terminaux portuaires et intérieurs spécialisés.

De par les impératifs économiques qu'elle sous-tend, la conteneurisation a été à l'origine de changements importants au plan organisationnel: intégration horizontale sous forme de consortium (A.C.L., O.O.C.L., Canada Maritime); ententes de coordination (St-Lawrence Coordinated Service); accords d'affrètement d'espace (Slot Chartering) etc...

Par ailleurs, ce même phénomène a eu pour effet de rationaliser les trafics en les concentrant, au plan maritime, à un nombre déterminé et limité de ports, particulièrement avec la mise en exploitation des fameuses lignes autour-du-monde (Round the World).

Que dire des gains de temps appréciables réalisés grâce aux conteneurs? De l'apparition du concept de "juste à temps" (Just in Time)? Des réductions notables des vols, pertes et avaries aux cargaisons? De la variété de conteneurs spécialisés mis à la disposition des chargeurs? De plus, comment ne pas rappeler que le conteneur a suscité de grandes innovations techniques: navires cellulaires; trains unitaires, de plus en plus constitués sur les quais portuaires (on dock trains); land-bridges; wagons à double gerbage (Double Stack); E.D.I. (échange de données informatisées) etc... La R.& D. reste très active à ce niveau et aboutit à d'autres résultats remarquables comme ceux-ci:

- Développement de terminaux à haute densité informatique et robotique comme celui qui doit ouvrir en 1993 au port de Rotterdam;
- Apparition de terminaux intérieurs;
- Construction de navires cellulaires sans cales (Hatchless containerships) tels ceux de Nedlloyd;
- Maximisation de la capacité de chargement tout en réduisant les coûts d'opération, ce qui a abouti à la nouvelle génération des porte-conteneurs, les "Post-Panamax" de 3000 à 3250 E.V.P., surtout sous l'impulsion d'A.P.L. (American President Lines);
- Importance cruciale de l'information et de l'échange de données qui a imposé l'E.D.I. comme outil de gestion et d'opération puisqu'il est de plus en plus question d'éliminer la documentation traditionnelle pour lui substituer des documents électroniques. À cet égard, il faut rappeler que le secteur des transports a été le précurseur de l'E.D.I. et qu'il a servi de modèle à d'autres domaines de l'activité commerciale et industrielle;
- Mise au point du conteneur réfrigéré fonctionnant à l'énergie solaire, le SOLAR J. BOX, conçu particulièrement pour les climats froids par MOL (Mitsui O.S.K. Lines) et quatre autres partenaires;
- Création chez Hamburg-Süd et commercialisation d'une lance anti-incendie pour éteindre le feu à l'intérieur d'un conteneur sans en ouvrir les portes, ce qui permet d'agir promptement pour maîtriser le sinistre et le circonscrire, même en mer.

Bref, les exemples peuvent être multipliés à souhait car les progrès en la matière semblent quasi-illimités, les effets bénéfiques de cette révolution n'étant pas épuisés. Il est indéniable que le transport multimodal de conteneurs est devenu, par-delà le service et le support au commerce, une source de développement économique aux plans des infrastructures, du matériel, des techniques, de la logistique et des systèmes, compte tenu des ressources humaines et financières requises.

Cependant, si tout a été dit et écrit sur les avantages et les éléments positifs de la conteneurisation, il est bien rare que soient abordés les difficultés et problèmes soulevés par celle-là. Le bref exposé critique qui suit n'a pas d'autre prétention que celle d'attirer l'attention des chargeurs, des transporteurs et des autres intervenants de la chaîne sur certains inconvénients. Le but visé est de mettre en relief des mesures de prévention et de précaution destinées à limiter les problèmes et leur ampleur, et à améliorer davantage les qualités et l'utilité de cet outil précieux qu'est le conteneur au profit de tous les usagers.

2. Côté face: de nombreux problèmes mal maîtrisés

2.1 Au plan matériel

2.1.1 Des problèmes techniques

Ruptures de charge fréquentes, nombreuses opérations de manutention, déplacements utilisant divers modes de transport, sur des distances parfois très grandes, durant un temps assez long, sous d'importantes variations climatiques... etc... mettent en évidence les multiples mouvements, vibrations, chocs, oscillations et autres manoeuvres ou phénomènes susceptibles d'endommager les cargaisons et d'entraîner des conséquences commerciales et financières assez lourdes. Dans un petit fascicule publié par Affaires extérieures et Commerce extérieur Canada[3], figure un exemple-type de ce que peuvent subir un conteneur et son contenu durant une expédition internationale multimodale:

- Douze déplacements différents (camion, chemin de fer, navire)
- Huit opérations de replacement
- Neuf opérations de mise au sol
- Peut-être plusieurs changements de température et de niveau d'humidité
- Neuf opérations de levage diverses
- Un déplacement sur 4 000 à 8 000 milles (6 400 à 12 000 km)
- Entre leur chargement et leur arrivée chez le destinataire, les marchandises ont passé de 30 à 45 jours en transit

Durant tout ce cycle, peuvent survenir des vols, des pertes fortuites ou causées en raison de l'arrimage, de la manutention, de l'eau etc... Le Conseil canadien des assureurs maritimes a établi que 83% de toutes les pertes de cargaisons pourraient être prévenues. Le plus significatif, c'est que 45% des pertes pouvant être prévenues sont dues à des opérations de manutention et d'arrimage inadéquates[4]. De telles données rendent compte de l'ampleur des problèmes: méconnaissance des techniques élémentaires d'arrimage; négligence ou efforts insuffisants en matière de préparation, de conditionnement, d'emballage et d'étiquetage de la cargaison; choix de conteneur inapproprié; lacunes dans l'inspection de l'état du conteneur (étanchéité, portes, verrous, joints et charnières).

Bref, malgré l'expérience et un passif non négligeable, les dommages, pertes et vols persistent, avec leurs impacts économiques, notamment au plan des assurances, et commerciaux pour les chargeurs ou les transporteurs, selon le cas. Pourtant, des mesures préventives simples éviteraient gâchis, réclamations, poursuites judiciaires et mauvais climat d'affaires.

Ainsi, si le conteneur offre indéniablement un haut degré de protection, de fiabilité et de sûreté, il requiert tout de même des soins appropriés avant toute expédition, à la fois pour l'état de la boîte elle-même et pour la cargaison qu'elle est censée transporter avec le maximum de garantie quant à son intégrité et à la préservation de sa qualité.

2.1.2 Des problèmes de normalisation et d'adaptation

. Si la variété de conteneurs spécialisés disponibles sur le marché constitue un atout de taille face à la diversité des besoins d'expédition de marchandises de toutes sortes, la prolifération récente de conteneurs hors-normes, par contre, soulève des difficultés. Une telle multiplication dans le transport intérieur terrestre pose de sérieux problèmes dès lors que l'on tente d'imposer l'usage de ces conteneurs hors-normes au trafic maritime et multimodal international, problèmes de normalisation à l'I.S.O. et d'infrastructures de transport, particulièrement au niveau des équipements portuaires de manutention et de la structure des navires. Il est vrai que, dans le commerce maritime international, continuent de dominer deux types de conteneurs standard, à savoir le 20' et le 40' (mesures caractérisant leur longueur), de 8' de large et de 8'ou 8'6" de haut. Cependant, du point de vue de la longueur, sont apparus les conteneurs de 45', 48' et 53', même si ces deux derniers sont, pour l'instant, confinés au territoire américain.

De plus, si la largeur maximale semble limitée à 8', certains modèles voient le jour: 2,5 mètres en Europe et 8'6" en Amérique du Nord où cette mesure s'impose à des conteneurs de 45', 48' et 53'.

Enfin, pour ce qui est de la hauteur, celle-ci peut être, outre les 8' et 8'6" courants, de 9' ou 9'6", y compris pour les conteneurs de 20' et de 40'. Cependant, la hauteur maximale, même pour les conteneurs les plus longs (53') reste de l'ordre de 9'6". Ce qui n'est pas sans créer des problèmes en matière de gerbage ferroviaire notamment. On comprend aisément que les difficultés en la matière viennent de l'inadaptation de certaines infrastructures routières, ferroviaires (ponts; viaducs; tunnels) et surtout portuaires (grues portiques, chariots élévateurs) et des navires cellulaires eux-mêmes conçus et construits spécifiquement pour l'E.V.P., donc pour recevoir des conteneurs de 20' et 40', de largeur et de hauteur standard.

L'adaptation des infrastructures et systèmes terrestres aux nouvelles dimensions semble progresser tant en Amérique qu'en Europe, mais il en est tout autrement des ports et des navires porte-conteneurs compte tenu des coûts prohibitifs correspondants.

Le trafic intercontinental devrait échapper aux contraintes liées à toutes ces variantes de dimensions qui, bien que pouvant être acceptables aux plans routier et ferroviaire internes, constituent des éléments de perturbation de l'interface portuaire et maritime, de la productivité et de la régularité des flux intermodaux internationaux. En ce sens, armateurs, autorités portuaires et autres intervenants concernés devraient résister de façon plus claire aux pressions dont ils sont l'objet de la part de certains expéditeurs et transporteurs terrestres soucieux d'augmenter leurs volumes de fret. Ceci même s'il semble que certaines lignes s'accommoderaient de l'introduction limitée du 45' pour des trafics particuliers et d'autres conteneurs hors-normes, dans la mesure où leur nombre reste marginal.

. Un autre problème sérieux continue d'envenimer les relations entre partenaires de la chaîne de transport: il s'agit du poids excessif de

cargaison stockée à l'intérieur des conteneurs, imputable à certains expéditeurs. Cela peut être source d'accidents en cours de manutention, ou, plus fréquemment, d'amendes pour surcharge infligées aux camionneurs. L'ampleur d'une telle situation est loin d'être négligeable car une étude de l'Administration américaine des autoroutes indiquait que 30% de tous les conteneurs, tant à l'import qu'à l'export, sont susceptibles d'être surchargés par rapport aux normes routières[5].

À ce niveau aussi, la méconnaissance de la réglementation sur les charges limites et les abus dont font preuve, délibérément, certains chargeurs, sont des réalités auxquelles les opérateurs doivent faire face, d'autant plus que les transporteurs maritimes sont réticents à effectuer un contrôle systématique préalable, long et coûteux.

2.1.3 Quelques récriminations écologiques

. La popularité grandissante du conteneur dans le transport intérieur et international et l'augmentation du parc mondial de conteneurs ont attiré l'attention de groupes dédiés à la protection de l'environnement, tel le Rainforest Action Network. C'est que le plancher des conteneurs est fait de bois dur tropical dont la solidité convient à des poids pouvant excéder 30 tonnes. L'acier n'est pas utilisé à cette fin du fait que son poids diminuerait la capacité de chargement du conteneur. Les efforts de substitution ne sont pas très poussés en la matière.

. D'autres critiques ont trait à l'utilisation de peintures toxiques résistant mieux à la corrosion marine et de C.F.C. (chloro-fluorocarbones) dans les conteneurs réfrigérés. Là encore, l'utilisation de peinture à l'eau pose des problèmes de séchage en climat froid et de résistance à l'eau de mer; de plus, le recyclage des réfrigérants n'est pas systématisé et la recherche de substituts aux C.F.C. n'a pas encore abouti à des résultats probants.

. Enfin, l'accentuation du phénomène de la conteneurisation, l'accroissement des échanges commerciaux par conteneurs, les millions de mouvements de repositionnement de boîtes vides et les pressions du "Just in Time" ne sont pas sans soulever des inquiétudes quant à la qualité de l'air, au bruit et à la congestion routière en zones urbaines densément peuplées compte tenu de l'utilisation massive de flottes importantes de camions.

2.1.4 Des problèmes d'espace

. Du point de vue des activités portuaires, les pressions sont grandes pour le développement d'espaces pour terminaux à conteneurs, en raison particulièrement de la vive concurrence que se livrent les ports aux plans international et même interne. Une telle extension s'effectue souvent au détriment de certains trafics traditionnels de cargaisons générales non conteneurisées telles que l'acier ou les marchandises palettisées comme les fruits. Il est souvent difficile de concilier sur les mêmes quais ces différentes activités.

. Dans certains pays, par ailleurs, la volonté des citadins de se réapproprier et de revitaliser des espaces riverains à des fins

résidentielles et récréatives se heurte parfois aux intérêts portuaires obligés de planifier l'occupation du sol en fonction des besoins commerciaux, y compris le conteneur et toute l'infrastructure requise. La solution ne peut résider que dans un équilibre harmonieux entre ces deux tendances car rejeter les préoccupations environnementales et urbaines des citoyens est aussi irréaliste que tenter de forcer des ports à se relocaliser ailleurs.

2.2 Au plan juridique

2.2.1 Le mauvais arrimage de la cargaison conteneurisée

De nombreux chargeurs, comme on l'a vu ci-haut, continuent d'ignorer qu'une préparation inadéquate de la cargaison, particulièrement des points de vue de l'emballage et de l'arrimage en fonction d'une expédition par mer, est de nature à leur faire perdre tout recours valable contre le transporteur maritime en cas de dommages à la cargaison (voire de perte totale de conteneurs et de leur contenu, par exemple ceux qui servent de citernes et qui sont insuffisamment remplis).

Bien plus, certains expéditeurs peuvent se voir imputer les dégats occasionnés au navire par de tels pertes ou dommages, comme le confirment plusieurs décisions de justice et d'arbitrage.

Tout ceci met en évidence la nécessité impérieuse pour le chargeur de procéder avec soin à la préparation de sa cargaison et du conteneur, et de se doter d'une bonne couverture d'assurance.

2.2.2 Les conteneurs chargés en pontée

L'expansion considérable de la conteneurisation dans le commerce maritime international ne s'est pas accompagnée d'une évolution au même rythme de certaines pratiques commerciales en matière de lettres de crédit et du régime juridique de responsabilité pour perte ou dommages.

Les progrès technologiques au niveau du conteneur et des navires spécialisés ont atténué de beaucoup la distinction qualitative classique entre cargaisons en cale et en pontée, du fait de la réduction radicale des risques de la pontée pour les marchandises dès lors qu'elles sont conteneurisées. Ce n'est d'ailleurs pas sans raison si certains armateurs se dotent depuis peu de navires porte-conteneurs sans cales (hatchless). Il est vrai que des aléas du transport en pontée subsistent en raison des intempéries, surtout le vent et les vagues. Il y a quelques années, certains pouvaient se permettre d'exagérer en affirmant, comme M. Samuel T. Byron Jr, président du comité de prévention des pertes de l'Institut américain des assureurs maritimes que «the only day a container is completely waterproof is the day it's manufactured»[6]. Si l'étanchéité pose encore des problèmes et si des conteneurs continuent à être perdus après avoir été projetés par dessus bord lors de tempêtes, il faut admettre que des progrès techniques ont grandement amélioré la situation tant au niveau de la qualité de la boîte que du design des navires.

Des problèmes subsisteront tant que la distinction entre cale et pontée existera aux yeux de certains chargeurs et aussi longtemps que des vendeurs seront contraints, par le truchement de lettres de crédit, de présenter un «connaissement net - chargé à bord en cale». À ces niveaux, l'évolution des mentalités commerciales est bien lente par rapport aux progrès technologiques. Cependant, on ne pourra nier cette réalité pendant très longtemps, particulièrement le fait qu'un porte-conteneur ne peut être concevable sans un imposant gerbage de conteneurs sur son pont et sans un plan de chargement qui combine la nature et le poids des cargaisons d'une part, et l'ordre préétabli des escales d'autre part; c'est dire qu'il n'est pas toujours possible de satisfaire l'exigence de l'expéditeur quant au chargement en cale et que ce dernier se justifie de moins en moins. La question centrale du chargement en pontée est celle de la responsabilité du transporteur maritime, laquelle est déjà assortie d'une limitation en vertu de la convention internationale applicable, à savoir les Règles de La Haye de 1924 qui ne pouvaient donc traiter du conteneur, apparu plusieurs décennies plus tard.

En vérité, des problèmes persistent moins en raison de l'inadéquation des Règles de La Haye que de la nature des relations entre transporteur et chargeur, les deux n'ayant pas souvent intérêt à effectuer la déclaration relative au chargement en pontée. Ainsi, le premier peut transporter plus de cargaisons et maintenir un certain avantage par rapport à des concurrents, (évitant de majorer ses tarifs pour couvrir la responsabilité accrue découlant de la pontée). Quant à l'expéditeur, il se contente de taux de fret moins élevés. En agissant ainsi, l'un et l'autre peuvent miner leurs relations et doivent s'en remettre aux tribunaux qui, malheureusement, interprètent les Règles de façon non uniforme, et ce en l'absence de textes spécifiques. La situation se complique en raison d'une pratique qui veut qu'un connaissement net, donc ne mentionnant pas le chargement en pontée, atteste d'une mise en cale de la cargaison. De plus, les Règles de La Haye ne couvrent pas les marchandises en pontée, à moins que le connaissement en fasse mention expressément et qu'une clause spéciale y rende lesdites Règles applicables. Le danger est grand de voir le transporteur insérer une clause d'exonération de responsabilité préjudiciable au chargeur et à son assureur. Même dans les cas où les Règles de La Haye s'appliquent, avec leur limite de responsabilité du transporteur de 500,00 $ par unité, l'expéditeur aura du mal à obtenir pleine indemnisation à moins qu'il établisse la preuve, devant le tribunal, qu'il y a eu "déviation déraisonnable" aux termes des Règles elles-mêmes. Peu à peu, la jurisprudence s'est fortement appuyée sur une notion élargie de la "déviation raisonnable" (en l'absence de mauvaise intention ou de négligence manifeste) pour imposer la limite de responsabilité des Règles de La Haye à de nombreux litiges de chargement en pontée, reconnaissant ainsi, de plus en plus, que celle-ci est un élément primordial de la nature même du porte-conteneurs.

Dans l'attente de textes internationaux mieux adaptés et plus spécifiques, et de lois internes appropriées, il reste que les Règles de La Haye - malgré leur caractère vieillot par rapport à la technologie moderne et au dynamisme de la conteneurisation - peuvent régir assez convenablement le transport de conteneurs en pontée, à condition toutefois que les transporteurs et les chargeurs en suivent pleinement

les prescriptions, déclarent formellement que le chargement est effectué en pontée, s'entendent soit sur un taux de fret approprié soit sur la limite de responsabilité des Règles, et s'assurent chacun en conséquence.

2.2.3 Le conteneur: colis ou unité?

Sous le régime international des Règles de La Haye de 1924 et des dispositions législatives canadiennes qui en découlent dans la Loi sur le transport des marchandises par eau de 1936, le transporteur n'est responsable que jusqu'à concurrence de 500,00 $ par colis ou par unité de fret. Cette limite a bénéficié d'une certaine indexation dans d'autres pays qui ont adopté les amendements de 1968 ou le protocole de 1979, ce qui explique que du trafic d'importation au Canada s'effectue en vertu de meilleures limites, celles des Règles de La Haye-Visby: 2 DTS (droits de tirage spéciaux) par kg, ou 667,67 DTS par colis. Quant au tout nouveau régime international, ou Règles de Hambourg de 1978, il n'est pas encore entré en vigueur et ni le Canada, ni les États-Unis ne se sont prononcés en la matière, alors que l'inflation a érodé la valeur des limites de responsabilité.

Quel que soit le régime applicable, une question de taille, à incidence économique, s'est posée dès l'apparition du conteneur: quelle est la nature juridique du conteneur? S'agit-il d'un colis ou d'une unité? Là encore, en l'absence de textes spécifiques, ce sont les tribunaux qui ont dû apporter des réponses sur la base d'interprétations pas toujours uniformes.

La solution du problème réside au niveau de l'intention des parties et de leurs déclarations. Ainsi, dès lors que le chargeur déclare la nature et la valeur des cargaisons excédant la somme de 500,00 $ par colis, ou bien le nombre de colis ou d'unités chargés, il s'assure d'une meilleure protection en regard de la responsabilité du transporteur, mais devra, en conséquence, payer du fret supplémentaire. Il aura donc parfois tendance à éviter ces coûts additionnels en omettant une telle déclaration. Pour sa part, le transporteur a tout intérêt à maintenir ses primes d'assurance à leur niveau le plus bas, et ce d'autant plus qu'il a la possibilité de procéder à l'inspection et au comptage des lots au préalable, et de rejeter toute déclaration de son client qu'il juge non fondée. Chacune des parties essaie donc de tirer un avantage en évitant tout fret additionnel susceptible de réduire la compétitivité de l'une et de l'autre; elles se retrouvent ainsi, en cas de litige, devant un juge chargé d'établir la qualité de colis ou d'unité en ce qui a trait à la cargaison ou au conteneur. Une telle situation est à déplorer du fait qu'elle est commercialement malsaine et comporte une part de risque, notamment pour le chargeur.

Il est donc de la plus haute importance que ce dernier ou son représentant habituel, le transitaire, s'attache à remplir avec minutie la documentation requise, en l'occurrence le connaissement, d'y lister les colis avec leur marchandise constitutive de façon à établir clairement que chaque paquet est un colis par lui-même placé à l'intérieur du conteneur; il doit notamment remplir correctement la colonne intitulée "Nombre de colis" ("No of Packages") et celle de la "Description des marchandises" ("Description of Goods"). Il devra

également obtenir les couvertures d'assurance adaptées à une telle situation. L'expéditeur réduira ainsi les risques de voir ses réclamations éventuelles rejetées et le conteneur assimilé à un colis ou à une unité.

Depuis la mise en service du conteneur, la jurisprudence a sensiblement évolué, considérant de moins en moins le conteneur comme un colis ou une unité, sauf circonstances très particulières (vrac conteneurisé sans autres formes de précision) ou lorsque le connaissement fait état du conteneur comme unité de chargement sans énumérer ou décrire de façon concise la cargaison, et que le fret est libellé en montant forfaitaire sans rapport avec la valeur des biens transportés. Déjà quelques signes laissent entrevoir une uniformité en la matière et un jour viendra où, de façon quasi unanime, le conteneur sera considéré comme une structure intégrante du navire spécialisé qui le transporte. Cependant, malgré la prédominance de cette conception restrictive, il revient aux parties, surtout au chargeur, de bien formuler leur déclaration car toute omission fortuite ou volontaire peut se retourner contre eux et leur occasionner des pertes économiques importantes. En effet, tant que des textes internationaux et internes n'auront pas réglé clairement la question, les tribunaux ne pourront rejeter systématiquement les prétentions des transporteurs de faire assimiler le conteneur à un paquet ou à une unité, si les expéditeurs ne prennent pas les précautions qui s'imposent pour leur propre protection.

2.2.4 Le conteneur victime de son succès

. Des déséquilibres de trafic d'ordre structurel (certains pays ont une balance commerciale de conteneurs chargés excédentaire) ou conjoncturel (comme le taux de change), occasionnent soit une surcapacité, soit une pénurie d'E.V.P. selon le cas et le lieu, ce qui pose toute la question du repositionnement des conteneurs à vide dont l'ampleur est énorme. Ainsi, selon une étude de Drewry Shipping Consultants[7] portant sur l'année 1989, 13 millions d'E.V.P. vides ont été transportés par voie maritime, occasionnant 1,5 milliard $ au seul chapitre des frais de terminaux. Mais le plus surprenant à cet égard, c'est que la majorité de ces mouvements à vide se sont produits entre des ports dont les flux sont relativement équilibrés... Dès lors, il est permis de s'interroger sur la qualité et l'efficacité de la gestion du parc à conteneurs de nombreuses lignes maritimes et de consortiums.

. La concurrence assez vive qui existe dans certains marchés comme celui de l'Atlantique Nord et le nombre élevé d'opérateurs et de navires sont des facteurs majeurs qui contribuent à maintenir les taux de fret à un niveau assez bas depuis de très nombreuses années. Si une telle situation est profitable aux chargeurs et au commerce international en général, elle est difficilement compréhensible du côté des armateurs qui, par ailleurs, ne cessent de garnir le carnet de commande des chantiers navals, surtout asiatiques, aggravant grandement le risque de surcapacité en navires porte-conteneurs. Ainsi, la compagnie japonaise N.Y.K. a estimé que la commande de telles unités était la plus élevée de l'histoire maritime, s'établissant à 273 navires porte-conteneurs à la fin de 1990, ce qui représente une offre accrue de 430 000 E.V.P. dans un marché pourtant affecté par la récession économique.

. Un autre phénomène à signaler: la concentration sectorielle entre les mains de quelques grandes entreprises asiatiques qui représentent près de 66% de l'offre totale de transport, sur le dix premiers armements mondiaux, sept étant originaires d'Asie[6]. S'il ne faut pas s'étonner d'un tel succès bâti sur l'efficacité et sur la libéralisation des échanges commerciaux internationaux, y a-t-il lieu de s'interroger sur cette sorte de prédominance?

. Dans un tout autre ordre d'idées, le conteneur est un outil tellement pratique qu'il peut être, malheureusement, utilisé à des fins prohibées. Aussi sert-il de temps à autre de cache à des passagers clandestins comme les six Roumains qui cherchaient à entrer illégalement au Canada à bord d'un navire reliant Le Havre à Montréal en 1991.

. Bien plus grave est l'utilisation du conteneur par des trafiquants de drogue pour alimenter les marchés illicites d'Europe et d'Amérique du Nord. La question a pris une ampleur telle que plusieurs pays ont adopté des mesures draconiennes. Malheureusement, celles-ci ont plus pour effet de pénaliser les parties que de décourager une telle contrebande de substances interdites. Ainsi, les programmes d'inspection de conteneurs par les Douanes mis au point notamment dans les grands ports canadiens sont de nature à occasionner des retards préjudiciables aux importateurs. Le transporteur, pour sa part, doit assumer tous les coûts liés à de telles inspections (manutention, dépotage, empotage, repositionnement), alors que l'opérateur de terminal est tenu de mettre à la disposition des douaniers un lieu destiné à cette fin.

Aux États-Unis, le problème est bien plus dramatique en raison de l'Anti-Drug Abuse Act de 1986 qui a considérablement alourdi les pénalités infligées aux armateurs en cas de découverte de drogues à bord de leurs navires: 1000,00 $ par once d'héroïne ou de cocaïne et 500,00 $ pour chaque once de marijuana ou ses dérivés. Certains transporteurs ont dû payer plusieurs millions de dollars d'amendes alors que leur responsabilité en la matière est nulle et que leurs moyens de prévention restent modestes face à l'ingéniosité sans limite des trafiquants.

L'impression qui se dégage d'une telle réalité est celle d'une profonde injustice dont font l'objet les transporteurs déjà victimes des trafiquants de drogues; en effet, ils ont à assumer, indûment, un double fardeau: effectuer un travail préventif d'inspection de type douanier et policier (qui relève des États), à leurs propres frais tout en assumant les coûts des vérifications a posteriori; ils se voient imposer, de plus, une responsabilité quasi-délictuelle aux conséquences monétaires très lourdes qui, normalement, en droit commun, ne peut leur être imputée.

3. Instrument moderne dans un contexte archaïque

En conclusion, on ne peut s'empêcher de répéter que le conteneur, outil d'une efficacité technique et commerciale tout à fait révolutionnaire, est non seulement victime de son succès considérable et de sa progression fulgurante, mais aussi et surtout d'une modernité qui transcende certaines pratiques et les règles de droit interne et international applicable. Un conservatisme encore vivace dans de nombreux milieux

d'import-export et surtout au niveau des législateurs et des conférences internationales explique en grande partie cette inadéquation entre le conteneur, illustration éclatante d'un dynamisme moderne, et les règles commerciales et légales archaïques qui le régissent tant bien que mal compte tenu du vide ou du flou juridique en la matière. Cela met en évidence la nécessité pour les intervenants, en particulier les chargeurs, de prendre les précautions matérielles, commerciales, documentaires et d'assurances qui conviennent le mieux à leurs intérêts.

Grâce au conteneur, le transport multimodal est devenu, plus qu'une mode ou un slogan, une réalité marquante de cette fin du XX[e] siècle; on y investit des sommes considérables, tous modes, infrastructures, systèmes et moyens de transport confondus. Pourtant, l'intégration et l'uniformisation ne se font pas sans heurts; ainsi, les opérateurs maritimes au Canada ont dû assumer durant 20 ans les conséquences des limites de responsabilité des chemins de fer en matière de conteneurs maritimes fixées par la Commission Canadienne des Transports (CCT) en 1972. Ces limites étaient de beaucoup inférieures à celles de La Haye-Visby et à la valeur des cargaisons et des conteneurs spécialisés. Ce n'est qu'à la fin de 1991 que l'Office national des transports a prononcé l'annulation des Ordonnances de 1972 et 1980 de la CCT, donnant enfin raison à la Fédération maritime du Canada. Quant à la Convention internationale sur le transport multimodal de 1980, elle n'est pas encore entrée en vigueur en raison du nombre insuffisant de ratifications. Il en est de même des Règles de Hambourg de 1978 pour ce qui est du relèvement de la limite de responsabilité du transporteur. Dans l'attente, il revient aux tribunaux de trancher; mais comment les inciter à tenir compte davantage des progrès technologiques et à une certaine uniformité?

Alors que le connaissement unique et direct s'est largement imposé dans les relations commerciales internationales, il est très difficile, voire impossible pour un opérateur en Europe d'obtenir une seule police d'assurance-responsabilité couvrant tous les pays de la C.E.E. où il est actif, et ce à quelques mois de l'avènement de l'Europe de 1993. De nombreux pays maintiennent des régimes d'assurance-responsabilité datant des années '20, et ne semblent pas encore disposés à prendre l'initiative d'une nécessaire adaptation et d'une uniformisation des régimes, des limites et de la documentation correspondants.

C'est dire que l'évolution est bien lente et que les signes encourageants sont si peu nombreux qu'ils méritent d'être signalés.

Ainsi, au plan interne, les États-Unis ont adopté une loi capitale à la fin de l'année écoulée, The Intermodal Surface Transportation Infrastructure Act of 1991 qui charge le secrétaire aux Transports de coordonner la politique fédérale de transport intermodal et de faire la promotion de celui-ci. La nouvelle législation crée aussi de nouveaux organismes compétents en matière de transport intermodal (Office; Advisory Board; National Commission).

Au niveau international, la Chambre de commerce internationale (ou ICC) et la CNUCED[9] ont eu l'heureuse initiative d'émettre des Règles pour les documents de transport multimodal qui fixent, à compter du 1[er] janvier

1992, un minimum de conditions standard pour les contrats de transport. Ces nouvelles Règles ne s'appliquent que si une clause du contrat ou du connaissement le prévoit expressément. En l'absence d'un régime public interétatique (convention internationale) en matière de transport multimodal, lesdites Règles constituent, avec le connaissement de la Fédération internationale des associations de transitaires et assimilés (FIATA), l'unique ébauche d'un cadre légal uniforme pouvant régir des relations contractuelles privées.

Il faut espérer que le dynamisme de la conteneurisation finira par vaincre les résistances et par accélérer les changements dans les pratiques, les textes... et les mentalités.

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1. E.V.P.: Équivalent vingt pieds (conteneur de 20') - Unité de comptage: un conteneur de 20' = 1 E.V.P.; un conteneur de 40' = 2 E.V.P..

2. N.V.O.C.C.: Non-Vessel Operating Common Carrier (opérateur maritime non-armateur).

3. Arrimage sécuritaire (Le Groupe Mariport Ltée) Ottawa, 1990, Affaires extérieures, Canada, page 8.

4. Arrimage sécuritaire, page 1.

5. Federal Highway Administration (Fairplay, July 20, 1989, page 23).

6. Conference of the International Union of Marine Underwriters, Hamburg -September 1986.

7. Fairplay, November 28, 1991 - page 2.

8. "World Containership Fleet and its State of Deployment", N.Y.K., in Journal de la marine marchande, 20 septembre 1991, pages 2258 et 2259.

9. Commission des Nations-Unies pour le commerce et le développement (ou UNCTAD).

Intercity Passenger Travel Demand Modelling: Present State and Future Possibilities

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1. INTRODUCTION

The continuing debate concerning the fate of Canadian intercity passenger rail services involves considerable uncertainty related to both the costs and demand expected to result from the adoption of any alternative. This paper addresses the demand side of this issue by reviewing recent experience in modelling intercity passenger travel in North America. In particular, the paper focusses on the state-of-the-art in intercity passenger modal choice modelling, which represents perhaps the single most critical component of the overall demand forecasting process. Section 2 of the paper reviews two methods which comprise the majority of recent efforts in this field: the multinomial logit model and the more general nested logit model. Section 3 reviews research investigating the functional form of intercity models. Section 4 then reviews six multinomial and three "structured" logit models which collectively are judged to represent the current state of intercity mode choice modelling. Finally, Section 5 summarizes the paper's major findings.

2. TWO COMMON MODELS OF INTERCITY MODE CHOICE

The dominant operational intercity passenger mode choice model currently is the multinomial logit model, which has the general functional form:

$$P_i = e^{V_i} / \Sigma_{j \in C} e^{V_j} \qquad [1]$$

where P_i is the probability that an individual will choose alternative i from a set of feasible alternatives, C; and V_i is the "systematic utility" of alternative i. V_i is a function of attributes of alternative i and the decision-maker. Given equation [1], the mode share elasticity of mode i with respect to a change in the k^{th} variable for mode j (X_{jk}) is $-\beta_k X_{jk} P_j$ where β_k is the value of this variable's parameter. Note that this cross elasticity is the same for "unchanged" modes $i \neq j$. This constant cross elasticity assumption represents the single biggest weakness of the logit model. It means that improvement in one mode will result in trip

diversions to the changed mode in fixed proportions from all other modes. It is, however, unclear whether actual intercity travel markets behave in this manner.

If this assumption proves untenable, then a more complex choice model is required. In current practice this typically means using some form of "structured" or "nested" logit model. In a nested logit model, it is assumed that the trip-maker's decision process is a hierarchical one in which various components of an overall "choice bundle" are sequentially chosen. For example, consider the lowest two levels of the Koppelman model discussed in Section 4: mode (m) and service class (c) choice. In the nested logit model, service class choice, conditional on mode choice, ($P_{c|m}$) and mode choice (P_m) are both ordinary logit models:

$$P_{c|m} = e^{Vc|m/\phi} / \Sigma_{c'} e^{Vc'|m/\phi} \qquad P_m = e^{(Vm+\phi Im)} / \Sigma_{m'} e^{(Vm+\phi Im)} \qquad [2]$$

where ϕ is a "scale parameter" which must lie between zero and one for a properly specified model, and I_m is the "inclusive value" associated with the lower level service class choice for mode m. This inclusive value is the expected maximum utility associated with the service class choice given that mode is selected. For logit models, this expected maximum utility is given by:

$$I_m = \log_e(\Sigma_c e^{Vc|m/\phi}) \qquad [3]$$

A nested intercity travel demand model is theoretically attractive. It provides a theoretically sound expression for the "trip induction" term to be included in the model's trip distribution stage, and it at least partially circumvents the constant cross elasticity assumption, in that it generates correlation among alternative choice bundles sharing common "upper level" components.

3. INVESTIGATIONS INTO MODEL FUNCTIONAL FORM

Gaudry and Wills [1978] show that many common intercity model functional forms represent special cases of a very general model constructed through the use of Box-Tukey or Box-Cox transformations of the model variables within a general linear regression model. Generalized mode split and total demand equations are eventually estimated for four modes (air, rail, bus, auto) using 1972 data for 92 Canadian city pairs. The general mode split model is:

$$MS_m = e^{Vm} / \Sigma_{m'} e_{Vm} \qquad V_m = \alpha_{m0} + \Sigma_k \alpha_k (C_{mk} + \mu_k)^{(\lambda k)} \qquad [4]$$

where MS_m is mode m's mode share, the various α terms are model parameters, the μ and λ terms are the transformation parameters which control the specific model functional form, and C_{mk} is the k^{th} explanatory variable for mode m (e.g.,

fare, travel time and frequency). Specific models were estimated involving different assumptions concerning the μ and λ parameters. In particular, the multiplicative model (used in many early intercity mode split models, see, for example, CTC [1970]) is recovered if these parameters are all set equal to zero. Similarly, setting the μ terms equal to zero and the λ terms equal to one yields the multinomial logit model. At least two important conclusions emerged from this analysis. The first is that the multinomial logit model performs particularly poorly relative to the other models. The second, more general, point is that the choice of functional form can have a dramatic impact on market share elasticities.

Gaudry and Wills [1979] continue this investigation of model functional form, in this case using a "Box-Cox dogit" model of the general form:

$$MS_m = \{e^{Vm} + \theta_m \Sigma_{m'} e^{Vm'}\} / \{[1 + \Sigma_{m'} \theta_{m'}] \Sigma_{m'} e^{Vm'}\} \quad [5]$$

where V_m is the transformed utility function defined in equation [xx] and the θ terms are the dogit parameters that further influence the shape of the overall function. In particular, they alter the modal cross elasticities relative to the ordinary logit case. One interpretation of these parameters is that they capture modal "captivity" effects among trip-makers. As in the previous study, various special case models (including the multiplicative and logit models) were estimated using 1976 observations for 56 Canadian city pairs. Perhaps the most significant conclusion from this analysis is the observation that "a minimum observed market share of 5% for all alternatives may be a rough [lower] bound for the convincing use of logit model." This is of particular importance in intercity applications where rail and/or bus often constitute "minority" modes within given travel markets and often are found to be poorly modelled by ordinary logit models.

More recently Gaudry [1989] has continued this comparison between logit, dogit and the "inverse power transformation logit", in which transformations are applied to the modal utility functions, rather than to the individual variables within these utility functions. Using 1976 data for 120 Canadian city pairs, the logit model is again found to be inferior to more generalized forms. In particular, significant asymmetry and captivity effects are found, impling that use of a logit model would underpredict the response to significant rail service level changes.

Finally, a somewhat similar exercise is presented in Oum and Gillen [1983] in which a very generalized utility function is used to derive a system of "average expenditure share" functions for five expenditure sectors that include intercity air, rail and bus services. This system of expenditure share functions was estimated using Canadian time-series data constructed for the period 1961-76, for a set of assumed parameter restrictions. In general, the estimation results indicated strong

support for the most general model developed, and tended to reject "the use of homothetic functional forms such as log-linear models."

4. SELECTED INTERCITY PASSENGER MODE CHOICE MODELS

4.1 Multinomial Logit Models

The TDA Model [TDA, 1976]: This model was developed for the Ottawa-Montreal corridor using 1972 on-board and roadside survey data. It is based on a very detailed statistical examination of the role which service variables and travellers' attitudes play in explaining intercity mode choice. In particular, factor analyses indicated that the two most important factors in modal choice are a "comfort" dimension and a "time and schedule" dimension. In addition, discriminant analyses indicated that many of the variables which best descriminate between modal groups are often not ranked highly in importance by travellers. Finally, based on eighteen modal attributes plus a wide range of time, cost and frequency measures, the best fitting logit models for "business" and "pleasure" trips were found simply to consist of: access plus egress time; door-to-door time; convenience of departures; and, for the "pleasure" model only, door-to-door cost.

The Ridout-Miller Model [Ridout and Miller, 1989]: This model was developed using 1969 CTC data for common carrier (air, rail, bus) usage in the Windsor - Quebec City corridor. Models were developed for each of business, "pleasure", and "personal" trip purposes. A variety of functional specifications were investigated for each model. Major differences were found to exist in the "best fitting" functional forms for the three models (over and above differences in parameter values for a given variable). These include the treatment of access and egress times, in-vehicle time and frequency. The models were found to best fit the data when a composite fare divided by income term is used. This implies that fare elasticities vary with income. Over and above income, however, socio-economic variables were found to play little role in explaining modal choice. A significant, correctly signed frequency term could not be obtained in the business model, most likely due to the relative invariance in observed frequencies in the estimation dataset. This lack of sufficient variability in observed modal service variables is a recurring problem in intercity demand modelling using revealed preferrence data, given the relatively small number of origin-destination pairs in most corridor-oriented datasets, as well as that most level of service attributes vary only on a city-pair basis. Finally, prediction success tables comparing the model's expected predicted mode choices for the sample versus the actual observed choices indicate that the model is unable to distinguish effectively between the rail and bus modes, which typically have similar travel times and costs for most trips.

The Wilson, *et al.* Model [Wilson, *et al.* 1990]: This model is estimated using 1984 Canadian Travel Survey (CTS) data. CTS is a home interview survey of Canadian "long distance" travel conducted periodically since 1977 by Statistics Canada. Wilson, *et al.* developed four-mode (air, rail, bus and auto) models for "eastern" and "western" Canada for business and non-business trip purposes. In contrast to the Ridout-Miller model, income enters this model as an alternative-specific, stand-alone variable rather than as interacting with travel cost. The model also divides both travel time and cost with trip distance, so that, in each case, the relative sensitivity to travel time and cost decreases as distance increases. As with the Ridout-Miller model, socio-economic variables other than income were not found to improve the model's fit of the observed data. Similarly, various "dummy" (i.e., 0-1) variables capturing effects such as party size, weekend travel, trip duration, and trip distance failed to make a significant contribution to the model.

The Wilson, *et al.* models also do a very poor job in predicting rail and bus mode shares. Rail and bus are "minority" modes in both models (representing, collectively, only 11% and 6% of the trips in the two samples). This problem is compounded by the household-based sampling method used which results, first, in relatively few usable observations overall, and, second, in very few observations of minority mode choices. These problems can be largely alleviated through use of choice-based, "on-board" surveys, since larger samples can be efficiently gathered and minority modes can be "oversampled" in a statistically valid manner.

The Abdelwahab, *et al.* Model [Abdelwahab, *et al.*, 1991; Abdelwahab, 1990]: This model was developed using the same 1984 CTS data base used by Wilson, *et al.* Twelve models in all were developed: one model for each of recreational travel, business travel, short-distance travel (less than 960 km.) and long-distance travel, with these four models being estimated for eastern Canada, western Canada, and Canada as a whole. A common set of variables was estimated in each of the twelve models. The primary purpose of developing these models was to test the spatial transferrability of intercity multinomial logit mode choice models. Formal statistical tests indicate that, even after "updating" model parameters prior to applying them to another region, eastern region models are not generally transferrable to western region models, and *vice versa*. These results are consistent with findings in the intra-urban case, in which transferrability is rarely observed, except for similar cities possessing similar transportation systems.

The PM Model [PM, 1990; OQRTTF, 1990; Ellis, 1990]: This model was developed by KPGM Peat Marwick for the Ontario/Quebec Rapid Train Task Force using 1987 Via Rail survey data (the same database used for the HORIZONS model discussed below). The model developed is a four-mode (air, rail, bus, auto) multinomial logit model, disaggregated by business and non-

business trip purposes. In this model, travellers are split into "low" and "high" income groups. Separate access/egress time and run time parameters are then estimated for each income group for each trip purpose, assuming that all other parameters in the utility functions (notably the cost parameter) are, on average, the same for the two groups. Two factors included in the model that are designed to explain the auto - common carrier competition over and above travel time, cost and frequency effects are "large city" and "group" dummy variables. While the parameters for these variables have expected signs, the statistical and numerical significance of these terms implies that further categorization of the market may be required in order to properly model modal choice in this corridor.

Large dummy variable and modal bias parameter values raise the question of the role of such terms in intercity models. They capture the "all else being equal", systematic preferences shown by travellers for the various modes. Such bias terms must be included in logit mode choice models so as to avoid biasing the other model parameters. In practice, these bias terms are often large relative to other factors in the model. The presence of such large constants raises several important concerns about the use of such models in forecasting. First, changes in level-of-service may result in small predicted changes in mode choice. Second, important variables affecting mode choice may have been omitted from the utility function. Third, modal splits for a "new" mode such as high-speed rail are very difficult to forecast, since it is unclear what the new mode's bias term should be. This last point obviously lies at the heart of much of the debate concerning intercity travel demand modelling. The elimination of this problem is the primary motivation of the "abstract mode" modelling approach characteristic of early aggregate modelling efforts. It is clear, however, that such abstract mode models are not achievable in practice, leaving modellers to deal with modal constants in as best a way as possible. In particular, this is a prime motivations for the use of the stated preferences data collection approach, discussed further below.

The Koppelman Model [Koppelman, 1989]: Koppelman has used 1977 Nationwide Personal Transportation Study data to develop four-stage nested logit models of U.S. intercity business and non-business travel. The four stages modelled are: trip frequency, trip destination, mode and service class choice. Although the lowest level service class choice enters the mode choice model utility function via an inclusive term, the mode choice model *per se* is essentially a multinomial logit model, conditional on destination choice, and hence is largely comparable to the other models discussed in this sub-section.

The time-cost-income structure of this model's specification is the same as the Wilson, *et al.* structure. Values of time, however, can not be deduced from this model since they were assumed prior to model estimation, and then used to

construct a "generalized cost" term to use in the model estimation. This approach was adopted in order to circumvent the high collinearity between travel time and cost that was found in the data -- a common problem in intercity travel demand modelling. As in the Ridout-Miller model, bus and rail frequencies were found to be statistically insignificant for business trip mode choice, while being correctly signed and significant for non-business trips.

4.2 "Structured" Logit Models

Both models reviewed in this sub-section use the "stated preference" approach to travel behaviour surveying. Considerable research has been undertaken to develop and assess stated preference based models for travel demand applications (e.g., Louviere, *et al.* [1981], Louviere and Hensher [1982], Hensher, *et al.* [1988], Ben-Akiva, *et al.* [1990], and Morikawa, *et al.* [1991]). Stated preference approaches provide the analyst with far greater control over the range and combination of service factors to which respondents are exposed. They also allow hypothetical or not-yet-existing modes or service levels to be tested for trip-maker responses. The major disadvantages of the approach are, first, that it requires very careful survey designs in order to ensure that valid responses are obtained. Second, some question still exists among some travel demand modellers concerning the overall validity of the technique; that is, can the method be trusted to provide useful estimates of what people will actually do when faced with a real, rather than hypothetical, choice?

SIGNALS, HORIZONS, COMPASS: These are three "generations" of essentially the same model design. SIGNALS was used by Via Rail in its 1984 high-speed rail study, [Via Rail, 1984] but has been largely superceded by the other two models. HORIZONS was developed for use in Via's 1989 review. COMPASS is the most recent version of this modelling system, and has been applied in several recent U.S. high-speed rail studies. These latter two models are discussed below.

COMPASS [TEMS, undated; TMS/Benesch, undated] is a multimode (air, rail, bus, auto) intercity modelling system. The modal split model assumes a "hierarchical" decision structure in which total demand is first split between auto and common carrier modes, the common carrier demand is then split between air and surface modes, and the surface mode demand is then split between rail and bus. At each stage a binary logit model is used for each trip purpose of the form:

$$P_1 = 1 / \{ 1 + \exp(-[B_0 + B_1 f(GC_i, GC_2)]) \} \qquad [6]$$

where P_1 is the probability of choosing alternative "1" from the set of alternatives {1,2}; GC_m is the "generalized cost" of travel by mode m; f() is either the the generalized cost of alternative 1 minus alternative 2 or the ratio of alternative 1's

generalized cost to that for alternative 2; and B_0, B_1 are model parameters.

The model parameters are estimated through regression analysis of the linearized form of equation [9]. The generalized cost terms for composite alternatives (e.g., for surface common carrier modes) are constructed by weighting the generalized costs of the individual alternatives comprising the composite. The modal generalized cost is defined as the sum of the total travel cost and the monetary equivalent of the total travel time and route frequency, based on computed values of time and frequency. These values of time and frequency are derived from an attitudinal survey of intercity travellers, segmented by trip purpose, mode, distance (short/long) and income (high/low), designed to elicit the respondents' stated mode choice preferences as a function of modal attributes.

HORIZONS [Via Rail, 1989] was developed during the 1989 Rail Passenger Review Study. A key difference between HORIZONS and COMPASS is that HORIZONS uses the nested logit inclusive value to represent composite mode generalized costs, rather than the *ad hoc* weighted average costs described above. Two important points concerning this model should be noted. First, the goodness-of-fit of the final, nested logit version of the model was found to be considerably better than earlier versions of the model based on the weighted average composite cost terms. Second, a few of the ϕ values estimated are greater than 1.0 in value. This indicates that the decision structure is possibly mis-specified, and, hence, alternative decision structures should be investigated.

The CRA Model [Brand, *et al.* 1991]: The starting point for the development of the Charles River Associates (CRA) model is the observation that the constant cross elasticity assumption of the multinomial logit model appears unrealistic for the intercity mode choice case. Further, it is argued that nested logit models do not satisfactorily resolve this problem, since they still assume constant cross elasticities within a given decision structure level. Given that auto, air and bus users are observed to possess very different values of time, etc., it is expected that "current" users of these modes will divert to rail at various rates with respect to various types of rail service changes. Further, the nature of travellers' values of times, etc. are "revealed" through the fact that have chosen a given mode. Thus, for example, we "know" that current auto users will be quite cost sensitive but relatively time insensitive, and hence more likely to divert to moderately priced rail options than more expensive options. Therefore, an approach which directly captures these different tradeoffs within these sub-markets should perform better than one which only captures the "average" response of the aggregated market.

Given these observations, the CRA model uses "direct" demand models to predict the origin-destination flows by mode for each of the air, auto and bus

modes, in the absence of high-speed rail. Bi-modal logit models are then used to predict the diversion from each of these modes to high-speed rail, given the introduction of this mode. That is, three separate logit models are used to estimate the rail-auto, rail-air and rail-bus competition. Choice-based stated-preferences survey methods are used to elicit auto, air and bus users' tradeoffs between their current mode and high-speed rail attributes. Each model then simply consists of cost and time terms plus a high-speed rail constant.

5. SUMMARY, CONCLUSIONS, FUTURE WORK

Some fairly clear conclusions concerning modelling intercity mode choice have emerged from this review. The first is that a minimum level of disaggregation is required to achieve behaviourally plausible, policy-sensitive models. This disaggregation must include the development of separate models for business and non-business purposes (with further disaggregation of the non-business category, as appropriate). The model also must be sufficiently disaggregated spatially to permit reasonable calculations of access and egress travel times and costs by mode.

Second, with the notable exception of income, few socio-economic variables have been found to affect intercity mode choice in a consistently significant way. Brog [1982] similarly reports "surprisingly little impact" of socio-demographic variables based on detailed attitudinal survey results from West Germany.

Third, both aggregate and disaggregate modelling results indicate that the "simple" multinomial logit model is not an appropriate model formulation for intercity mode choice, due to its constant cross elasticity assumption. Various forms of "structured" logit-based models can be used to circumvent this problem.

Fourth, the use of stated preference techniques is becoming commonplace as a means of determining plausible values of time, etc. for predicting travellers' responses to the introduction of essentially new services such as high-speed rail.

Despite the considerable improvements in the intercity demand modelling state-of-the-art which has occurred over the past twenty years, several issues remain which require further investigation if this state-of-the-art is to continue to develop and if the contribution of these models to intercity passenger policy formulation and decision-making is to be maximized. The first is a need to explore intercity travel market segmentation in a more detailed, systematic way than has generally been undertaken. The role of trip distance, income as a categorizing rather than explanatory variable, auto ownership (an almost totally unexplored variable in the intercity context), and seasonal variations in travel

choices (again, almost totally unexplored but surely of significant interest in the Canadian context) all require considerable additional investigation.

Second, a need exists to explore in a systematic way the various options for "structuring" the intercity mode choice process. Additional options also exist, including alternative orderings of choices within the binary choice. Extending this concept, a need exists to apply the use of very generalized functional forms (typlified by the work of Gaudry) within the context of the "structured", disaggregate models characteristic of current operational methods. Computational complexities undoubtedly exist with respect to this approach. Nevertheless, use of such generalized functional forms typically widens the range of testable model assumptions, as well as provides useful insights into the extent to which the more restricted functional forms (and, hence, the underlying theory generating these restricted functional forms) are adequately capturing observed behaviour.

In general, these needs point to the more basic need for treating intercity travel demand modelling as a research task; that is, as a process of hypothesis formulation and testing designed to improve our understanding of intercity travel behaviour in general and our practical capabilities for predicting future travel behaviour in particular. This approach can be contrasted with the all too common approach adopted in this field in which models are treated as proprietary tools that are designed to promote a particular point of view and that are not open to peer scrutiny and professional, informed debate. Without such scrutiny and debate, however, the modelling state-of-art will inevitably fail to achieve its potential, will inevitably suffer from a general lack of credibility, and, hence, inevitably fail the policy formulation process it is intended to serve.

REFERENCES

Adelwahab, W.M. [1990] "Transferability of Intercity Disaggregate Mode Choice Models in Canada, **Canadian Journal of Civil Engineering**, Vol. 18, pp. 20-26.

Abdelwahab, W.M., J.D. Innes and A.M. Stevens [1991] "Development of Disaggregate Mode Choice Models of Intercity Travel in Canada", unpublished manuscript, Fredricton: Dept. of Civil Engineering, University of New Brunswick.

Ben-Akiva, M.E., T. Morikawa and F. Shiroishi [1990] "Analysis of the Reliability of Stated Preference Data in Estimating Mode Choice Models", **Proceedings of the Fifth World Conference on Transport Research**, Yokahama.

Brand, D., T.E. Parody, P.S. Hsu and K. Tierney [1991] "Forecasting High Speed Rail Ridership", presented at 71st Annual Meeting of TRB, January, 1992.

Brog, W. [1982] "The Application of the Situational Approach to Depict a Model of Personal Long-Distance Travel", presented at 61st Annual Meeting of TRB, Jan.

CTC [1970] **Intercity Passenger Transport Study**, Ottawa: Research Branch, Canadian Transport Commission, September.

Ellis, R. [1990] "Intermodal Substitution and High-Speed Rail: Evidence from the United States and Lessons for Canada", in D.W. Gillen (ed.) **Canadian Transportation Policy**, Policy Forum Series - 18, Kingston: John Deutsch Institute for the Study of Economic Policy, Queen's University, pp. 51-60.

Gaudry, M.J.I. and M.J. Wills [1978] "Estimating the Functional Form of Travel Demand Models", **Transportation Research**, Vol. 12, pp. 257-289.

Gaudry, M.J.I. and M.J. Wills [1979] "Testing the Dogit Model with Aggregate Time-Series and Cross-Sectional Travel Data", **Trans. Res. B**, 13B, pp. 155-166.

Gaudry, M.J.I. [1989] "Asymmetric Shape and Variable Tail Thickness in Multinomial Probabilistic Response: Three Model Type Families in a Quasi-Direct Format Application to Intercity Travel Demand with Aggregate Canadian Data", draft, Montreal: Centre for Transportation Research, University of Montreal, June.

Hensher, D.A., P.O. Barnard and T.P. Thruong [1988] "The Role of Stated Preference Methods in Studies of Travel Choice", **Journal of Transport Economics and Policy**, Vol. XII, No. 1, pp. 45-58.

Koppelman, F.S. [1989] "Models of Intercity Travel Choice Behavior", presented at 68th Annual Meeting of TRB, January.

Louviere, J.J., D.H. Henly, G. Woodworth, R.J. Meyer, I.P. Levin. J.W. Stones, D. Curry and D.A. Anderson [1981] "Laboratory-Simulation Versus Revealed-Preference Methods for Estimating Travel Demand Models", **Transportation Research Record 794**, pp. 42-51.

Louviere, J.J. and D.A. Hensher [1982] "On the Design and Analysis of Simulated Choice or Allocation Experiments in Travel Choice Modelling", Working Paper 50, Iowa City: Institute of Urban and Regional Research, The University of Iowa.

Morikawa, T., M.E. Ben-Akiva and K. Yamada [1990] "Forecasting Intercity Rail Ridership Using Revealed Preference and Stated Preference Data", presented at 70th Annual Meting of TRB, January.

OQRTTF [1991] **Ontario/Quebec Rapid Train Task Force Final Report**, Ontario/Quebec Rapid Train Task Force, May.

Oum, T.H. and D.W. Gillen [1983] "The Structure of Intercity Travel Demands in Canada: Theory, Tests and Empirical Tests", **Trans. Res.**, 17B, No. 3, pp. 175-191.

PM [1990] **Analysis of the Market Demand for High Speed Rail in the Quebec/Ontario Corridor**, report to Ontario/Quebec Rapid Train Trask Force, Vienna, Va: KPMG Peat Marwick, June.

Ridout, R. and E.J. Miller [1989] "A Disaggregate Logit Model of Intercity Common Carrier Passenger Modal Choice", **Canadian Journal of Civil Engineering**, Vol. 16, 1989, pp. 568-575.

TDA [1976] **Mode Choice for Intercity Passenger Travel Montreal-Ottawa**, Working Paper, TP 234, TDA 75, Montreal: Transportation Development Agency.

TEMS [undated] **The Compass System, Demand Forecasting and Strategic Economic Analysis System**, Hamilton: Transportation & Economic Management Systems, Inc.

TMS/Benesch [undated] **Tri-State High Speed Rail Study Chicago - Milwaukee - Twin Cities Corridor**, report to the Illinois, Minnesota and Wisconsin DOT's.

Via Rail [1984] **High-Speed Passenger Rail in Canada, Volume II, Appendices**, Montreal: Via Rail Canada, April.

Via Rail [1989] **Passenger Rail Demand Forecasting Study, Final Report**, 1989 Rail Passenger Review Working Paper T015-6-32, July.

Wilson, F.R., S. Damodaran and J.D. Innes [1990] "Disaggregate Mode Choice Models for Intercity Passenger Travel in Canada", **Canadian Journal of Civil Engineering**, Vol. 17, pp. 184-191.

Logistics of Exporting Hay: To Compact, or Not to Compact

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INTRODUCTION

During the past decade, a significant expansion has occurred in the world trade of forage products. Although Asia is the fastest growing market for forage imports, large volumes of hay are also moving to Europe and to parts of North America. In the United States and Canada, some regions are consistent exporters of hay, while others are regular import markets. In addition, short term markets for hay occur each year in some parts of the continent, because of floods, droughts or other environmental problems.

The largest consistent import market for forages in North America lies in the southeastern United States. Whereas Manitoba's location tends to be a disadvantage in other export markets (e.g., Japan), it favours Manitoba in the southeastern United States. The route is served by rail and truck transportation alternatives that create economic freight rates, while no other competing hay supplier is located significantly closer. The keys to economic feasibility are the identification of the least cost method of shipping baled hay from Manitoba to the southeastern United States, and the identification of the product characteristics that command the highest possible prices.

The "Sunbelt" States

The sunbelt, as the southeastern states have become known, is the fastest growing part of the United States. The migration of the retirement population and the re-location of manufacturing to this region is generating a buoyant demand for livestock products, and leisure horse-related activities. Although agriculture is well-developed in the southeastern U.S., it remains a net importer of feed stuffs.

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The investigation was limited to horse-owners and dairy operations because beef cattle can use locally grown forages, while the quantity of hay demanded by other types of livestock is not significant. Potential hay markets for the dairy and horse industries were examined in Kentucky, Tennessee, North and South Carolina, Mississippi, Alabama, Georgia and Florida. In most years, the states north of Florida are capable of producing high quality forages. Although spot markets for hay could result in any year throughout the "sunbelt" states, only Florida appears to be consistent importer.

Florida and Georgia have a large demand for top quality hay. Both states have sizable dairy industries, and Florida also has a large horse population. Forages grown in this climate are too coarse for horses and are low in protein. The trend to increasing scale and concentration of the dairy industry favours the import of hay. Dairy producers that operate large commercial production facilities in these states purchase the majority of their feed. Available data indicate that Florida imports close to 500,000 tons of forage annually (Government of Canada, 1989).

Market Structure

The Florida horse industry ranges from individuals who own a couple of horses for pleasure use, to commercial farms that raise horses for racing, showing, and breeding. Non-commercial operations generally purchase hay through a broker and use grain supplements to achieve a balanced feeding program. Large operations also use hay brokers, but some will buy hay directly from other U.S. States or Canada. The main difference between the large and small operations is that commercial horse farms are more interested in the quality and cost of feed.

The supply of hay for the horse market is controlled by a few brokers who import hay from several areas, including New Mexico, the northern United States and Canada. Most hay brokers guarantee their product, and understandably, they are very sensitive to the quality and consistency of the hay received.

Although hay brokers also supply the dairy industry, larger dairy operations often deal directly with hay exporters. Also, the demand in the dairy market appears to be more price elastic, which is to be expected given the need for dairy producers to work on a margin between the price of milk and the price of feed.

Stated Preferences of Hay Buyers

In order to examine the preferences of hay buyers, a market survey was undertaken of horse owners and dairy producers. The survey was designed to elicit information about buyer practices and preferences. The questionnaire was formatted to permit a conjoint analysis of the stated preferences.

Hay Buyer Survey Results

The 30 surveyed horse farms purchase 100 percent of their hay requirements. A sizable percentage of the farms are operated by women, and they expressed an interest in small square bales that weigh approximately 60 pounds. String and plastic ties appear to be favoured over wire ties. Although not all purchased hay features a chemical analysis, most hay buyers would like one.[1] Compacted bales are not viewed favourably in the Florida horse market. Most individuals would only accept compacted bales, if the price were discounted.

The five major quality attributes that are most desired by horse owners are: alfalfa/grass mixture ratio; protein; colour; stem size; and the moisture level. A consistent mixture of alfalfa and grass is important, but interestingly, the most preferred hay bale is 100 percent alfalfa. A maximum of 20 percent protein content, with a minimum of 15 percent is becoming more critical in this market, as more emphasis is being placed on the nutrient value of the feed. The appearance of the hay is often used by buyers as an indicator of quality. In this case, colour and stem size appear to be the most important. Stem size is a practical consideration for horse owners, because horses, (race horses in particular) are more likely to reject the hay if it is not palatable. Similarly, moisture content, which may affect palatability, must be acceptable.

On an individual basis, horse farms do not consume large quantities of hay. The largest tonnage of hay imported by an individual farm in the survey is 73 tonnes per year. The average buying price in the Florida horse market ranges from US$190/ton to US$220/ton. Converting to Canadian dollars and metric tonnes, these values become CAN$240/tonne to CAN$278/tonne, assuming a US$1.00 = CAN$1.15 exchange rate.

The major differences between the horse and dairy markets pertain to the physical appearance of the bales and the nutritional analysis. The dairy industry prefers larger bales because of the volumes handled. The appearance of the bale is less important provided that the cows will accept the hay. Dairy producers are interested in three measures of nutritional value: crude protein, acid detergent fibre, and neutral detergent fibre. Crude protein should be at least 20 percent for export to the southern dairy market. The acid and neutral detergent fibre should be low, approximately 25 percent.

There appears to be a considerable resistance amongst dairy producers to hay prices greater than US$190 per ton. Coastal grass and protein supplements are substituted in the feeding program when the price of "imported" alfalfa hay becomes too costly.[2]

The annual volume of hay purchased by individual dairy farms ranged from 950 tons to 8000 tons. Most dairy producers use hay brokers to supplement the hay they acquire from out-of-state hay producers. Compacted hay is accepted in this

market and the surveyed dairy producers are willing to consider export quality compacted hay from Manitoba, if it is competitively priced.

Conjoint Analysis

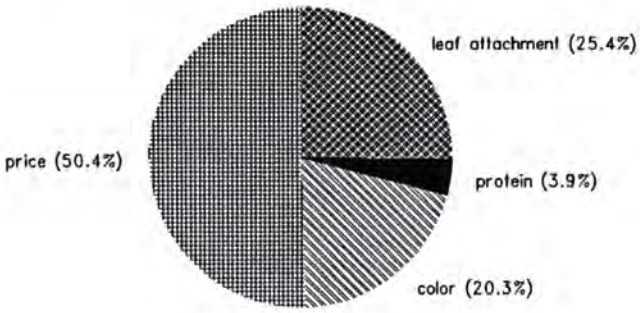
Conjoint analysis is a statistical method used to quantify the quality attributes of goods and services. The concept underlying conjoint analysis is that consumers view products as "bundles of attributes". Although buyers find it difficult to define the weights they place on the individual quality characteristics of an item, if given a choice between a group of goods with different attributes, buyers can choose the one they like the best. The method of conjoint analysis is based on the assumption that buyers can express their decisions in the form of a subjective ranking.

Horse Industry Stated Preferences

For the horse industry, four attributes are tested: hay colour; leaf attachment; crude protein; and price. With the dairy industry respondents, hay colour was replaced with a chemical analysis of neutral and acid detergent fibre content. The respondents are read a description of the hay and asked to assign a rating of its desirability between one and ten. This procedure is repeated four times with four different hay quality descriptions.

Figure 1 represents the relative importance of the features using the conjoint analysis. The high rating given to protein content is very interesting for Manitoba exporters. The northern latitude enables Manitoba farmers to grow consistently high protein hay. Clearly, this is a quality feature that should be foremost in any promotional campaign for Manitoba hay to this market. The horse owners do not appear to be as concerned about the individual quality features, as they are about the price of hay. Further analysis of the data suggests that US$220/tonne (CAN$278/tonne), is the level where price becomes extremely critical.

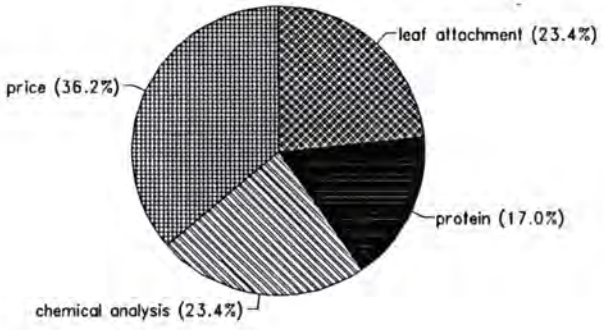
Figure 1 Relative Importance of Features in the Horse Industry



Dairy Industry Stated Preferences

Figure 2 represents the relative importance to the dairy industry of protein, leaf attachment, chemical analysis and price, as measured by the conjoint analysis. It is noteworthy that the relative importance of the features is considerably closer in the dairy industry than in the horse industry. The appropriate interpretation of the two markets is that the dairy industry pays more attention to quality, than the horse owners.

Figure 2 Relative Importance of Features in the Dairy Industry



Summary

The ideal hay for the horse market in Florida could be described as a square 100 percent alfalfa bale, preferably non-compacted, with an average weight of sixty pounds, and free of mould or foreign material. A chemical analysis is optional, but there is a growing demand this information. A protein level of approximately 20 percent is required. The desirable visual characteristics are: a bright green colour; a small stem size; and, leaf attachment greater than 75 percent. Manitoba exporters who can supply hay that meets this description, can expect to receive a delivered price around US$200/ton (approximately CAN$250/tonne) in the Florida horse market.

The ideal hay for the dairy industry in Florida and the southern part of Georgia would be large 100 percent alfalfa bales, with a complete chemical analysis and no mould or foreign material. The three most important nutritional variables are crude protein, and the neutral and acid detergent fibre content. The protein level must be greater than 20 percent and the detergent fibres as low as possible. The outward appearance of the hay is less critical for dairy producers than horse owners, but it should still look like quality hay. Dairy producers in Northern Florida and Southern Georgia are in willing to pay US$150/ton to $190/ton for delivered hay, which is approximately CAN$190/tonne to CAN$240/tonne.

Although the quality of hay is important, it is overshadowed by price. Consequently, shippers must search for the method of transport that minimizes the price to the buyer. The next section considers alternative methods of transportation and the economics of compacting hay.

TRANSPORTATION

The cost of transporting hay from Manitoba to the southeastern United States represents over half of the delivered price. Among the alternative means of transport that are available, trucking companies can provide several sizes of enclosed and flat deck trailers, while the railways offer boxcars and intermodal trailer service. All modes of transport are examined to determine their cost, and competitive advantage.

The logistics costs of exporting hay can be reduced by increasing the density of the product. There are two basic methods used to increase the density of hay: dehydration and compaction. Dehydration has the advantage of "sanitizing" the hay, but the process is more expensive than compacting. Dehydration includes such things as cubing and pelleting. Compacting involves simply squeezing the regular bales to half their size with a large hydraulic ram. Compacted hay is also considered to be more desirable because the length of the fibre is not altered by the processing. The compacted bale usually commands a higher price than the either cubing or pelleting. Using either dehydration, or compacting, enables shippers to load the full weight limit of 40 foot ISO containers.

It is generally assumed that compacting, or dehydration, is necessary to serve distant markets. This assumption was examined for the export of Manitoba hay to Florida. The results suggest that the costs of increasing the density of hay may not be warranted if "high-cube" trailers are available.

The rates quoted in this section are for the month of August 1991. Although the absolute levels of these rates are subject to change, the relative differences between the various transportation options are likely to remain consistent. Freight rates are analyzed for regular and compacted bales to determine the benefits of compacting hay prior to shipping. The compaction cost is approximately $50/tonne for a commercial operation (Tyrchniewicz, Prentice and Jeffrey, 1991). If a producer were doing his own compacting, this cost could be reduced. For comparison, the producer's own compacting cost is assumed to be $30/tonne.

Truck Transport: Enclosed Vans

The large numbers of refrigerated vans that are used to transport fresh produce out of Florida provide an opportunity to move hay as a southbound load.[3] The northbound movement is seasonal, and as a result the cheaper rates for moving the hay into Florida are also seasonal. Fortunately for Manitoba hay exporters, the seasons are complimentary. The largest volume of Florida vegetables and fruit movements occur between December and June, which is the period when hay prices are seasonally high. During August, the rates for a van shipment of hay from Winnipeg, Manitoba to Ocala, Florida range from $2800/load to $3100/load. These rates could be reduced ten to twenty percent in winter and early spring months.

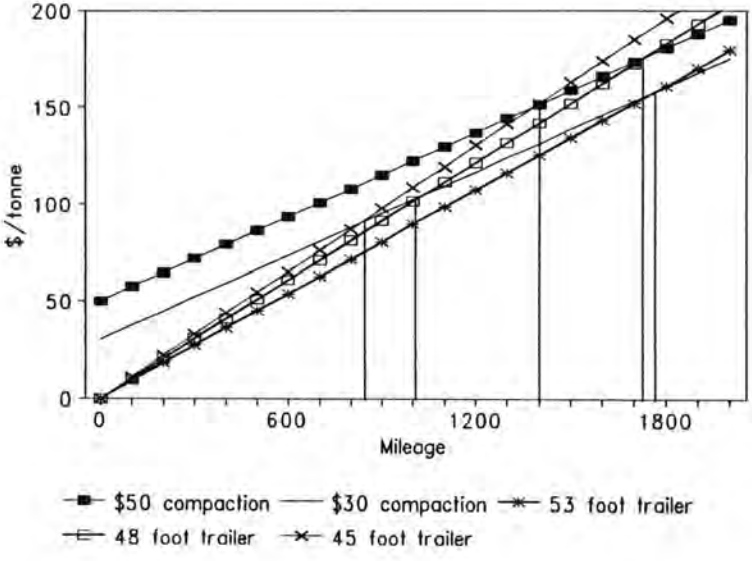
Truck weight restrictions on the U.S. Interstate Highway system permits a maximum load of 21 tonnes. Regular hay bales reach the volume limit of enclosed vans before the weight restriction. In a 48 foot trailer, the weight of a full load of regular bales is approximately 15 metric tonnes. A 48 foot trailer load (15 tonnes) of regular bales would cost CAN$2950 to ship to Ocala, Florida from Winnipeg, Manitoba or CAN$197/tonne. To take full advantage of these vans, the hay must be compacted to increase its density. Using compacted bales, a full load (approximately 21 tonnes) can be packed into an enclosed van. Using the same freight rate, a load of compacted bales would cost CAN$140.50/tonne to ship. However, the cost of compacting must be added to the freight rate. At the commercial rate of $50/tonne, the total cost for compacting and shipping is CAN$190.50 per tonne.[4]

Clearly, the longer the distance, and the smaller the dimensions of the enclosed van, the greater are the benefits of compacting. For short to medium distances, the total cost may be lower for shipping regular bales. Figure 3 illustrates the breakeven points for shipping regular and compacted bales in three different trailer lengths: 45 foot, 48 foot and 53 foot. In each case the weight limit is constant at 21 tonnes. The costs for compacted bales are based on a commercial rate of

$50/tonne and an assumed farm rate of CAN$30/tonne. The freight rate is assumed to be CAN$1.52/mile for all truck sizes.

The vertical lines indicate the breakeven distance for shipping regular bales versus compacted bales for each trailer size. For example, at the farm level compacting cost, and the shortest trailer length (45 foot), it is more profitable to compact bales for markets beyond a distance of 916 miles. At the other extreme, using commercial compacting costs and a 53 foot trailer, compacted bales are only profitable to ship for distances greater than 3000 miles. This suggests that if 53 foot trailers are available, Manitoba producers can avoid the costs of compacting, and serve the Florida market more economically with regular bales.

Figure 3 Breakeven Transportation Distances for Different Sizes of Enclosed Vans: Compacted versus Regular Hay Bales



Truck Transport: Flatbed Trailers

Flatbed trailers are widely used for shipments of hay in local markets. It is easier to ship large round bales on flatbed trucks because they have no walls to restrict loading and unloading of the trailer. Although the loads can be covered with

tarps, there is more risk that water damage could occur. Moreover, flatbed trailers have more limited backhaul opportunities, which means there are likely to be fewer rate cuts for loads to the southeastern United States.

Freight rates for a flatbed trailer from Winnipeg, Manitoba to Ocala, Florida average CAN$3100/load. The load of a flatbed trailer is restricted to 162 inches above the surface of the road and a width of 102 inches. Assuming the dimensions of a standard square bale are 18" x 15" x 40" and its weight is 60 pounds, a 48 foot flatbed trailer can hold approximately 15 metric tonnes of hay. To move 15 tonnes of regular baled hay from Winnipeg to Ocala would cost approximately CAN$206/tonne, while to move 21 tonnes of compacted hay would cost CAN$148/tonne. Assuming a compacting charge of $50/tonne and a 48 foot flatbed trailer, the breakeven distance for compacted hay is 1,618 miles. Using a compacting charge of $30/tonne, the breakeven distance drops to 972 miles.

Rail Shipment: Boxcars

The two most commonly used boxcars in Canada and the United States are the fifty foot and the sixty foot. The freight rates for boxcars are lower than other means of transporting the hay, but they are more time consuming to load and have a longer travel time. Given the "shelf life" of hay, speed of shipment is not very important, but the reliability of the shipment may be. Although, the railways are improving their customer service performance the predictability of delivery is generally inferior to trucking.

A minimum of two railway lines are required for the shipment of hay from Winnipeg, Manitoba to Ocala, Florida. The route examined in this analysis connects the Burlington Northern Railway (BNR) (from Winnipeg to Birmingham, Alabama) with the CSX railroad (to move the load from Birmingham to Ocala).[5] The BNR rate for hay in a fifty foot boxcar to Birmingham, Alabama is CAN$1,894 while the rate for a sixty foot boxcar is CAN$2,084. CSX rates to move these cars from Birmingham to Ocala are CAN$1,256 per fifty foot boxcar and CAN$1,327 for the sixty foot boxcar. The total cost of moving the hay to Ocala Florida in fifty foot boxcars is CAN$3,150, while the cost of moving the hay in sixty foot boxcars is CAN$3,411.

A fifty foot boxcar holds approximately 21 tonnes of regular hay bales or 40 tonnes of compacted bales, while a sixty foot boxcar can hold approximately 25 tonnes of regular bales or 50 tonnes of compacted bales.[6] As a result, the freight rates for a fifty foot boxcar are CAN$150/tonne for regular bales, while compacted bales can be shipped at CAN$79/tonne. The sixty foot boxcar can transport regular bales at CAN$136/tonne and compacted bales at CAN$69/tonne.

The breakeven distance for regular versus compacted bales using a fifty foot boxcar (based on a $50/tonne compacting charge) is approximately 1350 miles. The

mileage travelled before the load should be compacted with the sixty foot boxcar is approximately 1420 miles. With the producer compacting his own hay, (approximate cost of $30/tonne) the breakeven distance is reduced to 820 and 850 miles for the fifty foot and the sixty foot boxcars, respectively. In addition to these rail costs, the exporter must move the hay to a rail siding for loading, and the hay buyer must arrange for local delivery from the railway yard. These costs are difficult to estimate, but could add up to CAN$25/tonne to the total cost. In addition, the buyer must accept full boxcar loads of hay to realize the minimum freight costs. This may be accommodated by hay brokers or a large dairy operation, but many hay buyers do not have the equipment or the capacity to handle this size of load.

Railway Shipment: Intermodal Trailers

Railways offer intermodal services based on wheeled highway trailers that are loaded on ninety-foot railway flatcars. Intermodal trailers can be positioned directly at the producers loading facility, and transported without transloading to the purchaser's door. In this report only the forty foot trailers are examined. The forty foot box is not best suited for hauling regular hay bales, because of its smaller size and capacity. A forty foot intermodal trailer can hold 20 tonnes of compacted hay bales, but only 11 tonnes of regular bales.

In this example, the intermodal trailers are moved by road to Fargo, North Dakota and then loaded on BNR flatbed railcars. The railcar is moved to Birmingham, Alabama by BNR, then transferred to the CSX rail system and moved to Orlando, Florida. Subsequently, the trailer is removed from the railcar and pulled by truck from Orlando to Ocala, Florida.

The cost of moving intermodal trailers from Winnipeg to Ocala, Florida totals to CAN$2690 load. This works out to approximately CAN$135/tonne with the compacted bales and CAN$245/tonne with the regular bales. These freight rates indicate that hay compacting is economically beneficial for markets greater than 880 miles, based on a $50/tonne compacting charge. Using the $30/tonne compacting charge, compacting is beneficial for markets beyond 530 miles.

A summary of the costs of moving hay by the various means of transport is presented in Table 1. The lowest freight rate is the 60 foot boxcar, but these costs exclude local pickup and delivery. The minimum door-to-door total cost for compacted hay is CAN$185/tonne for intermodal (piggy back) trailers. For regular bales, the cost of 53 foot trailers (CAN$174/tonne) is cheaper. If 53 foot trailers can be obtained, Manitoba hay exporters may choose to ship regular hay bales.

TABLE 1 The Cost of Shipping a Full Load of Hay to Ocala, Florida From Winnipeg, Manitoba, in Canadian Dollars per Metric Tonne

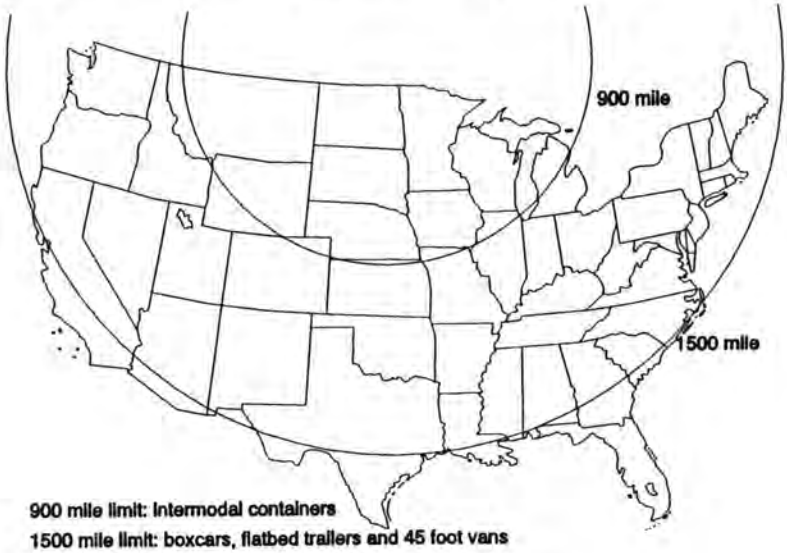
Form of Transportation	Uncompacted hay	Compacted hay with compacting charge *
Truck		
Van 45 foot **	$210/tonne	$194/tonne
Van 48 foot **	$196/tonne	$194/tonne
Van 53 foot **	$174/tonne	$194/tonne
Flatbed **	$196/tonne	$198/tonne
Rail		
Fifty foot Boxcar	$150/tonne	$129/tonne
Sixty foot Boxcar	$136/tonne	$119/tonne
Intermodal Trailer	$245/tonne	$185/tonne

* The compacted hay rate to Ocala Florida includes the $50/tonne compaction charge.

** Same weight limit.

The cost tradeoff between compacted and regular bales is illustrated in Figure 4 for various distances and trailer sizes. The circles represent the maximum distances in which it is more economical to transport regular hay bales, assuming a compacting cost of CAN$50/tonne. The intermodal container has a breakeven radius of approximately 900 miles. For distances of greater than 900 miles the combined cost of compacting and shipping is less than the cost of shipping the equivalent volume of regular bales. Boxcars, flatbed trailers and 45 foot dry vans have a breakeven radius of approximately 1500 miles. The 53 foot van has a breakeven radius of approximately 3000 miles.

Figure 4 Breakeven Radius for the Different Types of Transportation



CONCLUSIONS

The compaction of the hay may not be necessary for marketing in most parts of the United States. When transportation distance breakeven points are calculated for the various methods of transporting the hay, most markets can be served by regular bales. Given that compacted hay is not well received in the horse markets, and that the dairy producers prefer large bales, the wisdom of commercially compacting hay for the Florida market needs to be reconsidered.

Compacted square bales are likely to remain more economic for overseas shipments, because the volume limits (40 foot intermodal containers) are unlikely to be changed. If a lower cost farm level compactor can be developed, this would decrease the transportation distance breakeven points, and could make shipping compacted hay more economical by rail within Canada and the United States. Undoubtedly, the costs of alternative transportation methods deserve to be reviewed regularly by hay shippers.

REFERENCES

Beilock, Richard and J.Freeman. "Backhaul Movements of Produce Haulers in the 1980s." Journal of the Transportation Research Forum. 31,2 (1991):425-32.

Government of Canada. Domestic and International Markets for Canadian Forage and Forage Seed, Agriculture Canada, Policy Branch, May, 1989.

Louviere, Jordan J. Analyzing Decision Making - Metric Conjoint Analysis. Sage Publications, 1988.

Tyrchniewicz, Allen J., Barry E. Prentice and Scott Jeffrey. Exporting Compacted Hay from Manitoba: An Assessment of Market Potential, Transportation Considerations and Profitability for a Hay Compacting Operation. Department of Agricultural Economics and Farm Management, University of Manitoba, Extension Bulletin No. 91-1, January 1991.

ENDNOTES

1. All hay brokers require a chemical analysis of the hay before purchasing the shipment.

2. The main suppliers of pure alfalfa hay to the Florida market are located in New Mexico.

3. Florida is estimated to ship over 200,000 trailer loads of vegetables and fruit annually (Beilock, 1991).

4. Mixed loads of regular and compacted hay could be an alternative, but the market acceptance of these shipments needs to be determined.

5. A number of other routing possibilities are conceivable that could connect one of the Canadian rail lines through Ontario to a U.S. line. Although the route may be longer, the competing rail lines normally match the lowest available freight rates.

6. The capacity of the boxcars are dependent on the type of boxcar, therefore the capacities are average figures.

ACKNOWLEDGEMENTS

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Evaluating Public Transport Services According to Traveller Perceptions: The TRAM Method

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1.0 INTRODUCTION

The design of public transport networks involves making a number of tradeoffs among service characteristics. For example, one such tradeoff involves the question: should a network provide faster and more direct routes with resulting longer walking distances to stops, or should it provide shorter walking distances by having routes that penetrate into neighbourhoods and are therefore slower and more circuitous? An indication of traveller preferences would help designers identify appropriate solutions regarding such tradeoffs.

TRAM, which stands for Transit Routes Attractiveness Model, was developed to help answer such tradeoff questions. It is a tool for assessing traveller perceptions of the attractiveness of public transport services. It provides a single numeric measure of the satisfaction travellers associate with a specific network of public transport services. Each traveller's perception of not just a single route, but rather an entire collection of available routes, is considered. The resulting measure can be used to compare alternative network structures and identify the one that provides the highest satisfaction overall. It can also be used to evaluate existing transit service and to identify sub-standard service areas with respect to traveller perceptions.

The development and testing of TRAM are described in this paper. Section 2 presents the theoretical basis for TRAM and contrasts it with what has been done previously. Section 3 describes the process of calibration for use in Edmonton, Canada. Section 4 describes various test applications and discusses the results. Section 5 offers conclusions about TRAM and its application.

2.0 THEORETICAL BASIS

The basis of TRAM is the composite utility measure used with the logit model. In this section the general nature of this composite utility measure is described and its application in the case of public transport is presented.

2.1 The Composite Utility Measure

The logit model is a mathematical model that represents the behaviour of individuals selecting one alternative out of a set of alternatives. It attempts to represent the attractiveness individuals associate with each alternative and how this attractiveness is influenced by the attributes of the alternatives. It is this measuring of perceived attractiveness that is of interest here.

The logit model works by first assigning a utility value to each alternative and then using these utility values to establish a probability of selection to each alternative as follows [15,16]:

$$\text{Prob}(m^*,p) = \frac{e^{U(m^*,p)}}{\sum_{m \in M<p>} e^{U(m,p)}} \qquad (01)$$

where: m = index representing alternatives
p = index representing individuals
M<p> = the set of alternatives available to individual p
m* = one particular alternative in the set M<p>
U(m,p) = utility assigned alternative m for individual p.

The utility value for an alternative is a numeric measure of the satisfaction associated with the alternative. It is like a generalised cost, but with the opposite sign, and is determined using a utility function that is intended to represent how attributes of the alternative influence the satisfaction associated with the alternative. This utility function is typically linear-in-parameters, as follows:

$$U(m,p) = \sum_{k \in K} \beta(k) \cdot X(k,m,p) \qquad (02)$$

where: k = index representing attributes
K = the set of attributes considered
X(k,m,p) = a measure of attribute k as it is for alternative m for individual p
ß(k) = coefficient for attribute k.

Observations of the behaviour of individuals in the choice situation being considered are used to estimate the ß(k) for all k∈K. The analytic form of the logit model with a linear-in-parameters utility function is convenient to work with when performing this estimation. Computer programs that do this estimation are readily available and the statistical properties of the resulting estimates are "well behaved" [15]. Consequently, this formulation is a very attractive one for use in modelling choice behaviour and it enjoys widespread use in the transportation field [14].

The composite utility measure is a single value that represents the utility individuals associate with the entire set of alternatives M<p> as a single entity. It is not just the sum of the utility values for the alternatives, but is defined so that it is consistent with the assumptions made in the development of the logit model, taking into account that there is a probability of selection associated with each alternative. It is as follows [21]:

$$\tilde{U}(p) = \ln \left[\sum_{m \in M<p>} e^{U(m,p)} \right] \qquad (03)$$

where: $\tilde{U}(p)$ = the composite utility individual p associates with the entire set of alternatives M<p>.

This measure has been given a variety of different names that refer to its different properties. It has been called the "inclusive cost of travel" [4] and "a measure

of accessibility" [2]. These names are like the name "composite utility" in that they stress the measure's representation of an entire set of alternatives as a single entity. It has also been called the "expected maximum utility" [20] and the "stochastic analog of the expected indirect utility" [7]. Both of these names emphasize the measure's consistent treatment of the probability of selection associated with each alternative and associated acknowledgement that the alternative a given individual will choose cannot be known with certainty.

Another of the properties of the composite utility measure is that changes in its value are equivalent to changes in the consumer net benefit for the set of alternatives [21], which makes it appropriate for use in evaluation as proposed here.

A total composite utility value can be defined for a group of individuals as the sum of the separate composite utility values for each individual in the group as follows:

$$\tilde{U}(P) = \sum_{p \in P} \ln \left[\sum_{m \in M<p>} e^{U(m,p)} \right] \qquad (04)$$

where: $\tilde{U}(P)$ = the total composite utility for the group of individuals P.
P = the group of individuals

An average composite utility value can be defined for the group P as follows:

$$\bar{Y}(P) = \frac{\tilde{U}(P)}{N(P)} \qquad (05)$$

where: $N(P)$ = the number of individuals in the group P.

The calculation of $\tilde{U}(P)$ in a given application using equation 04 above requires values for each attribute for each alternative for each individual, that is, for $X(k,m,p)$ for each $k \in K$, $m \in M<p>$ and $p \in P$. This can be an onerous data requirement. As a result, a simplification is adopted where representative values for $X(k,m,p)$ are determined for a smaller set of typical individuals, each typical individual representative of some subset of the entire group P. The composite utility for a given typical individual is then taken as the value for all those individuals in the corresponding subset. This simplification modifies the calculation, making it as follows:

$$\tilde{U}(P) = \sum_{t \in P} N(t) \cdot \ln \left[\sum_{m \in M<t>} e^{U(m,t)} \right] \qquad (06)$$

where: t = index representing typical individuals and corresponding subsets of the group P
$N(t)$ = number of individuals in subset t
$U(m,t)$ = utility value for alternative m for typical individual t, which is calculated using the representative values for the attributes for individual t.

2.2 Composite Utility for Public Transport

The public transport service available to a traveller can be viewed as a network of alternative routes. The term "route" in this case refers to any path through the

network of services. This path may include transfers from one vehicle to another or include a segment of the network where several lines run together and thereby provide a more frequent service. These routes together form a set of alternatives for which a composite utility value can be determined.

In theory, the set of route alternatives available to an individual is infinite: any sort of path involving multiple transfers is theoretically an available alternative. For practical reasons, some form of rule or rules defining the set of available alternative routes must be adopted. This can be done without loss of a behavioural basis if such rules are taken to represent how individuals eliminate from consideration all but the "sensible" alternatives.

Care must be taken when selecting the set of route alternatives to be represented in a given situation. The expression for the total composite utility includes the full utility effect of each alternative and thus tends to over-emphasize the combined impact of any subsets of more similar alternatives [21]. For example, if two routes overlap for much of their lengths, with the result that they are highly similar and therefore viewed as one alternative by most travellers, the total composite utility determined with the two routes included as separate alternatives will over-emphasize the impacts of these routes. This means that each alternative should be reasonably distinct from all the others and that much more similar alternatives should not be coded as separate alternatives.

Determining the composite utility value for a set of public transport route alternatives requires a utility function for a logit model representing behaviour in choosing public transport routes. Such a utility function has the following form:

$$U(r,p) = \sum_{k \in K} \beta(k) \cdot X(k,r,p) \qquad (07)$$

where: r = index representing alternative public transport routes.

Any of the attributes of public transport service thought to influence peoples' perceptions are potential candidates for inclusion in the utility function. For an extensive list of examples of such attributes, see [5]. On the basis of previous work, the following attributes should be considered: walking distances, wait times, fares, ride times, transfer times, comfort, and reliability of service [12].

The data required to estimate the $\beta(k)$ in the utility function (equation 07) are observations of this route choice behaviour. Each of these observations concerns the behaviour of one traveller, indicating the values for the attributes for each alternative in the available set as well as the selection made by the traveller.

2.3. Relation to Previous Work

Utility has been used in the evaluation of public transport services in the past. Measures with the form of U(m,t) above have been used to represent how travellers perceive single route alternatives. For examples, see [3,6,13,16]. However, the composite utility measure whose use is proposed here, with the form of U(p) above, is different. It takes into account the entire network of available route alternatives, not just one alternative. This provides a more complete evaluation of the network's performance in this regard. Furthermore, its use avoids the need to select a single alternative for each representative individual, doing so in a way that is consistent with the 'stochastic analog' interpretation of the measure indicated above.

Measures of this form have been used in the context of choice among modes, where a single value is determined for a set of mode alternatives. For examples, see [4,7]. However, its use in the context of public transport networks as proposed here appears to be new.

3.0 CALIBRATION

Applying TRAM in a given area requires a utility function that represents the perceptions of travellers in that area. In general, observations of the route choice behaviour in the area must be obtained and used to estimate the ß(k). The calibration of the utility function to behaviour in Edmonton, Canada is described in this section.

In June 1983, 1702 individuals employed by 80 different employers located in the central business district (CBD) of Edmonton were interviewed concerning various aspects of their trip to work [10]. A total of 834 of these individuals indicated they regularly used public transport for their trip to work and these 834 were also asked to indicate the specific route they used, including where they boarded, where they transferred (if at all), and where they alighted.

An examination of the data collected in these interviews indicated that the selected route always had the following characteristics:

- a walking distance to the first stop or station less than 1500 metres;
- a total of less than three transfers; and
- a final alighting stop or station within an area centred on the CBD.

This suggested that route alternatives without all three of these characteristics are extremely unlikely to be selected and therefore could be excluded from the sets of available alternatives in order to consider only "sensible" alternatives and keep the number of alternatives down to a manageable size.

Observations of route choice behaviour were developed using the above interviews along with detailed route maps and operating schedules for all the bus and light rail services in the Edmonton metropolitan region at the time of the survey. A set of 1 to 5000 scale maps and aerial photographs of the entire area was also used. This provided a total of 250 observations including 869 alternative routes for use in estimation.

Estimates of the utility function coefficients were obtained using a computer program that employed the maximum likelihood procedure described by McFadden [15]. This program identifies the values for the coefficients that make the model do the best possible job of reproducing the behaviour displayed in the observations.

A variety of alternative utility function specifications including various combinations of measures representing attributes of public transport routes were considered. All the attributes listed above were considered except fare, which did not vary between routes in Edmonton and thus did not play any role in choice among routes, and reliability, for which there were no data.

The utility function found to provide the best fit was as follows:

$$U(r,p) = \underset{(-8.80)}{-0.00634}\cdot OWALK(r,p) \underset{(-5.50)}{-0.158}\cdot RIDE(r) \underset{(-8.42)}{-2.83}\cdot NTRANS(r) \underset{(-3.02)}{-0.600}\cdot HDWAY(r) \underset{(-4.27)}{-0.00335}\cdot DWALK(r,p) \quad (08)$$

with: $\mathcal{L}(0) = -288.7$; $\rho^2(0) = 0.38$; and %COR=72.0

where: OWALK(r,p) = the walking distance, in metres, along the shortest path from the home of individual p to the stop or station where the first vehicle in route r is boarded.

RIDE(r) = the total time spent in public transport vehicles for route r, in minutes.

NTRANS(r) = the number of transfers included in route r.

HDWAY(r) = the time between successive opportunities to use route r, in minutes. If there were no transfers then it was the time between successive runs of the vehicles travelling the route. If there were transfers, then it was the time between successive opportunities for the entire trip, including all transfers.

DWALK(r,p) = the walking distance, in metres, along the shortest path from where the last vehicle included in route r is alighted to individual p's work location.

(The value in brackets below each coefficient estimate is the t-statistic for the original estimate's difference from 0.)

Values for the measures $\mathcal{L}(0)$, $\rho^2(0)$ and %COR are reported for the utility function. These measures concern the model's goodness-of-fit for a given utility function. $\rho^2(0)$ is like the R^2 measure in linear regression: it ranges between 0.0 and 1.0 and larger values indicate a better fit [8,19]. Its values are typically less than 0.5 and the value of 0.38 obtained here represents a very respectable fit. %COR indicates the percentage of observations where the model assigned the highest utility to the alternative that was selected.

The utility function shown in equation 08 was then used to represent travellers' perceptions in the testing of the TRAM method in Edmonton. A more detailed discussion of this utility function and its component terms and a more complete description of the development of the associated logit model of public transport route choice behaviour are provided elsewhere [9].

4.0 TESTING

In order to examine the full range of representation provided by TRAM, a variety of alternative structures and service configurations were considered for a hypothetical network. This network concerns bus routes serving a hypothetical urban area containing 88 city blocks set in a system of roads that roughly follows a rectangular grid pattern. It is shown in Figure 1.

All public transport trips leaving the area were assumed to end at a single common destination that is a further 20 minute bus ride south from point A and involves no destination end walking distance. Multiple destinations (and thus an entire origin-designation matrix of trips) can be considered by adding together the results for each separate destination. Because consideration of multiple destinations would add more calculations but would not demonstrate anything further, only a single destination was considered. Furthermore, if the alternative route configurations being considered do not differ outside the hypothetical area, then the assumption of a common destination merely establishes a different constant component for the total composite utility. It will not have any effect on what is indicated with regard to the impact of changes to the public transport services within the hypothetical area only.

The total population in the area was split into 88 subsets, each subset corresponding to a block. The population for each block is shown in Figure 1. The

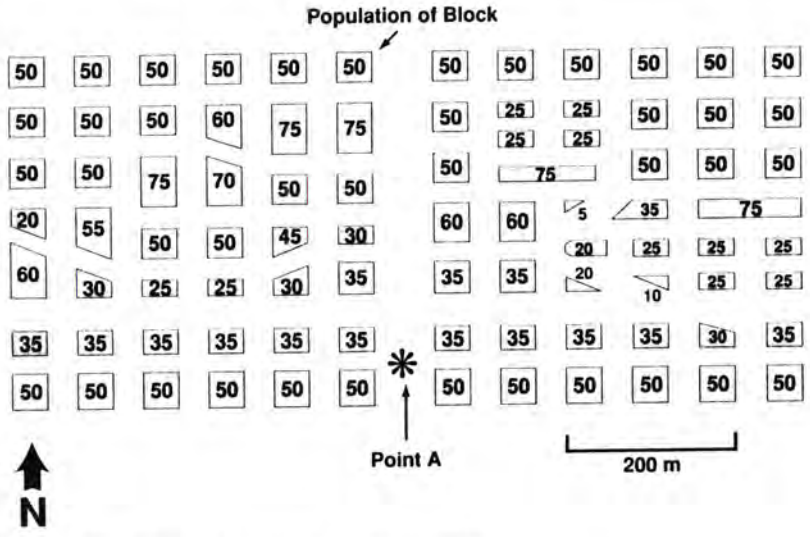


Figure 1: Hypothetical area considered in examples

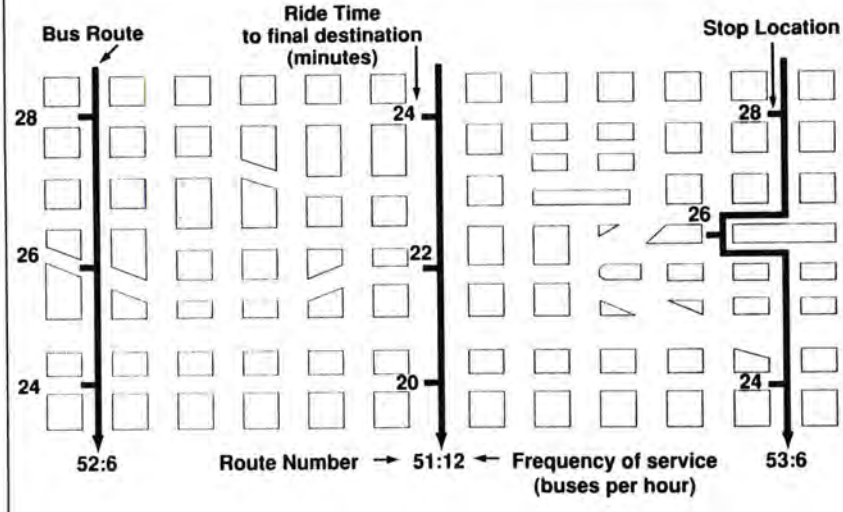


Figure 2: Base Network; against which the other are compared
Composite Utility; -6592 in total, -1.721 per person, -8.606 per rider

public transport trip generation rate (for trips destined to the common destination) was assumed to be 0.20 trips per person for all blocks. All the travellers from a given block are represented using a typical traveller whose trip starts at the centroid of the block. Travellers are assumed to use the closest stop for each route and to use the minimum distance walking path when walking to stops.

Consistent with the Edmonton calibration, all routes in the hypothetical area with an origin end walking distance less than 1500 metres are available to the travellers from each block. The routes considered in the examples are assigned numbers (arbitrarily starting at 51) and these numbers are used to refer to the routes in subsequent discussions.

Each alternative configuration considered represents some change in service relative to a base network. The results for each configuration therefore show the impact that the corresponding change has on traveller perceptions. The changes in service that are considered with the different configurations concern the following:

- moving location of a stop;
- increasing frequency of service;
- increasing riding times and decreasing walking distances;
- decreasing service frequencies and decreasing walking distances;
- introduction of bus priority measures; and
- adoption of feeder to line-haul network structure.

The results for all the alternative configurations are summarized in Table 1, which shows the resulting total composite utility and the average composite utility per person and per rider for each configuration. Illustrations of the configurations are also provided in figures as indicated in Table 1

The average composite utility values shown in Table 1 can be used to compare networks when populations and riderships are not equivalent, as would be the case when networks for different areas are being compared. The two values, per person and per rider, provide slightly different perspectives: the average per person (or per resident or per household) concerns the population, and should be used when considering such things as balancing levels of service in different areas; the average per user concerns the users only, and should be used when considering such things as user satisfaction. The total composite utility shown in Table 1 concerns aggregate conditions and should be used when considering such things as total ridership.

The first route configuration considered, called the "Base Network", is shown in Figure 2. The utility values for the Base Network on their own mean little because the 0 value does not constitute any identifiable reference point a priori. It is the changes in these values that are important.

The route configuration shown in Figure 3, called the "Changed Stop Network", differs from the Base Network in only one minor respect: the location of the middle stop has been adjusted slightly. The change in total composite utility brought about by this minor adjustment is +12. This serves to indicate the sensitivity of the composite utility measure in this application.

The route configuration shown in Figure 4, called the "Increased Frequency Network", is the same as the Base Network except that it has 50% more buses per hour on route 51. This increased bus frequency decreases the headways on route 51 such that there is an increase in the total composite utility of 707. With regard to the effects of other frequencies, Figure 5a shows a plot of the total composite utility for this structure of routes as a function of the frequency of buses on route 51. At very low

Table 1: Summary of Results for Alternative Network Structures and Configurations

network	change in network relative to Base	composite utility				Figure
		total	per person	per rider	total relative to Base	
Base	-	-6592	-1.721	-8.606	-	2
Changed Stop	moved stop location	-6580	-1.718	-8.591	+12	3
Increased Frequency	50% more buses per hour	-5885	-1.536	-7.683	+707	4
Zig-zag	longer ride times; shorter walk distances	-6708	-1.751	-8.756	-116	6
Base Plus Priority	becomes express service	-5458	-1.425	-7.126	+1134	-
Dispersed	shorter walk distances; lower service frequencies	-8719	-2.276	-11.38	-2127	7
Feeder - Line-Haul	local feeding express configuration	-6864	-1.792	-8.961	-272	9

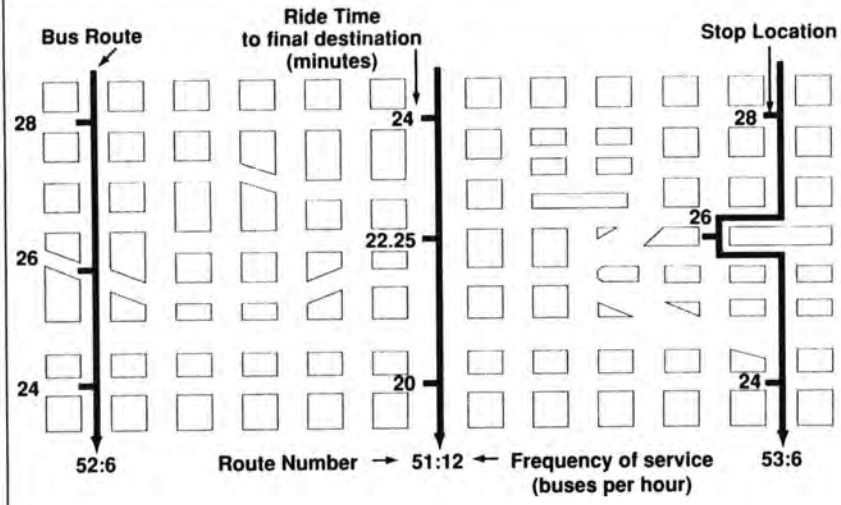


Figure 3: Changed Stop Network; location of one stop changed for route 51
Composite Utility; -6580 in total, -1.718 per person, -8.591 per rider

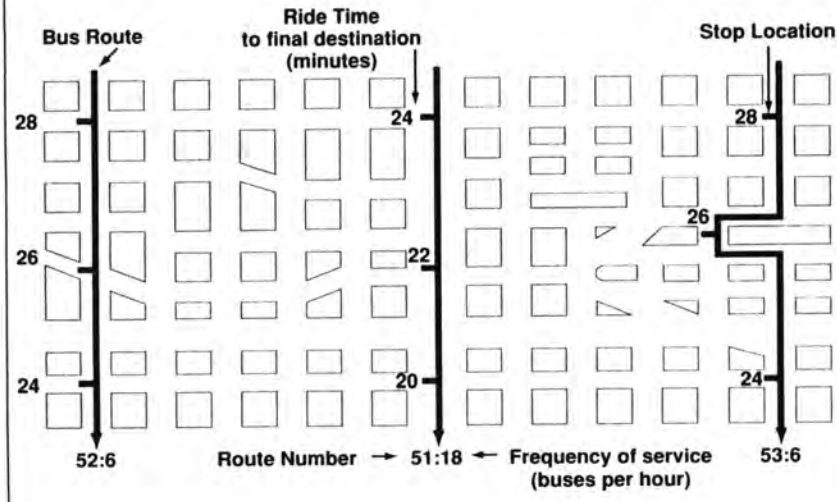


Figure 4: Increased Frequency Network; frequency of service changed for route 51
Composite Utility; -5885 in total, -1.536 per person, -7.683 per rider

frequencies, the total composite utility is at its lowest (-9012) and does not change. This occurs because route 51 at such frequencies is so unattractive relative to routes 52 and 53 that it is virtually ignored, and routes 52 and 53 establish the composite utility for the area. At higher frequencies, route 51 has an impact, but the impact for a given change in frequency decreases as frequencies get higher.

In the type of analysis where only a single route alternative is considered for each traveller - and the rest of the alternatives making up a composite utility value for the network are ignored - the results can vary widely and look very different from the plot shown in Figure 5a depending upon the rule used to select the single route for each individual. The results for two possible rules are compared with the TRAM results in Figure 5b. One line, labelled "single minimum walk alternative", shows the results when the route providing the minimum walking distance is used for each traveller. Another line, labelled "single maximum utility alternative", shows the results when the route providing the maximum utility is used for each traveller. These different results could lead to different conclusions about the most appropriate tradeoffs to make involving the attributes of route 51 and the rest of the network.

The route configuration shown in Figure 6, called the "Zig-zag Network", has longer riding times and shorter walking distances than does the Base Network. These two networks typify the two alternative configurations considered in the introduction to the paper. In this case, the analysis indicates that the Base Network has a composite utility that is 116 higher, which means it is slightly more attractive overall. It is important to note that this is not a general result. In general, the composite utilities would be different with different frequencies and walking distances - and a configuration like that of the Zig-zag Network might turn out to have the higher composite utility in some cases.

Route 54 in the Zig-zag Network could be sped up so that the riding time from point A to the final destination is 10 instead of 20 minutes - perhaps as a result of the introduction of some form of bus priority system. Then the Zig-zag Network would have a composite utility that is 1150 higher than what it was before. It would also be higher than the composite utility for the Base Network (without any bus priority system) by 1034.

The "Base Plus Priority Network" is created by introducing to the Base Network the bus priority system mentioned above, with the result that the riding time from point A to the final destination is 10 instead of 20 minutes. This brings about an increase of 1134 in the total composite utility. It can be seen from Figure 5 that the same increase could be brought about by increasing the frequency on route 51 to approximately 25 buses per hour. The costs associated with the introduction of the priority system could then be compared with the costs associated with this increase in frequency, and the cheaper option identified. Of course, whether or not the demand for bus use justifies the capacity provided by 25 buses per hour is another matter that would also have to be considered.

The route configuration shown in Figure 7, called the "Dispersed Network", is another configuration that requires the same number of buses as the Base Network. It provides shorter walking distances than the Base Network. The ride times for some travellers are not as long as they are with the Zig-zag Network, but the service frequencies are lower. There is no bus priority system. The composite utility for the Dispersed Network is 2127 lower than it is for the Base Network, indicating that the effects of the more attractive walking distances in the Dispersed Network are overshadowed dramatically by the effects of the less attractive frequencies.

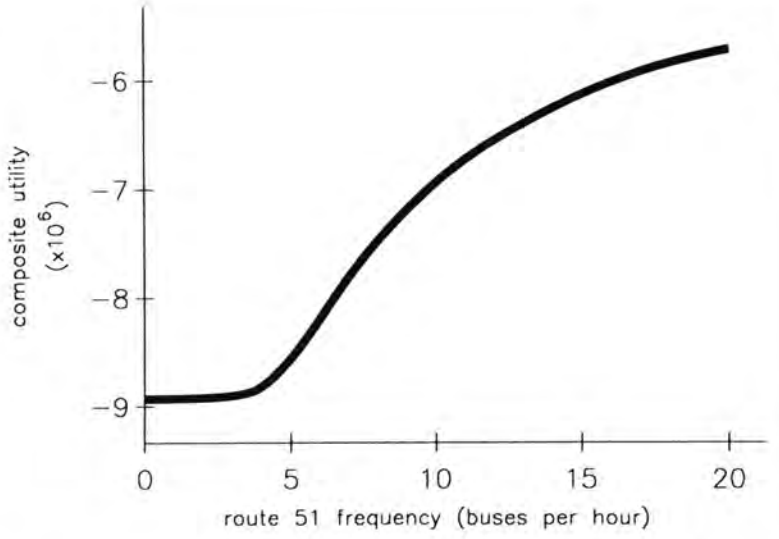


Figure 5a: Total composite utility as a function of route 51 frequency of service

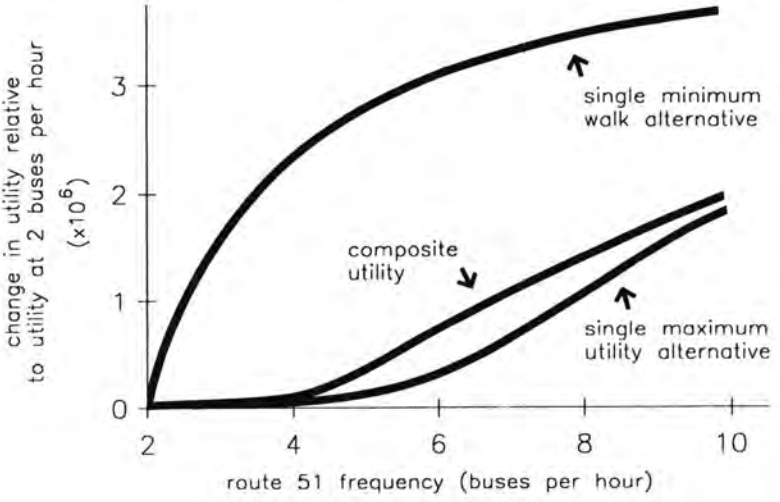


Figure 5b: Changes in total composite utility and in utility for single route alternative as a function of route 51 frequency of service; the results for both the "single minimum walk alternative" and the "single maximum utility alternative" rules for selecting the single route are shown

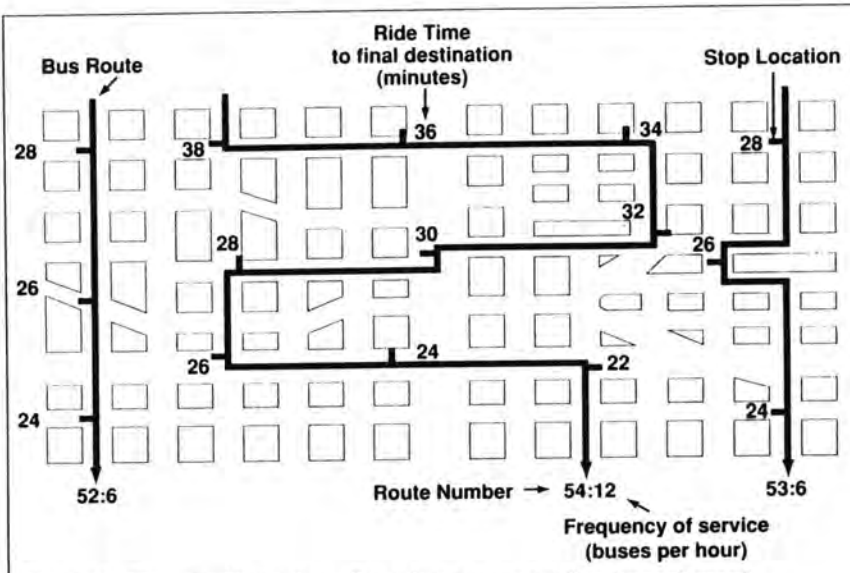


Figure 6: Zig - zag Network; walking distances and riding times changed
Composite Utility; -6708 in total, -1.751 per person, -8.756 per rider

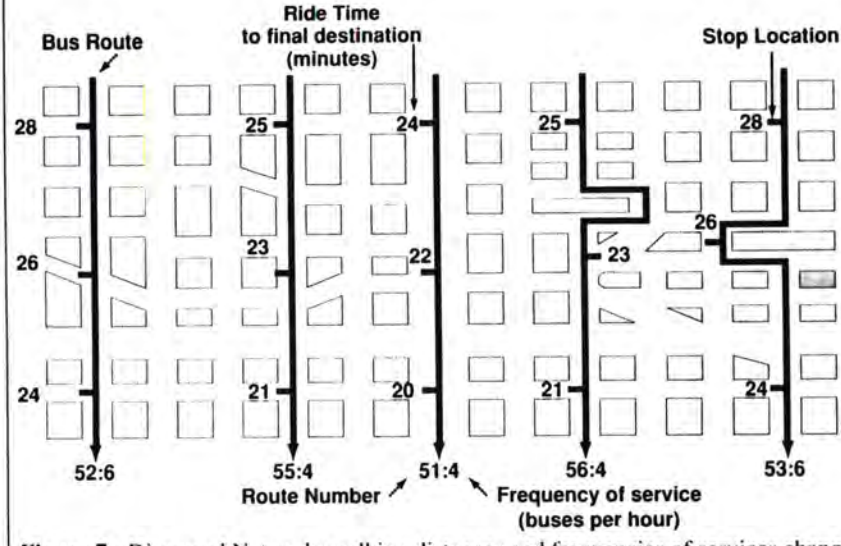


Figure 7: Dispersed Network; walking distances and frequencies of services changed
Composite Utility; -8719 in total, -2.276 per person, -11.38 per rider

In this evaluation, each alternative route's frequency is considered independently. This is the same as assuming that for the Dispersed Network the arrival times of the buses on routes 51, 55 and 56 are simultaneous. It is possible that the arrival times of the buses on routes 51, 55 and 56 are staggered so that together they provided a service frequency that is greater than their individual frequencies - which would increase the total composite utility. Such an evaluation would require a different representation of the alternatives and was not pursued in this work.

In order to examine how results from TRAM are influenced by the distribution of trip origins, the Base Network and the Zig-zag Network were re-evaluated with the population density tripled in certain blocks as indicated in Figure 8. For the Base Network, the total composite utility decreases by 1916 to become -8508. For the Zig-zag Network, it decreases by 3290 to become -12009. These large drops in total composite utility are for the most part due to the increase in the population in the area: when there are more users, there is a larger number of individual negative composite utility values added together. It is the changes in average composite utility that indicate the effect of the change in population distribution independent of the change in population magnitude. For the Base Network, the average composite utility per person increased by 0.07 when the population was increased, while for the Zig-zag Network, the average per person decreased by 0.06. This indicates that the Base Network is even more attractive relative to the Zig-zag Network when the population is more heavily distributed right along route 51.

The route configuration shown in Figure 9, called the "Feeder - Line-Haul Network", is an example of a configuration where one service, in this case route 57, collects riders and deposits them at a transfer point in order for them to transfer to another service that "line-hauls" them the rest of the way. Both the "bus feeder to rail transport" approach [11] and the "timed-transfer" approach [1] to network design employ this configuration. Apart from the transfer, the operating characteristics for all the routes in the Feeder-Line-Haul Network are the same as in the Base Network. The introduction of this transfer results in a decrease in total composite utility of 1130. Even if the line haul route is sped up so that the riding time from point A to the final destination is 10 instead of 20 minutes, the composite utility for the Feeder - Line-Haul Network increases 858 to only -6864, which means it still is not as attractive in total as Network A. This shows how TRAM could be used to identify cases where the service would be more attractive if buses did not stop or turn around at rail stations and transfer points, but rather continued on to other destinations.

Subsets of more similar alternatives can arise when there is a single line-haul service like the one depicted in the Feeder - Line-Haul Network and several bus services feed into it. Each feeder service in combination with the line-haul service is a potential route. All such potential routes share the same line-haul component and therefore are relatively more similar. As indicated above, care must be taken when selecting the alternatives in this situation. A single 'hybrid' alternative can be used to represent the service provided by the entire subset of more similar alternatives. The most appropriate properties of this hybrid are those that reproduce the corresponding properties of the particular alternative in the set of more similar alternatives with the maximum utility and also emphasize the improved conditions with respect to certain properties arising among the other alternatives in the set. Clearly, there is some judgement required at this stage of the formulation of inputs to the analysis. A more rigourous treatment of this situation involving the nested logit formulation [18,21] is possible, but was not pursued in this work.

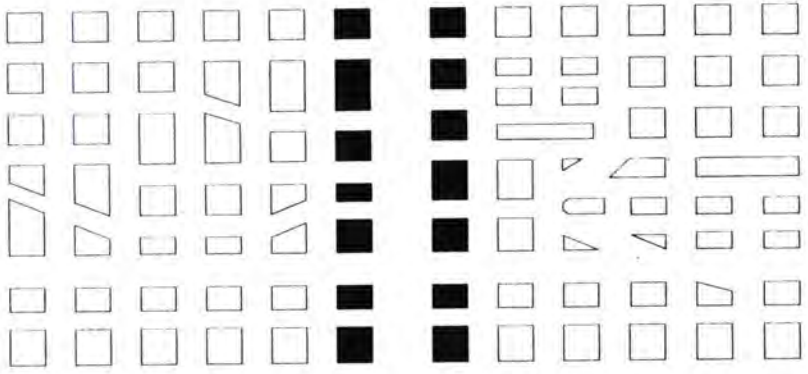


Figure 8: Hypothetical area: population is tripled in shaded blocks when the affects of population density are considered.

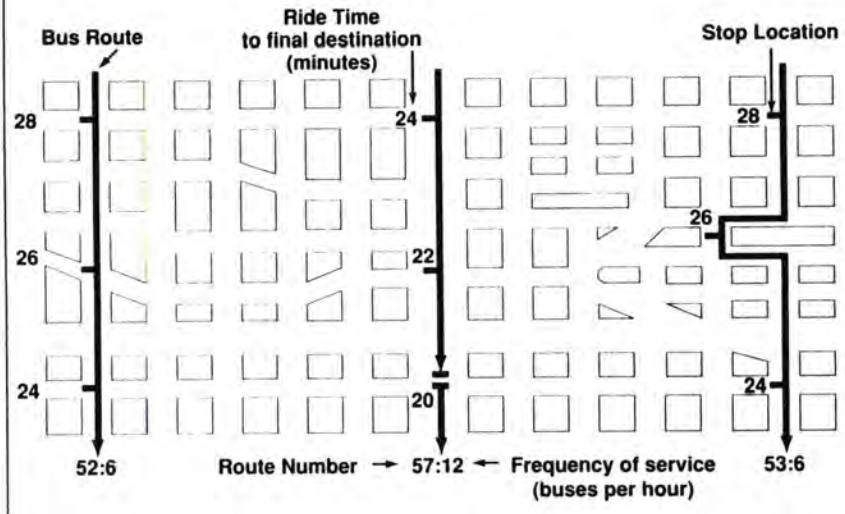


Figure 9: Feeder - Line-Haul Network: local to transfer to express configuration
Composite Utility: -6864 in total, -1.792 per person, -8.961 per rider

5.0 CONCLUSIONS

The testing described above supports a number of conclusions regarding the development and use of TRAM. These conclusions are presented below.

TRAM can be very sensitive, showing the impacts of changes as small as the location of a single bus stop.

The application of the method is relatively straightforward; only a few special points must be taken into account. It must be remembered that single composite utility values on their own have little meaning - it is the changes in these values that provide indications. It must also be remembered that separate alternatives are treated by the method as if they operate simultaneously and that subsets of highly similar alternatives are to be represented by a single 'hybrid' alternative.

The TRAM method has data requirements that are not insubstantial, although there is scope for reducing the magnitude of these requirements somewhat by aggregation. The total data requirements for both the calibration of the utility function and the determination of composite utility values for a given area or region are roughly similar to those for representing a public transport system when developing and using a mode split model.

The method allows considerable flexibility in terms of the selection of public transport attributes to be represented as having an influence on travellers' perceptions. In general, any influence that can be quantified can be included in the utility function.

The results arising with the use of the composite utility of an entire set of route alternatives can be substantially different than those arising with the use of the utility of only a single route for each traveller. The type of rule used to select the single route considered for each traveller can have a substantial effect. Because such differences in results can lead to different conclusions in the consideration of a given design, it follows that TRAM's use of the composite utility measure is appropriate and that caution should be exercised when other than the composite utility measure is used.

TRAM has promise as a practical and useful tool for establishing travellers' perceptions of the attractiveness of the service provided by public transport networks. As such it has a range of potential applications. It can be used to both (a) evaluate existing services by determining the composite utility values for these services as they are and (b) assess the impacts of service improvements by determining the changes in composite utility that would occur. The method has other potential uses. It could be used to identify areas with sub-standard services by establishing the average composite utility provided in an area and then checking if this value is below some specified minimum standard. The method could also be presented to the public as an item included in the decision making process that ensures that the public's concerns (in terms of their satisfaction with the system) are being taken into account.

In the examples considered, the Base Plus Priority Network had the highest total composite utility. This result supports the general conclusion that the residential to CBD network configuration that Edmonton travellers find most attractive overall is the one where buses operate as local services with reasonably direct routings (not too circuitous) at the residential end and then switch over to express service for the remainder of the trip to the CBD. Such a configuration is much more attractive overall than ones using feeding buses at the residential end to collect and then drop passengers at transfer points or train stations where there is a need to switch to another vehicle for

the express component. It would be inappropriate to generalize any further on the basis of the results presented here. This is because the results are affected to a large extent by the specific service characteristics involved and by the population distribution, both of which can vary considerably from case to case in reality. The utility function will also, in general, vary from city to city and be different for different types of trips with different purposes and frequencies. Of course, it is the inappropriateness of generalizing to any great extent that has led to the development of TRAM in the first place.

There is much scope for further development of the TRAM method. The extensions judged most appropriate for future consideration are outlined below.

The public transport trip generation rate is expressed as a fixed proportion of the population of each block in the examples. It could be made a function of the attractiveness of the available public transport service, increasing as the composite utility for the service increases. This would allow more complete determination of the impacts of changes in services.

A nested logit choice model could be developed for use in cases where there are subsets of more similar alternatives. This would provide a more rigourous treatment and avoid the need to come up with the properties of representative 'hybrid' alternatives in such cases, which is the most difficult aspect of the application of TRAM in its current form.

ACKNOWLEDGEMENTS

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REFERENCES

1 Bakker JJ, "Transit Operating Strategies and Levels of Service", Transportation Research Record 606, 1976, pp:1-5.

2 Ben-Akiva M and Lerman S, "Discrete Choice Analysis: Theory and Application to Travel Demand": MIT Press, Cambridge, MA, USA, 1985.

3 Clarens GC and Hurdle VF, "An Operating Strategy for a Commuter Bus System", Transportation Science, Volume 9(1), 1975, pp:1-20.

4 Domencich TA and McFadden D, "Urban Travel Demand: A Behavioural Analysis", North Holland / American Elsevier, Amsterdam, The Netherlands, 1975.

5 Golob TF, Canty ET, Gustafson RL and Vitt JE, "An Analysis of Consumer Preferences for a Public Transportation System", Transportation Research, Volume 6(1), 1972, pp:81-102.

6 Hansen E and Beimborn E, "An Assessment of the User Benefits of Intercity Bus Service", Transportation Research Record 1125: TRB, Washigton, D.C., USA, 1987, pp:78-88.

7 Hau TD, "Using a Hicksian Approach to Cost-Benefit Analysis in Discrete Choice: An Empirical Analysis of a Transportation Corridor Simulation Model", Transportation Research, Volume 21B(5), 1987, pp:339-357.

8 Horowitz J, "Evaluation of Usefulness of Two Standard Goodness-of-Fit Indicators for Comparing Non-nested Random Utility Models", Transportation Research Record 874: TRB, Washington, DC, USA, 1982, pp:19-25.

9 Hunt JD, "A Logit Model of Public Transport Route Choice", Institute of Transportation Engineers Journal, Volume 60(12), 1990, pp:26-30.

10 Hunt JD, "Description of Morning Commuter Survey", MCS Research Working Paper 7, Department of Civil Engineering, University of Alberta, Edmonton, Canada, 1984.

11 Hutchinson BG, "Characteristics of Urban Structure", Chapter 9 in Principles of Urban Transport Systems Planning": McGraw-Hill, Toronto, Canada, 1974.

12 International Collaborative Study Group on Factors Affecting Public Transport Patronage, "The Demand for Public Transport", Transport and Road Research Laboratory, Crowthorne, UK, 1980.

13 Kocur G and Hendrickson C, "Design of Bus Service with Demand Equilibration", Transportation Science, Volume 16(2), 1982, pp:149-170.

14 McFadden D, Train K and Tye WB, "An Application of Diagnostic Tests for the Independence from Irrelevant Alternatives Property of the Multinomial Logit Model", Transportation Research Record 637: TRB, Washington, DC, USA, 1977, pp:39-46.

15 McFadden D, "Conditional Logit Analysis of Qualitative Choice Behaviour", In Frontiers in Econometrics, editor P. Zarembka: Academic Press, New York, USA, 1974.

16 Newell GF, "Some Issues Relating to the Optimal Design of Bus Routes", Transportation Science, Volume 13(1), 1979, pp:20-35.

17 Richards MG, "Disaggregate Simultaneous Urban Travel Demand Models: A Brief Introduction", Transportation, Volume 3(4), 1974, pp:335-342.

18 Sobel KL, "Travel Demand Forecasting by Using the Nested Multinomial Logit Model", Transportation Research Record 775: TRB, Washington, D.C., USA, 1980, pp:48-55.

19 Tardiff T, "A Note of Goodness-of-Fit Statistics for Probit and Logit Models", Transportation, Volume 5(4), 1976, pp:377-388.

20 Williams HCWL and Ortuzar JD, "Behavioural Theories of Dispersion and the Mis-Sepcification of Travel Demand Models", Transportation Research, Volume 16B(3), 1982, pp:167-219.

21 Williams HCWL, "On the Formulation of Travel Demand Models and Economic Evaluation Measures of User Benefit", Environment and Planning A, Volume 9(3), 1977, pp:285-344.

GRAIN TRANSPORTATION AND HANDLING REQUIREMENTS AT THE WEST COAST IN 1995/96 AND 2000/01

I. INTRODUCTION

This paper is part of the Grain Transportation Agency's (GTA) ongoing mandate to examine issues in the grain handling and transportation system. The current paper builds on prior studies and examines capacity at the west coast with respect to potential demand and options available to meet that demand.

This paper is supported by a technical report[1] which is provided under a separate cover. The paper includes a brief overview of the system management, as well as the physical infrastructure, which moves grain through the grain handling and transportation system to meet sales. The objectives are as follows:

i) to project exports of the six principal grains and oilseeds (wheat, oats, barley, rye, flaxseed and canola) for the crop years 1995/96 and 2000/01;
ii) to assess current capacity of the system relative to the projections;
iii) to identify factors which affect current railway and terminal capacity; and
iv) to list some of the suggestions for non-capital and capital expenditures that have been proposed to deal with the constraints noted above.

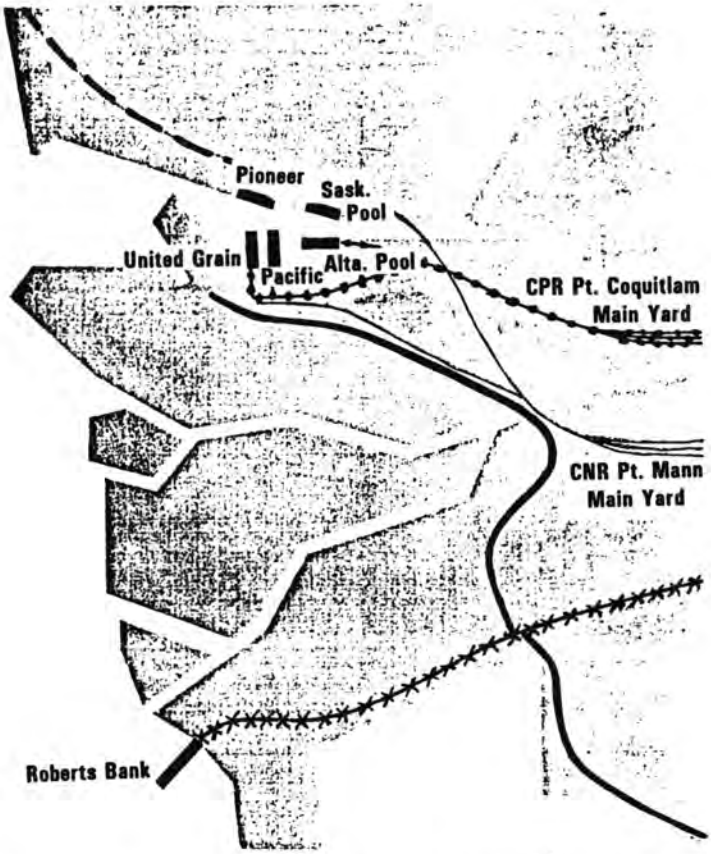
The GTA would like to acknowledge the co-operation and assistance of the terminal operators, the railways, B.C. Grain Shippers Clearance Association, the Canadian Wheat Board (CWB), and the Canadian Grain Commission, as well as others who provided input.

II. SYSTEM OVERVIEW

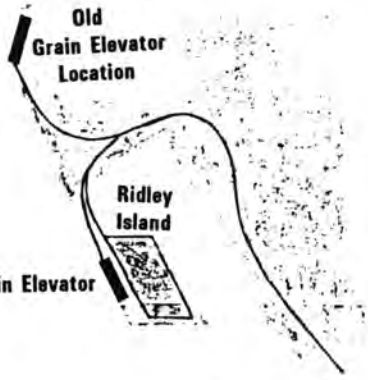
The six terminal elevators on the west coast are supplied with railcars by three railways, Canadian National Railway (CN), CP Rail and BC Rail Ltd. The five terminals that are located in Vancouver include United Grain Growers Limited, Pacific Elevators Terminal, Alberta Wheat Pool, Saskatchewan Wheat Pool and Pioneer Grain Ltd. Prince Rupert Terminal is located about 750 kilometres north of Vancouver in the Port of Prince Rupert. The Vancouver terminals are serviced by CN and CP Rail while CN alone handles the grain traffic for Prince Rupert. BC Rail Ltd. interchanges cars with CN for placement at both Vancouver and Prince Rupert terminals.

The railways transport grain cars from the Prairies to main holding and marshalling yards in Vancouver, distribute the cars to service yards and subsequently place the cars at the terminals. Grain destined for Prince Rupert is moved through

VANCOUVER



PRINCE RUPERT



CPR
CNR
BCR
BCHB
BNR

Tami Reynolds

Prince George and is placed in the terminal's yard. CN and CP Rail transport the bulk of the six principal grains and oilseeds handled by the west coast terminals.

The terminals are the interface between the railways and the vessels. They unload grain cars delivered by the railways, and clean and store the grain until it is required to load vessels. The terminals also can dry grain, however, tough grain is usually blended with drier grain to reach the correct moisture level.

III. SYSTEM MANAGEMENT

The grain handling and transportation system has evolved into a complex, regulated environment with management decisions made by a number of participants. The three major participants with roles in marketing and/or inventory management are the grain companies including the terminal operators, the CWB for wheat and barley, and the GTA for canola and oats. Rye and flaxseed are managed by the grain companies and the railways.

There are two main methods of selling grain through the west coast. The grain companies generally charter the vessel to supply buyers and cover the marine insurance (cost, insurance and freight or c.i.f.). The CWB generally delivers grain to vessels chartered by buyers (free on board or f.o.b.). While there can be marketing advantages to either method, the former may allow greater precision in matching grain demand and supply with vessel requirements. An estimate of the required grain program is developed in both cases based on previous experience with the importing countries. For example, countries like Japan are consistent in the volume and timing of their canola programs. Knowledge of international and ocean freight conditions is also used (e.g., labour disruptions, weather, etc.).

The grain program necessary to meet projected vessel requirements is developed with a planning horizon of about four weeks. The demand for grain in terminal position is determined by the projected requirement for vessel loadings and the need for a certain level of working stock of grain held in the terminals. The supply available to meet this demand includes stocks in the terminals, grain enroute to the ports, outstanding orders for grain waiting to be loaded in the country and new car loading orders.

The required unload program is communicated to the industry in the Three Month Plan. This Plan is prepared by the GTA in conjunction with the CWB, the grain companies, and the railways. The Plan shows firm tonnage and car unload requirements for the current month and initial projections for the following two months. Car loading programs are discussed at weekly operational meetings held in Winnipeg. Aggregate export programs are reviewed, and any relevant operating factors affecting programs are discussed at similar meetings held in Vancouver. Both meetings are attended by the railways, grain companies, the CWB and the GTA. There are also ongoing daily contacts among the parties as required.

Problems with synchronizing car unloading and vessel loading programs may result in vessel queuing. At times during the last five years as many as 24 vessels have been waiting for cargo. The reasons for vessel loading delays are numerous, but can be briefly identified as follows:

i) the bunching of vessel arrivals due to storms or the coinciding demand of several buyers;
ii) co-ordination problems with the size and timing of the car unloading programs and grain grades relative to requirements for the vessel programs;
iii) insufficient infrastructure to handle the commodity mix (number of grains and grades) and/or the peak demand, i.e., inability to present cars for unloading; to handle grain for unloading, cleaning, drying, and storage; and/or to load grain to vessels as quickly or in the volumes necessary to meet vessel loading requirements; and
iv) operating difficulties associated with factors such as rain or the availability of longshoremen.

The problem of delays can be minimized to some degree if there are adequate buffer stocks. The buffer must be large enough and must be sufficiently close to export positions to allow for a reasonably quick response or sales could potentially be lost or deferred. The buffer can be in the form of terminal storage, railway cars in or near the port, and/or interior terminal or primary elevator stocks.

As an illustration of the magnitude of the terminal storage buffer, terminal stocks at the west coast generally range from a low of 400 000 tonnes to a high of 700 000 tonnes. The terminals tend to have difficulty accumulating cargo lots of grain at 400 000 tonnes or less and tend to have difficulty unloading grain due to lack of usable storage at 700 000 tonnes or more. This would suggest that the maximum terminal storage buffer is about 300 000 tonnes or the equivalent of approximately eight ships (at an average of 35 000 tonnes each). However, indications are that the west coast operates most effectively when Vancouver has some 450 000 tonnes in stock and when Prince Rupert's stocks are approximately 100 000 tonnes. This suggests that the optimal level of stocks at the west coast is around 550 000 tonnes[2] which is some 150 000 tonnes above the low stock level and which implies that 150 000 tonnes is an optimal terminal storage buffer.

Table III.1 shows the relative costs per day in 1991 of the different means to keep a buffer compared with the cost of vessel demurrage. The relative costs suggest that the lowest cost option is to store grain in an elevator. It is relatively more costly to store grain in railway cars or pay demurrage on a waiting vessel.

TABLE III.1: COMPARATIVE COST PER DAY, 1991

	Cents Per Tonne
Primary Elevator Storage[1]	3.7
Inland Terminal Elevator Storage[2]	4.7
Port Terminal Elevator Storage[2]	4.7
Lease Car Costs[3]	14.8
Vessel Demurrage[4]	20.0

[1]CGC, 1991/92 Primary Elevator Tariffs for wheat, storage costs are paid after the first 10 days, excluding the day on which storage ends.

[2]CGC, 1991/92 Terminal Elevator Tariffs for wheat, for each day or part thereof excluding the day on which storage period ends.

[3]($400 per month for short-term leases/30 days)/90 tonnes = 14.8 cents/tonne. The cost would increase to 16.9 cents per tonne if the four year average tonnes per car of 78.7 is used.

[4]Dispatch is paid if the ship is loaded within five days from the time passed to the time cleared. Dispatch is approximately half the demurrage. Demurrage is paid for the time in excess of five days. Demurrage of approximately $5,000 per day is paid for a 25 000 tonne vessel.

IV. PROJECTED EXPORT DEMAND IN 1995/96 AND 2000/01

Table IV.1 shows projected exports from the west coast to be approximately 24.0 and 26.2 million tonnes for the six principal grains and oilseeds in 1995/96 and 2000/01 respectively. These projections are based on the assumption that west coast exports will be 70 per cent of the exports from western Canada. Discussions with industry participants and projections by both Westac and the Transport Institute at the University of Manitoba would tend to support these forecasts.

TABLE IV.1: PROJECTED ANNUAL EXPORTS BY PORT

	1995/96	2000/01
	million tonnes	
Vancouver	18.1	19.8
Prince Rupert	5.9	6.4
West Coast	24.0	26.2

The annual projections are converted to weekly car unload requirements by port based upon the shipping weeks in 1995/96 and 2000/01. This conversion was based upon the historical seasonal handling and transportation patterns for the four-year period starting in 1986/87. This analysis suggests that May and June are peak months for Prince Rupert and Vancouver, respectively, and the average weekly car unload requirements for these peak months are shown in **Table IV.2**. Actual unloads would be higher or lower depending on operational circumstances at the time, but should average to approximately these levels.

TABLE IV.2: PROJECTED WEEKLY CAR UNLOAD REQUIREMENTS FOR PEAK MONTHS

	Peak Month	1995/96	2000/01
		weekly unload requirements	
Vancouver	June	5,050	5,530
Prince Rupert	May	1,790	1,940
West Coast	June	6,580	7,190

Note: The weekly unloads are similar to the weekly guidelines published in the GTA's Three Month Plan.
The weeky unload requirements by port do not add to a west coast figure because the peak months differ based upon historical patterns.

The following factors may affect future exports:

i) the potential resolution of the Uruguay Round of the General Agreement on Trade and Tariffs (GATT) negotiations with respect to the level of farm subsidies;
ii) the potential agricultural trade requirements in both the short-term and long-term resulting from political and economic changes in the USSR and Eastern Europe;
iii) the Canada-U.S. Trade Agreement (CUSTA) and the potential tri-country agreement between Canada, the U.S., and Mexico may affect the level and direction of North American grain movements;
iv) the Gross Revenue Insurance Plan (GRIP) may affect agronomic and allocative decisions leading to changes in the mix and level of crops available for export; and
v) any changes to western grain transportation policies, such as the method of payment of the Crow Benefit and possible system efficiencies, may lead to significant structural changes affecting marketing patterns.

V. PROJECTED DEMAND RELATIVE TO CURRENT CAPACITY

Table V.1 shows projected peak weekly demand relative to estimated weekly car unload capability. Indications are that there will be capacity problems at the port within the foreseeable future.

Terminal operators supplied their projections of current port capacity. This information would suggest that terminal operations are generally limited by the car unload capability. Terminal operators estimate unload capability to be 4,560 and 1,470 cars per week at Vancouver and Prince Rupert respectively. It would appear that this throughput capability is inadequate to meet peak demands. However, peak movement at the two ports has historically occurred in different months. It seems likely that if the west coast were challenged, operational management would maximize both ports simultaneously. Nevertheless, overall capacity at the west coast of 6030 unloads per week would still appear inadequate to meet projected demand in 1995/96 and 2000/01.

TABLE V.1: PROJECTED PEAK DEMAND RELATIVE TO CURRENT CAPACITY

	Peak Weekly Unload Requirements		Estimated Current Weekly Unload Capability	
	1995/96	2000/01	Terminal Operators	Historically Sustainable Level
Vancouver	5,050	5,530	4,560	3,970
Prince Rupert	1,790	1,940	1,470	1,635
West Coast	6,580	7,190	6,030	5,305

Note: The weekly unload requirements by port do not add to the West Coast figures because peak months differ.

An alternative estimate of current weekly unload capability is the historically sustainable level. This level has been estimated by using the highest four week average achieved since 1986/87 which includes two years with record movements. A period of four weeks was chosen as a reasonable time frame to account for all factors such as rail service, terminal and vessel capacity, maintenance, and operational circumstances while still capturing previous peak performance. It should be noted that the sustainable level exceeds the throughput capability estimated by the terminal operators at Prince Rupert. This suggests that the terminal operators may have been on the conservative side in their estimate of the current capacity at Prince Rupert. Nevertheless, based upon historical levels, throughput capacity appears inadequate to meet peak demand in both 1995/96 and 2000/01.

As a further illustration of the projected shortfall in capacity, the projected weekly unload requirements for each month were compared with the historically sustainable level with the result summarized in **Table V.II**.

TABLE V:II: NUMBER OF MONTHS THAT THE SUSTAINABLE LEVEL FALLS SHORT OF THE PROJECTED WEEKLY UNLOAD REQUIREMENTS

	1995/96	2000/01
Vancouver	11	12
Prince Rupert	4	7
West Coast	10	12

It is apparent that the projected shortfall in capacity in Vancouver is not simply an isolated occurrence during the peak months. In order to give a more global assessment of projected demand relative to current capacity, the information from **Table V.1** has been compiled in **Table V.III** on an annual basis in terms of tonnage requirements and capability: the historical annual record performance has also been included for comparative purposes. Regardless of the estimate of current capacity, the system will be challenged to meet projected demand in 1995/96 and will likely be inadequate in 2000/01.

TABLE V.III: PROJECTED ANNUAL DEMAND RELATIVE TO CURRENT CAPACITY

	1995/96	2000/01	Terminal Operators	Historically Sustainable Level	Historical Record
				million tonnes	
Vancouver	18.1	19.8	18.7	16.2	13.0
Prince Rupert	5.9	6.4	6.0	6.7	4.8
West Coast	24.0	26.2	24.7	21.7	17.0

Note: The annual figures for the terminal operators and for the historical basis assume that the weekly capacity is achieved for each of 52 weeks with an average load of 78.7 tonnes per car.

An evaluation of strictly railway capability to meet demand requires two steps. The first step is to project movements of all commodities to the west coast. The second step is to compare these projections to current and planned infrastructure. This is necessary because grain is only one of the commodities handled by the railways. Although such projections are beyond the scope of this study, Westac has made projections of up to 62 million tonnes in 1995/96 and up to 64 million tonnes in 2000/01. The railways confirm that there is adequate capacity in terms of infrastructure, locomotives and crews to meet current and anticipated demand as indicated by Westac. In addition, a recent study by Transmode Consultants Inc.[3] suggested that there are no significant railway capacity problems in the Port of Vancouver. This does not mean, however, that the rail service will always be adequate or timely as Transmode has indicated that there may be areas which will act as bottlenecks during peak periods.

This would suggest that the maximum capacity of the west coast for grain exports is not limited by a single factor, rather it involves all elements of the handling and transportation system.

VI. FACTORS AFFECTING CAPACITY

The factors affecting throughput capacity have been identified through terminal records of unloading delays, discussions with system participants, and the Transmode study.

The terminals record downtime during unload shifts as a way of identifying potential problems at the terminal/rail interface. Based on these records for 1990/91, 92 per cent of the unloading delays are due to:

i) insufficient storage space;
ii) elevator-related duties, such as maintenance and repair;
iii) track configuration and switching delays for pulling empty cars, and placing loaded cars; and
iv) the occasions when the terminals are without cars to unload.

Commodity mix has also been raised as a factor reducing the level of achievable unloads. A preliminary review of commodity mix issues did not find that this significantly affected throughput in general. Yet there was some difference in throughput between Vancouver and Prince Rupert terminals which may be due to the age of the terminals and number of grades and grains handled. However, further study is required to relate the effect of individual car arrivals of different grains on handling capability.

As indicated earlier, there are potential bottlenecks in Vancouver that could affect timely rail service. Factors involved are as follows:

i) Transmode indicates that there are a number of sections of the main lines leading into Vancouver and on the lower Mainland on which heavier usage may lead to increases in delays. These delays would be due to congestion at peak periods.
ii) There is a potential for disruptions to bridge traffic and increased frequency of bridge openings to accommodate vessel traffic. CN Rail is particularly vulnerable to problems at the Fraser River and Second Narrows Bridges.
iii) Congestion of the rail yard on the north shore of Burrard Inlet in Vancouver and current difficulties in implementing productivity measures introduced by CN has resulted in some problems with timely service to the two terminals on the north shore.
iv) While there appears to be sufficient capacity for the interchange of cars between railways, participants feel that the issue is one of timeliness.
v) Operating agreements between the railways relating to such items as running rights and interchanges, need to be kept current to reduce delays. This is needed because of the extent of individual railway operations on other railways' tracks and yards in Vancouver.

VII. SUGGESTIONS TO IMPROVE CAPACITY

Suggestions to improve capacity include proposals which may or may not require substantial capital investment. Most suggestions are directed toward improving Vancouver infrastructure and grain flow, which has the greatest potential for alleviating constraints in throughput. In addition, an alternative option is noted.

The suggestions which do not involve substantial capital investment include:
i) smoothing the flow of grain into the port by having a continuous work week for the terminals;
ii) further study of options to address grain stocks and commodity mix issues such as:
   - rationalizing the grading system,
   - designating facilities to handle certain grades and grains, and
   - accumulating cargo lots before they reach the ports;
iii) examining system management practices which affect throughput such as:
   - selling methods like f.o.b or c.i.f.,
   - grain arrival patterns,
   - further car pooling in Vancouver and car interchange options, and
   - options for handling specialty crops;
iv) considering the option of a single port railway to consolidate management of traffic in the Port of Vancouver;

v) addressing the issue of demurrage or storage charges on rail cars used for extended storage of bulk commodities, including specialty crops; and
vi) examining a number of options to improve co-ordination such as:
- a common computer network and terminology,
- rotating maintenance and repair programs for both the terminals and railways,
- aligning all grain handling agreements so they work in concert, and
- ensuring all labour contracts are current (from tug workers to railway employees).

Suggestions which would require capital investment include:
i) continuation of renovations and upgrades to terminals, such as modifying vessel berths and terminal shipping galleries to match shipping requirements to the larger vessels, and a review of cleaning capacity relative to the mix and level of grain received;
ii) additional storage facilities in proportion to the size of anticipated programs, and additional or re-configured trackage to increase the throughput of several terminals; and
iii) additional terminals or bulk handling facilities to accommodate the increase in projected programs or to consolidate the handling of bulk commodities.

If an ongoing shortfall in capacity occurs at the west coast, exporters are likely to consider alternative routes to satisfy customer demand. Once Canadian routes have been exhausted, U.S. routes to such ports as New Orleans, Portland and Seattle may be examined. However, current regulatory and institutional constraints tend to make these routes non-competitive for western Canadian grain.

VIII. SUMMARY

The findings of this report indicate clearly that the capacity of the west coast ports would have be increased during the course of this decade to handle greater grain shipments from western Canada. Projections suggest that by 1995/96 the west coast will need to export 24.0 million tonnes of grain. By 2000/01, export levels will reach 26.2 million tonnes. Estimates of current capacity range between 17.0 and 24.7 million tonnes.

At the operational level, the grain handling and transportation system is subject to periods of increased activity to meet buyers' demands. During these times the weekly unloading of rail cars at terminals becomes the primary limiting factor. The ability of ports to meet peak unload requirements is essential.

It is projected that in five years, peak weekly unload requirements at the west coast will reach 6,580 cars, and by 2000/01 will reach 7,190 cars. Estimates by terminal operators would suggest that the west coast could not meet these levels of

performance in 1995/96 or 2000/01. Moreover, historically sustainable levels would suggest that the west coast would not have sufficient capacity to meet export demand during ten months of 1995/96 and any month in 2000/01.

Indeed, record production could lead to even greater export levels which may mean west coast capacity will be insufficient for grain shipments sooner than predicted.

Since capacity will not be sufficient to meet export demand by the end of the decade, it is important to consider options to improve west coast throughput. Options such as a continuous work week, changing grain arrival patterns, further car pooling, increased co-ordination, or a single port railway could improve total throughput while requiring little expenditure.

More substantial improvements to total capacity at the ports may require sizeable capital expenditure. These options include continued renovations to terminals, more railway trackage, or construction of bulk handling facilities. Such proposals would demand a significant financial commitment and would need serious consideration.

In light of the coming shortfall in capacity at the west coast, it is important that all system participants consider means to increase grain throughput, and continue to make a concerted effort to do so.

ENDNOTES

[1] *Grain Transportation and Handling Requirements at the West Coast in 1995/96 and 2000/01 Technical Report.*

[2] The terminal operators have suggested that this figure may be as high as 650 000 tonnes.

[3] British Columbia Lower Mainland Freight Transportation System, prepared for Transport Canada, by Transmode Consultants Inc., April 1990.

ECONOMIC IMPLICATIONS OF HIGH SPEED RAIL SERVICE IN THE ALBERTA CORRIDOR

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Introduction

This paper sets out to identify the benefit/cost implications of a proposed High Speed Rail (HSR) service for the Edmonton - Calgary corridor and its effect on other modes within the corridor.

A study of the Edmonton - Calgary corridor published in 1990 established the parameters of intercity passenger demand in the corridor (Hall 1990). The High Speed Rail (HSR) share was established by a "Mode Abstract" model and showed that the Alberta HSR would claim upwards of 40% of business trips and 25% of nonbusiness trips based on a conservative economic scenario of zero income growth and 2% "relocation" population growth.

The question remains however whether such a service would be profitable in a normal commercial sense, given the economic scenario.

HIGH SPEED TRAINSETS

There are three present contenders, the Japanese "Shinkansen" of now dated technology, the French T.G.V. and the German I.C.E. There is little to choose in price and performance between the French and German trainsets. In the study, the 1st generation T.G.V. and the German I.C.E. were analyzed and the German train found to be the most energy efficient. Subsequently a second generation French T.G.V. entered service (September 1990) and in practise may prove to be superior. For the purpose of the study the German ICE was analyzed. However a more detailed assessment of available train sets would be required (a third generation TGV is now under development) before firm trainset choice decisions could be made.

Each set would initially be a 5 car set with a locomotive at one end and a driving trailer at the other, allowing "push-pull" operation. Sets can be expanded up to ten cars (with a locomotive at each end) as service demands. Both French and German sets are capable of this operation mode.

"In cab" signalling is proposed, using continuous monitoring coded track circuits. Conventional block signals would be confined to terminals and interlocking limits at emergency crossovers.

THE HIGH SPEED CORRIDOR

A rail alignment generally to the west of the existing CPR and Highway #2 alignments is proposed, with a downtown access into Calgary along the CPR alignment or next to Memorial Drive. In Edmonton access would be across the High Level Bridge. Intermediate suburban stations at North Calgary (near Calgary Airport) and South Edmonton are envisaged. Eventually stops could be justified at Red Deer, Airdrie and Leduc served by an alternating pattern of trains, some two stops only, some serving all stops. For the purpose of this analysis, only the North Calgary/South Edmonton stops are included. To minimize initial capital costs, a single track on a formation constructed for double track is proposed, with sections of double track to form passing locations, which will lower overall speed but, more importantly, lower initial capital and maintenance costs. As traffic grows, installation of the second track would be undertaken which would improve speed, increase rail's modal share and allow additional station stops. In the early years savings in capital costs appear to outweigh these latter advantages. Figure 1 shows the proposed alignment.

The track would be comprised of continuous welded rail on concrete ties, using chrome alloy steel rail for wear consideration rather than normalized rail. This rail is expensive but would cut down on rail renewal cycles.

Electrification will probably be at 50 k.v. A.C. using silver oxide copper catenary, again, expensive but reducing renewal cycles. The train sets are equipped with newly developed A.C. asyncronous motors, permitting economical use of alternating current without the need to "rectify" it onboard the locomotive to direct current for use in D.C. motors, the standard procedure until recently (A.C. motors traditionally were very poor at starting "under load" hence the use of D.C. motors using A.C. rectified current.)

The cost estimate allows for capital costs amortized over 25 years of all trainsets, track, electrification, signalling etc on a single track basis, installation of a second track at about year 12, annual maintenance cost, renewals of rails and catenary at 8 year intervals and overhaul of train sets after 4, 8, 16 and 20 years plus a major overhaul and refurbishment at year 12.

Capital and maintenance costs are summarized in Table 1

PASSENGER DEMAND

A set of overall travel demand models were developed, in terms of population and income, for both business and non-business trips. A further set of modal split models were developed to establish the potential HSR "share" of the market. (Hall and Wirasinghe, 1991).

A "conservative" population scenario of a 2% growth rate and static income growth has been assumed for the corridor.

Predicted overall business and non business trips were established for the 10 year period 1993-2013.

PASSENGER VOLUMES

Passenger revenues by HSR are derived from a modal split "abstract mode" model, which explains travel by any given mode historically, by referring its modal attributes to those of an "average" mode and establishing a "disutility of travel" function from which the modal split by an individual mode can be established. The attributes chosen were fare, frequency (number of trips per day) and travel time (including access and waiting time) for both business and non business travel. (Full details are given in Hall & Wirasinghe, 1991).

Rail's share of the passenger demand will therefore depend on the cost of travel, the service frequency and elapsed time between the journey's origin and destination. Various levels of rail demand can be established by varying one or more of the above parameters. In view of the differing characteristics of business and non business travel, separate modal shares were established in terms of a "peak period" fare ("Pullman fare and "standard" fare) and "seat sales" fare and frequency ("time of day" pricing, limiting cheap fare to a certain number of departures only). Elapsed time remains constant within the rail mode downtown to downtown elapsed time will be 72 minutes for any given trip purpose (but varies by origin/destination pattern). The business/non business profiles and origin/destination profiles are quite complex and will be the subject of a future paper.

SERVICE FREQUENCY

Rail frequency is set at 24 departure/day equivalent to present airbus frequency against a competition of 20 buses/day and an "equivalent headway" of 50 auto departures/day. A previous study recommended 8 trains/day of 10 cars each, a service short fall that does not take into account the natural "storability" of the rail mode and limits rail's "level of service" competiveness.

An 8 train/day frequency basis 10 car train set was tested and yielded a modal split of 34%, (as proposed to 40.5% for a 24 departure/day, 5 car trainset basis). There is no capital cost saving at 8 trains/day as six-10 car sets are needed as opposed to

12-5 car sets for the more frequent service although there are operational savings in staffing and energy cost. Non business suffers badly, down from 13.3% at 24 trains/day to about 9% (standard fare) and from 25% to 18% for the standard/cheap fare (half available headway) option.

MODAL SPLIT PROFILES

The modal split equations developed were applied against the values of the above explanatory variables to establish realistic modal splits, by mode, for both business and non-business travel. The effect of different High Speed Rail (HSR) trainsets on the modal split was also evaluated. A differential Fare policy was considered and a series of "profiles" were developed for these scenarios.

BUSINESS SEGMENT PROFILE

Business trip modal split profiles were developed and are given in Table 2. It should be noted that a peak 30 minute headway is assumed (three passing loops in operation, five train meets) with an hourly headway off peak (one passing loop in operation, three train meets). In each case, two of the train meet occur on the double track sections in the outskirts of Calgary and Edmonton. (See Table 2 and Exhibit 2)

The two-stop pattern gave the optimum modal split rail market share as being 40.5%, with air at 21% and no longer the dominant mode. Auto at 38,5% is almost equal to rail. Overall public transport share increases from 56% to 61.5%. The auto decline is not very significant in highway capacity terms but is important in rail revenue terms.

This scenario assumes that all business travel occurs in the peak periods and is inelastic to off peak fares. This is not strictly true but generates a Conservative revenue figure.

NON - BUSINESS MARKET SEGMENT MODAL SPLIT

Table 2 also gives the non-business market segment, initially assuming a non-business fare equal to the business fare ($80). The modal split to rail is 13.3%. For air, the present (1990) $116.20 one way standard airfare is not applicable for this market. Canadian offers seven and 14 day APEX fare plans which average out at $60 one way and this APEX fare plus a "weighted" standard fare were used to avoid an undue and unrealistic bias to rail.

On the above basis, air keeps a respectable 10.9% (down from 13.3%). Bus holds its own at 10.3% (up from 9.23% - increased overall service effect). Auto drops from 75.8% to 65.5%, a fairly significant drop in overall terms, but auto still remains very dominant. Clearly rail is gaining at the expense of air and auto, especially the latter. However, the auto overall figure still remains extremely dominant. Overall therefore, rail does not significantly decrease auto volume in an "all day" sense, but does

create a respectable market for itself. Air suffers slightly. "Farewars" could well result in air APEX fares matching rail. Even a "walk-on" air shuttle using rail ticketing techniques could arise, similar to British Air's "Air shuttle".

TRAINSET SPEED EFFECT IN MODAL SPLIT

Table 3 shows modal splits against trainset speed for the non-stop and two-stop situations. It will be seen generally that in the range of 200-340 km/h, trainset speed only slightly influences modal split. For the non-stop scenario, the modal split drops from 42% to 39%; for the two-stop scenario, from 40% to 38%.

There are reasons for this observation. If only elapsed time between terminals was taken into account, much wider differences would be noted; however, by including waiting time (25 minutes across the board, comprising 25-33% of journey time, irrespective of trainset) and access time (again trainset independent and comprising 8-12% of journey time), the in-trains time, though important, becomes less sensitive to overall journey times. Nevertheless, a 40.5% modal split is better than a 38% one. In a highly competitive environment, a 2.5% increase in traffic capture can make all the difference in profit or loss. This is not to say that air could not provide a fare lower than $116.20; they probably would. It would be necessary to determine the "lowest realistic" air fare and rerun modal split equations to establish rail share under an "airlines fight back/farewars" scenario. Data is however not available to the authors to perform this task.

CHEAP FARE EFFECT

Let us consider the effect of a cheap fare - one the airlines cannot possibly hope to compete with. Running the models against various "bus type" fares gave $45 as an "optimum" off peak non business fare. Running this fare for both business and non business market segments gave the "cheap fare" modal split to rail of 25%, air declining to 7.4% as does bus whose volume is now halved to 6.9%. Auto declines further to 60.7%. Table 2 gives details.

Is this fare exercise worthwhile? Consider 100 nonbusiness passengers at a fare of $80: 13.3 will choose rail yielding a revenue of $1064. Now at a fare of $45, 25 will chose rail yielding a revenue of $1125. Clearly a larger modal split has apparently maximized revenue and has virtually decimated air and bus traffic. The effect on business travel, however, in not to maximize revenue, for the modal split increased from 40% to 45% only (being less sensitive to fare) yielding $2025 revenue (45%) at a fare of $45 against $3200 (40%) at a fare of $80 - i.e. total fare is now $3150 as opposed to $4264. Most European rail authorities get around this problem by "charging what the traffic will bear". A standard fare is offered all day, with a cheap day fare after the business rush (usually available after 09:00 or 10:00 and available all day on weekends and public holidays). Often such tickets are not available in the afternoon return business peak rush (15.30-17.30) although

sometimes they are (BR has an "after 09:00 hours" rates only, tickets being available in the return peak).

Here it will be assumed that the optimum "non business" cheap tickets at $45 are available after 09:00 only and cannot be used from 15.30-17.30. This effectively limits the tickets to half of the service. Revenue is now maximized, at the modal splits shown in Table 2. Consider 100 non business persons at $80 (13.3% m.s.); revenue is, as before, $1064. Now at a modal split of 13.3% for half the departures (peak) and 25% for the other half (off peak) and assuming non-business travellers to be homogeneous across time giving a revenue figure of $532 (13.3% modal split of 50% of passengers at $80) and of $562.50 (25% of 50% of passengers at $45) totalling $1094.50 overall for non-business passengers and keeping business revenue intact at $3200, for a gross total of $4294.50, which is a 7% increase over the " all day" $80 fare at no increased operating cost.

This "selective pricing" is far removed from the traditional rail "pay by distance" technique since it "homes in" on different market segments and charges with fares based on time of day/day of week.

PULLMAN CLASS FARES

Pullman class accommodation can be provided, with appropriate fares for business travellers. Research has established a fare equal to about $110 in present day values (AED study 1983) too near to the air fare to get a major consumer response unless business travellers perceive the extra "luxury" as worthwhile. However, "Pullman" passenger volume cannot be predicted by the simple models developed here, since quality, comfort, passenger ambience, etc all come into play to justify the additional, almost 40% increase in fare.

THE GLOBAL MARKET

Modal split developed above are for "modal choice" trips. However there exists a substandard "down market" of "mode captive" trips, by intercity bus, of 8.6% of the total market, where "fare" itself is virtually the only choice criterion. Recasting the above "mode choice" trips globally and including the mode captive element, a final set of "global" modal splits is established by mode, trip purpose and by mode choice/mode captive criteria. This does not assume any transfer from bus to rail at the cheap rail fare policy of $45, although, offering a very cheap fare, near to bus fare, restricted to one departure/day (in the period after the morning peak, at about 11.00 am departure) will capture some of this market. Given no very cheap fare other than the $45 off peak fare, Global modal shares for both mode choice and mode captive markets for both business and non business travel are given in Table 4. It will be seen that, overall, rail's share is about 24%, air about 12%, bus 14% and auto dominant at 50%.

PROJECTED REVENUE

Based on generated passenger volumes with peak and off peak fares set at $80 and $45 respectively, actual and present worth revenue were developed for each of the 24 years of the pay back period. Total revenue is over $3.6 billion (approximately 60% business and 40% non business) giving a total present worth value of $1.2 billion based on a present worth factor of 10%. (see Table 5)

INITIAL BOTTOM LINE

The question is "is it worth it", what is the "Bottom line". As shown in Table 5 the capital and maintenance costs given in Table 1 represent a present worth value of $1.165 Billion. The present worth revenue is $1.20 Billion, yielding a rate of return of only 3.62%. Clearly this is not attractive enough to justify H.S.R. without further traffic development, traffic transfer and/or population and income growth.

Both population and income are set at a partiularly "bleak" scenario and while hopefully they will improve, neither factor can be particularly counted upon over the next decade or so. Again, the very large transfer from air to rail (over half the air traffic is transferred) would probably (after an initial "farewars" battle) result in reduced air frequency and a greater transfer to rail. Again this can by no means be guaranteed or assumed. Likewise closure of Edmonton Municipal Airport and transfer of corridor air traffic to Edmonton International will increase overall air travel time due to increased access times in Edmonton (mitigated however by the fact that the H.S.R. corridor itself could be used for a regional rail shuttle from Downtown to the Airport). Once again closure of this Airport cannot be assumed.

The initial bottom line revenue is simply not enough on base traffic alone (Edomonton-Calgary only) unless external factors change. Modal shift from highway is useful and welcome but is not high enough to warrant transfer of highway capital or maintenance funds.

POTENTIAL BOTTOM LINE

Fortunately a potential market does exist, but would have to be worked at very hard, with dedicated management. A satisfactory rate of return is assumed to be 12% or better. (Alberta Transportation have traditionally used 12% as justification for highway investment schemes.) Potential growth will be assessed at two "bounds". An "Upper bound" is estimated from growth potential and a "lower bound" of half the expected growth, as a sensitivity analysis. There are five major sources of potential increased traffic as under.

1) INDUCED TRAFFIC - Induced travel represents trips generated by any given new mode that would not have been undertaken by any existing mode due to some inherant attractiveness of the mode

(faster, cheaper than any previous mode) that creates an additional market. This phenoema cannot be explained historically by time series data but is an observed phenonenon.

Up to 100% induced traffic have been claimed for certain corridors where service has been improved. Discussion within the industry and with other researchers established that it cannot be ignored as a traffic growth but that a figure of 7% growth across all mode choice trip purposes was reasonable and conservative.

2) AIR TRANSFER TRAFFIC - Since H.S.R. will serve both major airports, the potential exists for transfer traffic to/from major national/international trunk air routes rather than the corridor trip by airbus. Only if the H.S.R. served Calgary Airport directly (at huge cost) could this potential be fully realized and then only with airline cooperation. Based on a 1984 Airport study (Stanley Associates 1984) over 2000 person/week use local air service to transfer at Calgary to national/international airlines from all Alberta regional centres, with 400 using other modes regionally and a further 2100 transferring to/from Northern Alberta by modes other than air.

Applying business modal split characteristics to this traffic about 43,000 persons annually could be attracted yielding a revenue of about 5% over base traffic at the "upper bound" and half of this at the optimistic "lower bound". It is assumed zero at the pessimistic "lower bound".

3) REGIONAL TRAFFIC (BUS & RAIL) - A stop at Red Deer will attract both Red Deer and regional traffic. Furthermore a integrated regional corridor bus service (possibly run by the rail corporation directly or under charter) could act as "through way" service linking together communities (that could never individually justify rail service) with Red Deer on "timed transfer" principles. A parallel corridor bus service serving Olds, Didsbury etc would tie in at Red Deer. "When you catch the bus you catch the train" (also the plane if potential 2 is implemented). "Out reach" services would be operated also to places such as Rocky Mountain House, Banff etc (not necessarily at rail frequency) and "all bus" journeys catered for (Carstairs - Olds, for example). This traffic is estimated at about 3% of base traffic (a present worth of about $36 million).

4) PARCELS EXPRESS - Most rail authorities in Europe and also Amtrak have developed "parcels express" services, also "closed pouch" mail, reintroducing a traditional passenger traffic for the first time in many years in some instances. The French postal authority "PTT" even has its own TGV train sets dedicated to mail service only. Typically this "head end" traffic (often in association with another carrier) can be worth up to 10-20% of passenger revenue. The H.S.R. service will experience lower revenues than that due to a lack of a comprehensive network, however, 5% can be conservatively estimated based on certain Amtrak corridor revenues. This figure

will be assumed at both lower and upper bound levels. If a regional bus service is established as mentioned above, a non comprehensive regional network becoming available will tend to promote revenue.

5) MODE CAPTIVE TRAFFIC - 8% of all corridor travel is by the downmarket, highly fare sensitive poor, who were analalysed by means of a separate mode profile modal. This traffic is worth capturing, at least in part. These trips are usually not pleasure trips being "job search" trips, support trips, visit family trips etc. Family discount fares are very important as are downmarket promotional fares (Golden Age fares, family teddy bear days etc). On a daily basis, a very cheap (bus fare equivalent) fare could be offered limited to selected departures only (e.g. 11.00 am departure only, return after 7.00 pm.) This revenue could be expected to produce additional 1-2% growth but is restricted here to 0.5% at both lower and upper bounds.

The possibility exists also of selling such tickets "in bulk" at a further discount to welfare agencies etc. Indeed peak and off peak tickets could also be sold similarly to business and government agencies for staff travel purposes (travel warrant schemes).

6) PULLMAN REVENUES - Pullman type service could be offered at a premium on top of the $80 ticket. This is highly "economy dependent" and can be labour and capital intensive (extra staff, Pullman cars). A $30 supplement would be needed to justify this service and assuming 25% of business travellers opted for the service yield about 5% over base revenue at the upper bound. At a lower bound it would not be offered or could be conservatively estimated at only half the above figure. It can only be included as an "optional" extra.

7) CATERING REVENUE - Catering would be limited to such food as beverage service with simple on board "freeze dried" meals due to the limited elapsed time in journey time. This service can be either profitable or a absolute loss maker. However, with simple service, about 2.5% over base revenue could be assumed, again as an option.

POTENTIAL RATE OF RETURN

Table 5 gives the different rates of return at the various "bounds". The lowest rate of return is 3.62% on base traffic only, the "pessimistic" lower bound, excluding both induced and air transfer traffic is 11.24%, (barely satisfactory), the "optimistic" lower bound, (with all potential growth factors assumed at half value) is 18.6%, without Pullman and catering revenue and 21.4% with these revenues.

Taking a very sanguine view of the economy yields rates of return of 24.8% without Pullman/catering revenue and 30.0% with these revenues.

ENVIRONMENTAL IMPACT

An environmental impact study has not been undertaken and no allowance made for the very positive environmental benefits of H.S.R. These issues should be addressed in a more detailed study.

CONCLUSION

H.S.R. will generate a rate of return varying from a low of 3.6%, (which will "pay the bills" and nothing else) through to a high of 30% given a sanguine view of the economy. A satisfactory rate of return in the 12-18% range can be expected but not on base traffic alone. Given a 4 year construction period and present economic circumstances, the project is probably 5-10 year distant. It is, however, important that a decision be taken soon and land reserved, especially in downtown areas of Edmonton and Calgary to reserve the all important downtown access, without which the economic benefits could never be realized. Regional traffic is very important, as to a certain extent is air transfer traffic. The project can serve all passenger markets from the upmarket business traveller to the downmarket mode captive person of limited means ("A train for all reasons"). The social and environmental aspects need to be investigated further but should both prove to be positive.

In all, a case is made for H.S.R. for implementation, probably by the turn of the century.

REFERENCES

Hall, J. A., (1990) "High Speed Trains for the Alberta Corridor" M.Eng. Thesis, Dept. of Civil Enginerring, University of Calgary, Calgary, Alberta

Hall, J. A. and Wirasinghe, S. C., (1991) "A Mathematical Modal of High Speed Trains in the Alberta Corridor, Proceedings, Canadian Society of Civil Engineers Conference, Vancouver B.C.

A.E.D. (1984) Calgary - Edmonton Intercity Passenger Study, Alberta Economic Development, Edmonton, Alberta

Stanley Associates (1984), Alberta Airport Passenger Survey, Calgary, Alberta

TABLE 1

CAPITAL MAINTENANCE AND OPERATING COSTS

	CAPITAL	MAINTENANCE	PRESENT WORTH
INFRASTRUCTURE	$640,000,000	$8,700,100/yr to yr 12 $13,900,000 after yr 12	$713,716,372
ELECTRIFICATION	$135,000,000	$750,000/yr	$143,702,353
SIGNALLING	$66,000,000	$2,200,000/yr	$74,146,716
CONTROL ROOM	(included above)	$400,000/yr	(included above)
TRAIN SETS	$180,000,000	$2,340,000	$260,559,275
OPERATION	-	$5,260,000/yr	$47,259,522
		present worth	$1,165,235,522

TABLE 2

MODE CHOICE MODAL SPLIT (2 Intermediate H.S.R. stops)

	BUSINESS		NON-BUSINESS		
	EXISTING	WITH H.S.R.	EXISTING	WITH H.S.R. (full fare)	WITH H.S.R. (cheap fare)
AIR	56.4	21.0	13.36	10.9	7.4
AUTO	43.6	38.5	75.88	65.5	60.7
BUS	-	-	10.81	10.3	6.9
RAIL	-	40.5	-	13.3	25.0

TABLE 3

TRAIN SPEED EFFECT ON MODAL SPLIT

TRAIN SPEED	Modal split to rail	
	NON STOP	TWO STOP
340 km/H	42%	40.5%
260 km/H	41.5%	39.5%
230 km/H	41%	39%
190 km/H	39%	38%

TABLE 4

GLOBAL MODAL SPLIT (2 Intermediate H.S.R. stops)

	BUSINESS	NON BUSINESS	MODE CAPITAL
AIR	6.42%	5.55%	-
AUTO	11.86%	38.43%	-
BUS *	-	5.23%	8.63%
RAIL	12.27%	11.61%	-

* Some of this traffic can be attracted to H.S.R. by fare policy.

TABLE 5

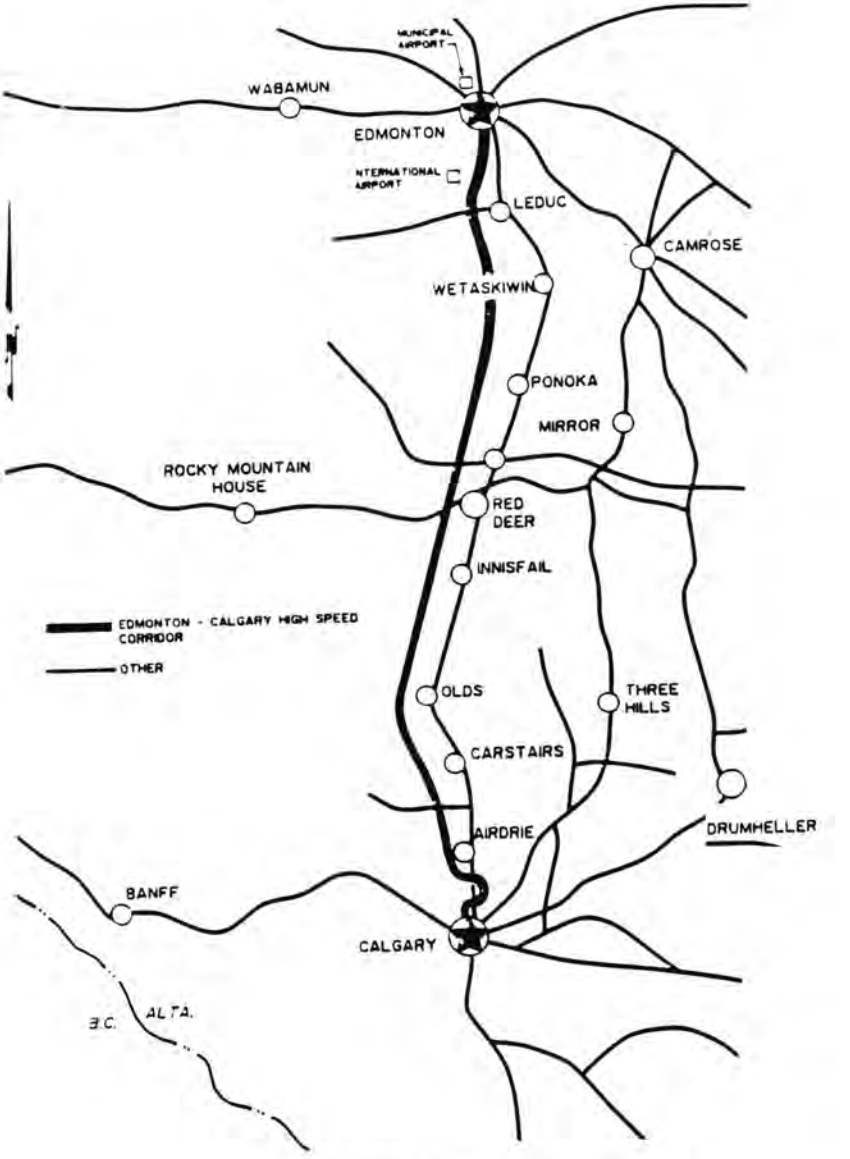
REVENUES AND RATES OF RETURN

	BASE	PESSIMISTIC lower bound		OPTIMISTIC lower bound		UPPER bound	
	$ ('000)	% over base	$ ('000)	% over base	$ ('000)	% over base	$ ('000)
Base Revenue	1,207,485						
Induced	-	-	-	3.5%	42,262	7%	84,524
Air transfer	-	-	-	2.5%	30,187	5%	60,374
Regional Traffic	-	3%	36,224	3%	36,224	3%	36,224
Express traffic	-	5%	60,374	5%	60,374	5%	60,374
Mode Captive traffic	-	0.5%	6,038	0.5%	6,038	0.5%	6,038
Rate of return	3.62%		11.24%		18.60%		24.80%
Pullman additon +	-		-	2.5%	30,187	5%	60,374
Catering addition	-		-	2.5%	30,187	2.5%	30,187
Adjusted rate x of return	-		-		21.40%		30.00%

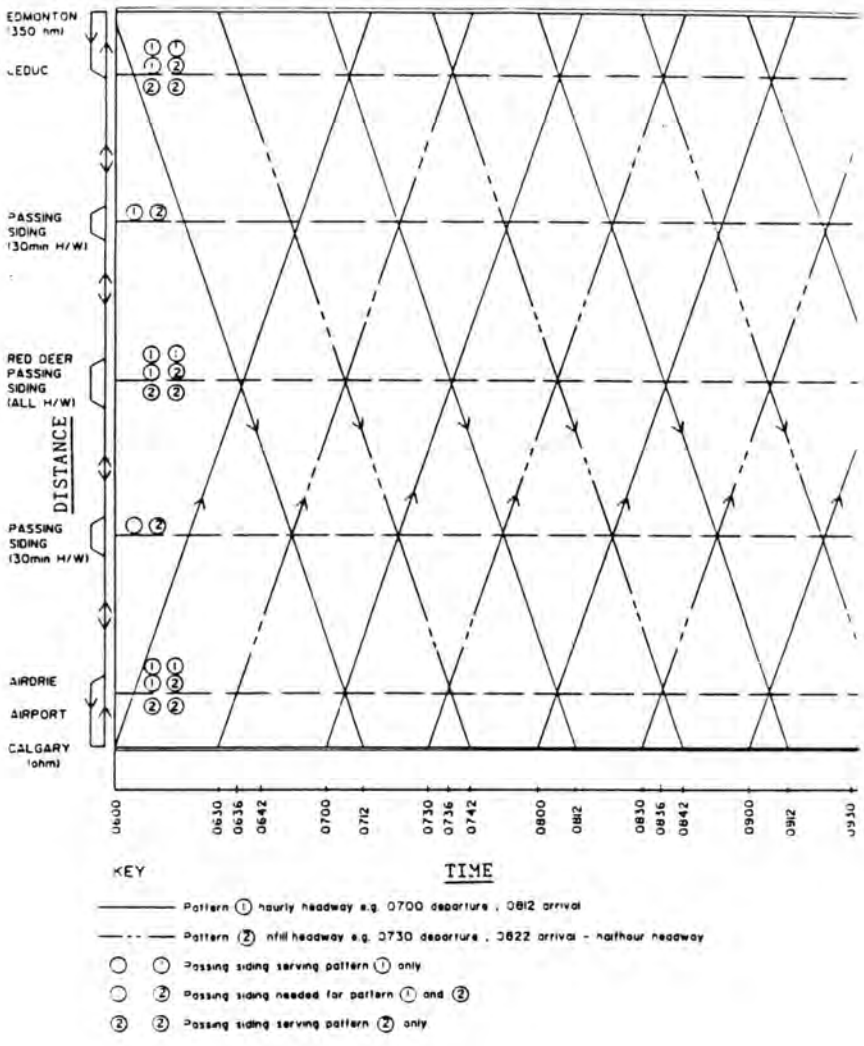
* Upper bound rates of return represent a sanguine view of the economy.

\+ Rate of return based on present worth cost of $1,165,522

x Rate of return based on present worth cost of $1,188,471,000 (including pullman/catering costs)



THE ALBERTA CORRIDOR **Figure 1.**



SPACE - TIME DIAGRAM FOR 60 AND 30 MINUTE HEADWAYS

Figure 2.

Airline Passenger Services: A Canadian Carrier Competitive Advantage?

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Introduction

The world of commercial aviation is changing quickly. Can Canada's two major air carriers, Air Canada and Canadian Airlines International Ltd. [CAIL] compete globally? Can they survive in the face of more and more concentration in the industry world-wide? Can they compete with American carriers if "Open Skies" with the United States becomes a reality?

Canadian carriers seem to have a disadvantage when compared to American carriers. There have been examinations of the competitiveness issue based on the efficiency of the Canadian carriers' operations, the size of their fleets, their financial strengths and weaknesses. Is there an area of potential strength, a competitive advantage for Canadian carriers that has been overlooked?

This paper looks at the field of passenger services. These are the services provided for the comfort of passengers during their travel with the airline. If Canadian carriers cannot compete with the large American carriers in terms of frequency, cities served and, perhaps, price, can they win a niche on the basis of their actual or perceived level of passenger service?

The whole prospect of the competitiveness of Canadian air carriers on the global scene has increasingly come under focus. The large losses that Canada's two principal scheduled service carriers have experienced recently has strengthened the debate. Another extremely important factor is that of the lengthy attempt at a new bilateral agreement with the United States. The two Canadian flag carriers, Air Canada and CAIL do not have nearly the same fleet size as the large American carriers. They do not have the same cost structure. They cannot offer the same number of points in the United States market. It remains to be seen if they have deeper pockets in a financial show down.

Canadian carriers may have an advantage that they have not yet fully utilized. That is the level of passenger service that they have typically provided to the passenger. This paper will examine their present position and possible advantages from capitalizing more fully on this advantage.

Passenger Services

What elements of passenger services are there? Any aspect of the passenger handling can fall under the title of passenger services. This can include almost any contact that the passenger would have with the air carrier throughout the whole journey. The handling of the passenger's reservation, passenger check-in, on-time performance, baggage handling, meals and in-flight services are all aspects of passenger services that can shape a customer's opinion of the air carrier and their inclination to use the carrier again.

There are elements of passenger services that are difficult to measure since they are essentially non-monetary in nature. If a carrier mounts an internal campaign to improve courtesy of its employees, this will not be apparent in its expenditures. A policy of non-smoking on flights may contribute to the pleasure of non-smokers and be an improvement for them in in-flight service which is essentially cost free. There are, fortunately, some elements of passenger service than can be more easily measured and compared. They will receive most of the focus in this paper.

What has been the trend in passenger service expenditures for the major Canadian scheduled service air carriers in the period 1986 through 1990? Table 1 shows several interesting patterns. Air Canada spent a relatively constant proportion of its operating expenses on passenger services. This remained in the 11.4 - 12.5% range throughout this period. It's major competitor, showed a greater variability; CAIL spent slightly more with a range of 10.8 - 13.1% during the period 1987 - 1990. In 1986, with CP Air, CAIL's international service predecessor, 12.8% of its operating expenses were passenger service costs. Wardair had expended more on a percentage basis than any other of the major Canadian players, at least until its takeover by PWA Corp in 1989. All three Canadian carriers spent a higher proportion than the major American carriers on passenger services.

Table 1: Passenger Services Expenditures as a Percentage of Total Operating Expenses, 1986-1990[1]

	1986	1987	1988	1989	1990
Canadian Carriers	%	%	%	%	%
Wardair	15.0	15.9	12.6	12.3	...
Canadian Airlines International	...	10.8	12.3	12.0	13.1
Air Canada	11.9	11.4	12.5	11.8	12.1
CP Air	12.8	...	...	...	...
American Carriers					
Delta Air Lines	11.4	11.8	11.9	11.5	12.3
American Airlines	11.8	11.8	11.7	11.4	12.5
United Airlines	12.2	11.6	11.3	10.7	10.1
Continental Airlines	9.8	9.9	9.7	9.4	8.9
Northwest Airlines	...	9.3	9.1	9.3	9.1

Source: Canadian carriers, Statistics Canada Air Carrier Operations in Canada and Canadian Civil Aviation; American carriers, International Civil Aviation Organization, Financial Data Commercial Air Carriers, Series F

Table 2: Passenger Service Expenditures, Air Canada and CAIL 1990

	%
Cabin crew salaries and expenses	42
Passenger food and supplies	44
Other passenger service expenses	14
Total passenger service expenses	100

Source: Statistics Canada, Canadian Civil Aviation

What are the major components of these passenger service expenditures? Table 2 shows how the money was spent by Air Canada and CAIL in 1990. Canadian carrier's have deliberately made passenger service a key marketing element.

Air Canada appears to continue to try to use passenger service as a means to attract passengers. An example of targeting the in-flight service to a specific market is their Oriental service. Groups of 10 or more in Hospitality Service or Executive Class on specific North American flights can order a meal with rice or noodles, green tea or Japanese beer, and a copy of the daily Nihon Keizai Shimbun newspaper. The Japanese tour group market is obviously the target group for this particular product. [enRoute Magazine, p. AC2]

How do the major Canadian and American scheduled service carriers compare with the key foreign competitors? Table 3 shows the proportion of total operating expenditures accounted for by passenger service costs in 1989 and 1990 for select Canadian, American and other foreign air carriers.

It appears, from the data in Table 3, that the major Canadian carriers gave a greater emphasis to passenger servicing than do the major American carriers. The Canadian carriers appear to trail, however, some of the major foreign operators. Singapore Airlines, showing the highest proportion of passenger services expenditures in Table 3, is well known for highly rated customer satisfaction. For example, in 1991, it was awarded the "World's Best Airline Award" by Conde Nast Traveller magazine, the Business Traveller International "Best Airline in the World" award and Financial World's "Best of Everything" award for Asian airlines. [Aviation Daily, Oct. 3/91, p. 23] At the other end of the scale, Aeroflot, which has a very poor reputation for customer service, was surpassed by all other carriers listed in the table.

Table 3: Passenger Services Expenditures as a Percentage of Total Operating Expenses

	1989 %	1990 %
Canadian Carriers		
Wardair	12.3	...
Canadian Airlines International	12.0	13.1
Air Canada	11.8	12.1
American Carriers		
Delta Air Lines	11.5	12.3
American Airlines	11.4	12.5
US Air	11.2	10.5
United Airlines	10.7	10.1
Piedmont	9.5	...
Continental Airlines	9.4	8.9
Northwest Airlines	9.3	9.1
Foreign Carriers		
Singapore Airlines	16.3	16.2
British Airways	15.5	15.0
Japan Airlines	12.7	12.3
Air France	12.7	...
Lufthansa	10.8	11.3
Aeroflot	7.3	7.1

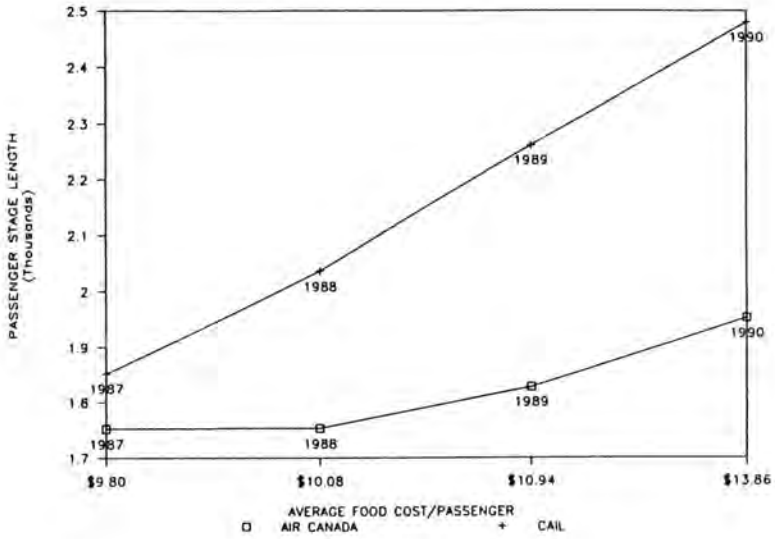
Source: Canadian carriers, Statistics Canada Air Carrier Operations in Canada and Canadian Civil Aviation; American and foreign carriers, International Civil Aviation Organization, Financial Data Commercial Air Carriers, Series F

Some caution must be taken in using an aggregate figure such as passenger servicing costs to measure the service level provided. Many factors can affect the level of expenditures.

The distance flown on average by each passenger is one factor. It is more difficult to expend large amounts on passengers in food and beverage service on short-haul than long-haul flights. Graph 1 shows the relationship between the average expenditure on food per passenger with respect to the average trip distance per passenger by Air Canada and CAIL over the period 1987-1990.

The longer the haul, the larger the expenditure per passenger. The longer haul on the Canadian carriers routes might partially explain their expenditure of a higher proportion of their operating costs on passenger services.

Graph 1: Passenger Meal Costs Versus Passenger Stage Length, Air Canada and CAIL, 1987-1990



Source: Statistics Canada Air Carrier Operations in Canada and Canadian Civil Aviation;

Trip distance is not the only explanation, however. The industry average for domestic in-flight food expenses in the United States is less than $6US per passenger . [Airline Executive International, p. 35] Air Canada and CAIL have a much higher average (see Graph 1). In Air Canada's 1989 Annual Report, Claude Taylor states that "One of Air Canada's fundamental operating strategies is to differentiate the Corporation's core passenger and cargo products from those of its competitors by providing superior customer care." [Air Canada, 1989, p. 4] That same year, the annual report of their

main domestic competitor states "Customer Service is the number one priority of Canadian Airlines." [PWA Corporation, 1989, p.7] The suggestion has been made that this emphasis on service in Canada is a result of "the higher level of service which Canadian passengers came to expect as a result of Wardair's presence." [T. Hine, 1991] Although at its peak, Wardair captured only 4.8% of scheduled service passengers (10.7% of the scheduled service market as measured by passenger-kilometres), the reputation of its service and the threat of its potential growth may indeed have had a strong influence. [Statistics Canada, Canadian Civil Aviation]

The difference in expenditures on passenger services can affect more than just the value or quality of the food service provided. Whether or not food service will be provided at all is sometimes the question. It is of sufficient importance to the passenger that this information is usually included by airlines in their published schedules, in travel agency resources such as the Official Airline Guide and in carrier reservation systems. The provision of food services is another area where Canadian carriers may have an advantage.

Table 4: Food Services--Ottawa-Toronto Versus New York-Washington

City-Pair	Food Service	Number of Flight Listings	% of Flights
Ottawa-Toronto	breakfast	16	22
	lunch	4	6
	snack	14	19
	none	38	53
	Total	72	100
New York Washington	breakfast	0	0
	lunch	0	0
	snack	54	30
	none	126	70
	Total	180	100

Source: OAG Desktop Flight Guide, Jan. 1/92, North American Edition

When one looks at the two similar business/government markets of New York-Washington and Ottawa-Toronto, there are significant differences in the meal services advertised by the carriers operating between these points. According to the January 1, 1992 Official Airline Guide [see Table 4], there were 72 different flight listings for Ottawa to Toronto, a distance of 364 kilometres. Table 6 shows that sixteen were listed as breakfast flights, four were listed as lunch service flights and fourteen were listed as offering snack

service. There were 180 flight listings for Washington to New York, a distance of 342-367 kilometres (depending on the airports used). None were listed as breakfast flights, none were listed as lunch service flights and fifty-four were listed as offering snack service. [OAG Desktop Flight Guide, January 1992]

All of the examination to this point would suggest that Canadian carriers are spending a greater proportion of their expense dollars on passenger services than are the major American carriers. At least in some markets, they do appear to offer more food services than American carriers.

Passenger Services and Consumer Demand

How important is the passenger service element in a passenger's choice? Can Canadian carriers offering a higher level of service impact on their market share? The importance or impact is probably the greatest when other factors influencing consumer choice are relatively equal. If two carriers are leaving at approximately the same time, with similar fares, to the same destination, the service factor becomes very important. The question of the quality of the meal and beverage service provided while perhaps a "frill", gains importance if other factors are equal. "Apparently, once all competitors have implemented the essential characteristics, such as departure times suitable to passenger needs, the only characteristic remaining to differentiate carriers is the frills. Thus, what is initially somewhat trivial becomes important in the selection process." [Taneja 1982, p. 71]

One of the key areas of passenger services is the in-flight service provided. It can be difficult to assess the impact on customer choice of some aspects of passenger services. A very large proportion of tickets are sold by travel agents rather than the air carriers. Problems encountered or good service delivered here will not necessarily be identified with the carrier. Reservation handling differences may also diminish as the competition amongst computerized reservation systems continues to lessen. Check-in services at an airport can be handled under contract by another airline. Problems at customer check-in such as congestion and delays may be blamed on the airport authority rather than the carrier. In-flight services may be especially important in terms of competition "as passengers will correctly perceive in-flight service as being the sole responsibility of the airline." [Stephen Shaw 1985, p. 169] While on-time performance problems can be blamed on the weather, air traffic control or airport congestion, a poor meal or poor service on board the aircraft will almost certainly be blamed entirely on the air carrier.

In a survey of U.S. residents and non-residents in the second quarter 1991, 13% of the former and 17% of the latter gave in-flight comfort and cabin service as their reason for choosing an airline. [Aviation Daily, October 3, 1991, p. 23] In a questionnaire for Consumer Reports covering 250,000

domestic U.S. flights between January 1989 and May 1990, 37% were unhappy with the food quality, 13% with in-flight service and 9% with the cleanliness of the plane. [Consumer Reports, July 1991, p. 462] All this would suggest that good passenger service can be used to attract customers and that perhaps greater emphasis should be given to this feature by Canadian carriers in the Canada-US markets.

It is obvious that Singapore Airlines, the number one carrier in Table 3 in terms of passenger service expenditures, thinks that passenger service can influence consumer choice. Not only do they spend on passenger service but they highlight this to the public. In a full page advertisement in a Canadian national newspaper, they stated in the largest type in the ad "INFLIGHT SERVICE EVEN OTHER AIRLINES TALK ABOUT". This attribute was listed before their claims on frequency, aircraft type and routing. [Globe & Mail, Nov. 7/91. p. A5]

Do Canadian carriers provide a better level of passenger service than their American competition? The figures in Table 1 show that they spend a higher proportion of their operating expenses on passenger services. Canadian carriers were chosen as the ninth and tenth best business class carriers in the 1991 Business Traveller reader poll. No American carriers made the list. [Globe & Mail, Nov. 16/91] Could Canadian carriers use their attention to passenger services to be more competitive, especially within the North American context? This would make sense if it was felt that the increased spending and attention to passenger services could influence the consumer's choice of a carrier.

Table 5 would suggest there does appear to be a relationship between expenditures on passenger services and the impression that it has on airline passengers. Although the order is not the same, those carriers with the higher passenger service expenditures were generally ranked higher than those carriers with the lower expenditures. Looking at the same issue of perceived quality, but by comparing the relationship between passenger service expenditures and complaints, Ozment, Morash and Clow found that "service expenditures do have an impact on service quality". [Ozment, Morash, Clow, 1991, p. 91] This would suggest that Canadian carriers should be able to leave a favourable impression relative to their American counterparts with respect to the quality of their product.

Table 5: Carrier Passenger Service Expenditures and Customer Ranking

Passenger Services Expenditures as a Percentage of Total Operating Expenses, 1990		National Institute for Aviation Research Ranking	Consumer Reports Ranking
American Airlines	12.5	American	Delta
Delta Air Lines	12.3	Delta	American
USAir	10.5	United	United
United Airlines	10.1	USAir	Northwest
Northwest Airlines	9.1	Northwest	USAir
Continental Airlines	8.9	Continental	Continental

Note: Only those carriers listed in column one have been shown in columns two and three.

Source: International Civil Aviation Organization, Financial Data Commercial Air Carriers, Series F; NIAR data quoted in Kiplinger's Personal Finance Magazine, August 1991; Consumer Reports, July 1991

Conclusion

Canada's international scheduled air carriers are facing a world of great change and increasing competition. The prospect of a new bilateral air agreement with the United States, raises the possibility of new opportunities but also new competitive pressures. One area that may help the Canadian carriers to compete in this market and in the world market is their level of passenger services provided. The major Canadian air carriers have historically devoted a higher proportion of their resources to the provision of passenger services than have the major American air carriers. This means that they have an advantage that does not require an increase in expenditures to obtain other than to inform the consumer of its existence. If the service level is maintained, and if it is made known to their prospective passengers, passenger service could be the advantage they need to maintain an adequate market share.

Note

The views and opinions expressed in this paper are those of the author and do not necessarily reflect those of Statistics Canada.

References and Notes

Air Canada, Air Canada 1989 Annual Report.

Airline Executive International, September 1991.

Aviation Daily, October 3, 1991.

Consumer Reports, Vol. 56, No. 7, July 1991.

enRoute, September 1991, (Airmedia, Toronto, Ont.).

Globe & Mail, November 7 and 16, 1991, (Toronto).

T. Hine, Cost Competitiveness of Canada's Airline Industry, "Address to Air Transport Association of Canada Annual General Meeting, November 11, 1991", (ScotiaMcLeod, Toronto).

International Civil Aviation Organization, Financial Data Commercial Air Carriers, Series F.

International Civil Aviation Organization, ICAO Statistical Yearbook--Civil Aviation Statistics of the World, Doc 9180.

Kiplinger's Personal Finance Magazine, August 1991, Vol. 45, No. 8, (Washington, D.C.).

OAG Desktop Flight Guide, North American Edition, January 1, 1992, Volume 18, No. 7, (Official Airline Guides Inc., Oak Brook IL).

J. Ozment, E.A. Morash, K.E. Clow, An Examination of Relationships Between Transportation Costs and Service Quality in the U.S. Domestic Passenger Airline Industry, "Proceedings of the Thirty-Third Annual Meeting, Transportation Research Forum", October 31 - November 2, 1991.

PWA Corporation, PWA Corporation 1989 Annual Report.

Statistics Canada, Air Carrier Operations in Canada, Statistics Canada catalogue no. 51-002.

Statistics Canada, Canadian Civil Aviation, Statistics Canada catalogue no. 51-206.

Stephen Shaw, Airline Marketing and Management, (Pitman Publishing Limited, London, 1985).

Nawal K. Taneja, Airline Planning: Corporate, Financial, and Marketing, (D.C. Heath and Company, Lexington, Massachusettes, 1982).

1. In Table 1, proportions have been compared rather than actual dollar expenditures per passenger or per passenger-kilometre. This eliminates the problem of changes in currency fluctuations but it does not, however, eliminate some other factors which could influence the analysis. The cost of in-flight labour could be higher due to more in-flight personnel per aircraft or higher wages per employee. These could create a higher proportion for passenger service expenditures as a percentage of total operating expenses. If a carrier has higher costs because of more personnel to serve the passengers, the discussion later in this paper as to the effect on consumer demand would be equally valid. If the labour is just higher paid, this might reflect more training, higher selection standards, again leading to passenger satisfaction. One element of passenger services costs that could negate the suggested link between expenditures and consumer satisfaction is that of interrupted trip expenses. If very high, they would probably not result in higher passenger satisfaction.

CRITICAL ISSUES IN PRIVATIZATION OF AIR TERMINAL AND AIRPORT FACILITIES

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1.0 INTRODUCTION

The factors which favour private versus public development of international airport facilities are diverse: These factors include:

- access to non-tradeable expertise
- risk-taking by the private sector
- urgent need to have modern airport facilities built quickly
- excessive government demands on the treasury
- speed of delivery
- maximizing revenue sources
- minimizing operating costs
- vertical integration of business ventures
- ingenuity in development of business plans
- raising of financing

Each of these factors will have its place in preparing a comprehensive business plan for the development of a new facility. At the same time, it is generally desirable to be able to accommodate some form of public participation in ownership.

The challenge facing many governments is a familiar one. That is to provide needed social services and capital construction projects without overly increasing spending and/or taxation.

The solution that many governments have found is in different forms of public/private partnerships to utilize government assets in levering private spending. This was the Canadian Government's chosen course in using its asset at Toronto International Airport (the land) to deliver a third terminal in less than three years. Private sector participation will also be a major funding source for the massive Hong Kong PADS project. Around the world, public/private partnerships are gaining currency as a method of building,

financing and operating public projects, whether airports, toll roads, or other elements of infrastructure.

From the national perspective, airport privatization is attractive as a way of generating increased investment in airport capacity. A medium or large airport represents an investment in excess of a billion dollars. Airports are a significant drag on the spending power of governments and unnecessarily so.

2.0 WHAT IS PRIVATIZATION

Privatization is a broad term, which covers a variety of ways in which functions and responsibilities are shifted from the public sector to the private sector. The most common form of privatization is the management contract, in which a private firm is hired by a municipality or airport authority to operate the airport, often with considerable authority to make decisions in a businesslike manner. Contract management means cost saving efficiencies and increased revenues.

Another form of privatization is the capital build-operate-transfer (BOT) technique wherein exchange for the franchise a consortium will design, finance, build, and operate a facility, deriving revenues from user charges to cover its investments over the life of the contract (typically from 20-40 years). At the end of this period, ownership of the facility generally reverts to the Government. BOT arrangements have been used for a number of years to build major motorways and tunnels in Europe especially in Italy and France and more recently with the Channel Tunnel. BOT techniques applied to airports offer several advantages over conventional airport development. These include the speed with which the project can be carried out in the absence of typical public sector tendering and procurement practices (in the case of Toronto it is estimated that the new terminal would have taken seven years if constructed in a conventional manner vs. three and a half years under the BOT process).

Moving further across the spectrum of private sector involvement, we have the private sector partnered with government in joint venture with ownership shared by the public and private participants. This technique is currently being applied in Czechoslovakia and in a number of other countries around the world. We are involved in a number of ventures in Europe, North America and Asia. In these cases the public sector and the private sector are joint venture partners with each bringing their own particular skills and abilities to the joint venture arrangement. In this situation the project development consultant's role is to assist in the development of the financing plans, the joint venture arrangements, ensuring financial viability as well as the major technical aspects of terminal design and infrastructure requirements.

A less common type of arrangement, however one that airport authorities support, is the arrangements which are currently underway for the development of the Front Range Airport in Denver, Colorado. In this instance, the project development consultant is acting on behalf of the developers of a commercial airport - Front Range Airport Denver. The development is being undertaken in support of the objectives of the airport authority currently developing the New Denver International Airport. In this way the complimentary development undertaken by the private sector at the private airport supports the overall objectives of the airport authority without financial support from the airport authority. In this particular instance our group is developing, on behalf of the owners, the financial plan and infrastructure designs for an industrial airport focussed on the air cargo industry and not passenger transport. The industrial market for this airport is seen to be aircraft related and support industries.

At the other end of the spectrum from pure government ownership is total privatization. A striking example of this is the development Terminal 3 at Toronto's Lester B. Pearson International Airport. In this case, our group served as an integrator and catalyst, identifying the opportunity, bringing together the private sector developers, financiers etc.

Another example is the sale to the public by the British Government of the major Southeast Area Airports (Heathrow, Gatwick and Stanstead) together with a number of smaller airports as BAA Plc. This development has freed up substantial capital funds from the sale of the Government's equity and allowed the government to avoid even greater future capital expenditure.

3.0 WHY PRIVATIZE?

The primary advantage in following this approach is that the government will gain access to private sector entrepreneurship, ingenuity, expertise, profit maximising behaviour, and scope of operations, as well as risk-taking capability (e.g., through the pledging of other assets) that will enable the project, or major components thereof, to be designed, financed, and constructed more efficiently and more effectively. In this way the government is able to get maximum leverage for its investment.

Other factors arguing for increased private sector involvement include:

- Enhanced financeability through improved access to different sources of both debt and equity capital.
- The establishment of expertise-driven exportable capabilities.
- Shortened construction times through fast track construction techniques.

- Lower construction costs through a shorter construction period and use of streamlined procurement procedures.

- Access to external non-tradeable expertise in design, construction, financing and operations.

- Access to private sector financing techniques.

- Avoidance of civil service employment rules.

The federal government was happy to make arrangements for the private sector development of Terminal 3 at Toronto because it perceived that the following benefits could be derived:

- Receipt of substantial rental payments from the developer within the terms of the lease.

- Saving of capital costs that amounted to over $500 million.

- Avoidance of construction and cash flow risks implied in the accelerated construction programme associated with this project.

- Benefit from the innovative financing and retailing structures proposed by the private sector developer with levels of risks previously unacceptable to the public sector.

The principal cost which the government incurred by embarking on the venture was a partial migration of tenants from the existing two terminals to Terminal 3, causing the government to forego a portion of the revenues derived from the airlines and the travelling public.

The overall success of this venture can be measured by the fact that Transport Canada initiated a proposal call process to re-structure and expand Terminals 1 and 2 on the same basis as Terminal 3.

4.0 INGREDIENTS TO ATTRACT PRIVATE SECTOR FUNDING

Following is a brief discussion of the ingredients necessary to attract private sector funding. While this list is not exhaustive, it does indicate those items which we believe to be essential in order for an undertaking of the type discussed in this paper to be successful.

1. True Commitment by Government

The first ingredient is commitment, on the part of both public and private partners. For government, this means a true commitment to the idea of privatization as a long-term strategy, and not just a short term fix. There must be a demonstrated need for the privatization option. This includes matters of financing, scheduling and project management.

2. Levels of Approvals

The level of approvals required to make the privatization work has to be understood. Government is good at making laws and regulations; they are not as good at running a business. On a fast-track public-private project these two activities are often in conflict and have to be reconciled. An ability to see down the road and anticipate some of these conflicts - the huge environmental unknowns for example - is essential.

3. Understanding the Cash Flow

Understanding the revenue possibilities of a privatized air terminal is key to the feasibility of a Terminal as a private venture. Defining these revenues definitively is critical to the concept of the terminal as a commercial, rather than just a transportation venture.

An airport or any other facility need not be a successful commercial venture in order to be a candidate for a B-O-T delivery process. It need not necessarily be profitable, if an acceptable subsidy level can be agreed upon and met over the life of the B-O-T contract. In the case of Terminal 3, this was not a consideration. In the case of the fixed link to Prince Edward Island a subsidy is the core of the arrangement. At another of Canada's airports it might be. In either case, private sector involvement can result in a facility that is built faster, more economically and has more to offer the traveller.

Another element required for a successful public-private venture is enough historical data to be able to model the economics of the facility. The economics, passenger volumes, etc. of the airport are important in defining revenues and structuring the deal. If accurate data are not maintained the government may compromise the value it receives.

4. Process

In creating a partnership that will work, it is necessary to establish a realistic and well-defined selection and evaluation process. To do this, the government team should be supported by external, non-biased and competent advisors.

5. Defined Time-Frame

Set definite start and finish date for the process, and a scheduled pursuit phase with pre-determined milestones.

6. Definitive Legal Understanding

It is necessary to have a clear development agreement at the outset. The essence of this agreement must be understood and the basic framework for first principles defined. For example, on the P.E.I. Fixed Link project, proponents will be looking at a federal government subsidy to a maximum level for a certain minimum threshold of services. The need is to define and develop the project within those parameters.

7. Financial Security and Assurances

There must be security for the debt which can be recognized by financial institutions. These could include government loan guarantees that were eventually offset by bonding of contractors. Exclusive rights or monopolies must be defined.

The legal understanding must include definition of limited and defined rights for all aspects of the development. It should include a detailed understanding of the assets pledged, whether land or other. It will include detailed coverage of the proposed revenue stream.

8. Information Base

A large information base available to all proponents in defining their submissions ensures the highest quality proposals. Different interpretations of data should not cause the differences between proposals.

9. Defined Risk

The concept of mitigated or distributed risk is the key in large-scale projects of this nature, as is the requirement for due diligence. The risk must be definable within accepted commercial business practices. If not, the proponent must be in a risk sharing business. An example of this is a subsidy such as that offered for the P.E.I. Fixed Link.

10. Attractive Business Climate Which is Undergoing Change

Any situation where investors are seeking out new opportunities because of excess capacity in the market place is considered attractive. In addition to the foregoing it is necessary to have a strong entrepreneurial

base, committed financial institutions, and strong technical and legal support all being innovative and able to function in new and changing circumstances in non-traditional roles.

5.0 PROCESS FOR SELECTING A PARTNER

The intent of the following section is to clarify the approach to be followed, in the selection of a suitable partner. We use the term partner intentionally because regardless of the terms of the agreement, the public and private sectors will have to work together to meet the dual objectives of public service and financial viability.

PHASE I: DEVELOPMENT OF PROJECT PRINCIPLES

This initial phase will clarify the objectives of the undertaking of and identify the concerns likely to arise during selection of the development partner. The product of this phase will be thorough understanding of the government's discretion for the project, a statement of project principles and a basic plan for the development process.

PHASE II: PROJECT INCEPTION

This phase of the project is designed to bring together all key personnel for the purposes of familiarization and data collection required for the selection of a suitable partner for the purpose of developing the Project. In this stage all background documentation will be obtained and working relationships established. An inception report will be prepared which details the scope of project and key issues for each of the project dimensions: Physical, Business and Process. These dimensions are key aspects of project development. The Physical dimension refers to the geological, technical, engineering and related aspects of the project. The Business dimension refers primarily to the financial, operating and institutional aspects of the project. The Process dimension refers to key dates, processes and times required to implement the project.

PHASE III CONCEPT DEVELOPMENT

This phase of the project is divided into four stages as follows:

- Goal Setting
- Concept Development
- Viability Assessment
- Market Testing

The final deliverable in this phase project is the recommended development concept and a long list of potential development teams.

Stage I - Goal Setting

During this stage discussions will be held to set priorities for the development of the new facility. The project scope will be analyzed with regards to the inter-relationship to other related developments. The interplay among the different objectives will be studied to ensure that all parties appreciate the trade-offs that will have to be made. A brief but comprehensive statement of goals and objectives will be developed.

Stage II - Concept Development

The Project Team will review and analyze broad principles of development along the physical, business and process dimensions. A series of families of alternative development concepts for further assessment and consideration will be developed. At the completion of this stage a summary of potential facility layouts, basic business plans and development timetables will be produced so that a list of feasible concepts for further analysis can be identified.

Stage III - Viability Assessment

During this stage a detailed analysis of a number of discrete feasible alternatives will be prepared. An assessment of the viability of each development concept will be conducted so that a short list of viable concepts can be taken forward for market testing and refinement.

Stage IV - Market Testing

In this stage the preliminary concept will be initiated with the development, contractor, and financing communities in order to confirm the viability of the concept and finalize the development concept. Screening of potential development teams will commence at this stage and the level of interest in the project assessed. A summary of market feedback and a final development concept will be put forward.

PHASE IV - PARTNERSHIP SELECTION PROCESS

This phase of the project will involve the administration of a proposal call process and the selection of two final partnership candidates. The ultimate deliverable in this phase is the recommendation of the two most compatible partner candidates.

Stage I - Information Package

In this stage the structure of the overall concept development will be finalized and the preliminary evaluation criteria and principles of

agreement will be development. Information will be contained in an information package and will form the basis of the documentation for the call for proposals for the selection of the interim partner.

Stage II - Call For Proposals

In this stage proponents will be briefed on the project, process and development concept and inquiries from the proponents will be responded to as appropriate. The final proposal evaluation methodology will be submitted for approval.

Stage III - Proposal Evaluation

In this stage the proposals received from the prospective partners will be evaluated. The evaluation will highlight the role of the Government under each of the proposals. The returns, risks and financial advantages to Government for each proposal will be highlighted. An evaluation of each proposal and a recommended shortlist will be provided so that in-depth interviews can be conducted.

Stage IV - Shortlist Interviews

In this stage in-depth interviews with the short listed proponents will be conducted. Any changes made to the proposals during the interview period will be analyzed. Responses to questions raised at the interviews will be analyzed and followed up if further clarification is required. A recommendation for the two final interim partner candidates will be provided for negotiations. One party will ultimately enter into a partnership agreement.

PHASE V NEGOTIATION OF DEVELOPMENT AGREEMENT

This phase of the project will involve the negotiation of the Development Agreement.

PHASE VI - IMPLEMENTATION

Once the development agreement has been executed, the project will enter the implementation phase culminating in the commissioning of the completed facility.

6.0 SUMMARY

All governments are facing considerable fiscal strain and will continue to do so for the foreseeable future. The demands from the health and social services elements of their mandates will place increasing strains

on treasuries as the population ages, leaving little room available for the funding of infrastructure refurbishment and expansion. The great post-war infrastructure developments that provided such prosperity to the western world in the 1950's, 60's and 70's are approaching the end of their useful lives. Without significant investment, the rate of decay will accelerate leaving all of us poorer and less able to compete in a global marketplace. Our prosperity in the year 2010 will be directly related to the infrastructure investments we make in the 1990's. Significant investment is required now. The traditional government ownership models will not work in the 1990's and privatization is a powerful vehicle for delivering needed infrastructure for the second millennium.

Canadian Ports: An Alternative Approach

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1. INTRODUCTION

Within the Canadian federal system, constitutional responsibilities and authority is divided between provincial and federal governments. Under the 1982 Constitution Act, the federal government is responsible for ports and harbours. Despite this authority, current Canadian ports administration is anything but homogeneous. Rather, Canada's 365 commercially oriented ports are a diversified, multi-layered and loose-knit mixture of crown corporation ports (Canada Ports Corporation), Harbour Commission ports, Transport Canada Public Harbours and Port Facilities, and private industrial harbour and wharf facilities. Their common element is various reporting relationships to the Minister of Transport and Cabinet.

In many instances, this uncoordinated mixture of ports compete with each other resulting in inefficient port development. The construction of an under-used container facility at Fraser River (a Harbour Commission) to compete with similar facilities at Vancouver (at the time a National Harbours Board port) reflects the failure to wisely allocate scarce financial resources (Goss, 1990).

Today's global economics requires efficient international trade. Canada is not isolated; rather it is part of a continental transportation system. The common border between Canada and the US is virtually invisible in terms of trade. This creates competitive opportunities for Canadian and US shippers to use alternative ports via effective intermodal transportation systems.

The US, like Canada, is also a federal system. In terms of its ports, however, authority and responsibility rests at the state rather than the national level. This has led to competition among US ports as each, often in partnership with the state government by way of supporting subsidies and tax assistance, struggles to maintain and enhance their market share. Such competition is often at the expense of other nearby ports. Compare, for example, the recent misfortune of the port of Baltimore where the newly opened Seagirt Container Terminal is struggling to attract traffic, with the aggressive and successful marketing efforts of the nearby Virginia Port Authority at Hampton Roads (Starr, 1991). Heikkila (1990) argues that strictly autonomous ports in the US results in a suboptimal resource allocation as a result of under-pricing port services (in a highly competitive environment) and over-supplying facilities.

Canada's geography dictates a need for local autonomy in port administration and operations. The Canadian ports dilemma is to balance central control (essential for an economically efficient national system of ports) with equality of economic development opportunity in all parts of the country. To a degree, the current national ports system reflects this dilemma. In 1983, the Canada Ports Corporation Act established the nation's major commercial ports as crown corporations both at the national level with the Canada Ports Corporation (CPC) headquartered in Ottawa and at the port level with Local Port Corporations (LPC). Harbour Commission ports and Transport Canada Public Harbours and Port Facilities remained in place under this new legislation.

Following almost a decade of operation under the 1983 Act, are changes needed to the national ports system to enable Canada to compete effectively in the today's global economy? This paper reviews the evolution of Canadian ports policy to determine its rationale and evaluate the national ports system in the light of today's rapidly changing economic and transportation environments.

2. EVOLUTION OF CANADIAN PORTS POLICY

The present Canadian ports system is a product of its historical evolution. An administrative structure for port operations and development predated Canada's Confederation in 1867. For example, the Trinity Houses of Quebec and Montreal (established in 1805 and 1839 respectively), controlled shipping and navigation in the St. Lawrence River as well the management of their respective harbours. Harbour Commissions under statutory authority from the colonial provinces were established.

2.1 British North America Act

Section 108 of the British North America Act of 1867 placed navigation and shipping under the exclusive jurisdiction of the federal government. In 1868, the Department of Marine and Fisheries was created. A number of harbours, originally incorporated under Acts of the former colonial provinces, came under the jurisdiction of this new Department (Appleton, 1989). The Department regulated public harbours and ports, but, with limited staff and vast geographic distances between ports and the national headquarters in Ottawa, it was not surprising to find a myriad of port and harbour commissions established.

By the 1920s, the Canadian port scene included harbour commissions, some under the direct control of the federal port administration and others more independent and oriented to municipal administration. The federal administrative structure consisted of one supervisor of harbour commissions, one clerk and two stenographers to monitor and regulate some fourteen harbour commissions. At the commissions themselves, administrative efficiency was hampered by a political patronage system that included the wholesale change in personnel following national elections.

These problems led Sir Alexander Gibb, in his National Ports Survey (1932), to claim that "the development of rival sites and changes of policy have involved

enormous and often unproductive expenditure". Gibb went further to argue that the lack of federal ports policy guidelines led to some port authorities "buying traffic" from other more business-like neighbouring ports by simply cutting, abolishing or failing to levy proper port charges.

2.2 National Ports Survey - 1931/32

Gibb's National Ports Survey formed the foundation of a radically revised ports system that centralized control over the country's major ports. Gibb sought to reconcile the need for local business involvement and autonomy in ports administration with earlier problems and the need for centralized fiscal control apparent during the 1930s Depression. He weighed the problems and benefits of retaining semi-autonomous harbour commissions with alternatives such as a centralized departmental approach or a crown corporation system. His fundamental philosophy was that: "the National ports have to serve more than local interests, and in the interests of the whole country, must be directed on national lines and in accordance with a definite coordinated policy".

In the end, he recommended the creation of a Central Harbours Board comprised of three members chosen for their business and technical expertise and in no way reflective of political or territorial concerns. This Board was to directly administer Canada's "five recognized national seaports": Montreal, Quebec, Vancouver, Halifax and Saint John; along with all of those ports of more than purely local importance.

2.3 National Harbours Board

Following Gibb's recommendations, the 1936 Department of Transport Act consolidated the Department of Marine with the Department of Railways and Canals and included the formation of the National Harbours Board (NHB). Seven harbour commissions were subsumed under the NHB (in addition to Gibb's five nationally recognized ports, Trois Rivières and Chicoutimi were added). Over time, the NHB assumed responsibility for the grain elevators at Prescott and Port Colborne and the ports of Churchill, St. John's, Belldune, Prince Rupert, Sept Iles, and Baie des Ha!Ha! Municipal harbour commissions continued to function independently of the NHB. Some of these commissions were eventually disbanded while others were created.

As befitted an organization created in the Depression, the NHB took a decidedly centralized approach to ports administration. The NHB ports over time became noted for their rigid centralized financial controls, isolation from municipal and provincial inputs, and the absence of communication with Commission ports (Dosman, 1978). In the Maritimes, the lack of municipal and provincial input into the local major ports of Halifax and Saint John led to the creation of municipal port development commissions. These commissions were financed through municipal and provincial taxes to promote trade through their local port to boost local employment.

The activities of port development commissions along with increasing provincial interest in port affairs eroded exclusive federal port authority. For example, the direct financial involvement of the Provinces of New Brunswick and Nova Scotia in the

development of Rodney and Halterm Container Terminals in Saint John and Halifax in the early 1970s reflected their growing concern over the port policies being developed in the Ottawa headquarters of the NHB.

2.4 Harbour Commissions

From 1827 to 1840, some 15 port charters were granted to municipalities by colonial authorities. Several commissions became known as federal commission ports as they had federal but no municipal involvement in their administration. As discussed above, these ports were subsumed into the NHB system in 1936. Municipal commission ports continued under their initial Acts of incorporation. These Acts varied depending upon circumstances at the time of their passage. The 1964 Harbour Commissions Act rationalized the formation and activities of the various commission ports.

Harbour Commission ports are required to be financial self-sufficient and reflect local interest. They operate with a considerable degree of autonomy. Local commissioners are generally business persons familiar with the port and its trade. The majority of the commissioners are federal appointees. The remainder are appointed by one or more of the municipal councils whose communities are adjacent to the port. Harbour Commission ports are not subject to the Financial Administration Act and are entitled to accumulate reserve funds for harbour planning and development. All Harbour Commissions, with the exception of Toronto and Hamilton (exempted from the 1964 Act), report to the Minister of Transport. Toronto and Hamilton report to the Governor in Council (federal cabinet). Currently there are nine Harbour Commissions: Toronto, Hamilton, Windsor, Thunder Bay, Fraser River, North Fraser River, Port Alberni, and Nanaimo (Foreman, 1988).

2.5 Transport Canada Ports

The Public Harbours and Port Facilities group under the direct jurisdiction of Transport Canada's Harbours and Ports Directorate (Canadian Coast Guard) comprises the majority of smaller commercial and non-commercial facilities throughout Canada. The 1985 Public Harbours and Port Facilities Act integrates these smaller facilities into an overall national ports policy. The administration of these numerous ports is divided amongst five regions. Local advisory councils may be established by the Minister of Transport as a means of decentralizing authority. Advisory council members are appointed by the Minister.

Public Harbours vary considerably in size and significance to adjacent local communities. Some serve as essential transportation links for isolated regions while others meet the needs of local industry. The revenues collected from cargo throughput in these facilities varies. As pointed out in the Annual Report (1989), "the majority of the public ports do not generate sufficient revenues to cover all of the capital, operating and administrative costs and therefore are funded largely by appropriations through parliament".

2.6 Towards a National Ports Policy

Commencing in the 1960s, the federal government sought to establish a rational and integrated national ports policy consolidating differing port administrations. The Manning Report (1971) is the first of several analyses of Canadian ports; all of which outlined the necessity of rectifying ports administration. Manning recognized that the environment that led to the creation of the highly centralized NHB ports in the 1930s had changed. Competitive threats from US ports and the growing significance of inland rail systems led him to recommend the creation of a single agency of government responsible for all federal ports and harbour activities.

Recognizing the need for reform, the federal cabinet in 1971 modified NHB ports by establishing advisory Local Port Authorities. Although these appointed bodies remained advisory, they provided an effective sounding board for reform. In addition, NHB took steps to: decentralize their operations to a regional level; streamline financial and administrative systems; establish port executive committees in Vancouver and Montreal; and create a National Ports Council. By 1974, the NHB had assembled a competent central staff operating this altered system.

In the February 1974, Speech from the Throne, the federal government announced its intentions to restructure Canadian ports. An interdepartmental committee again reviewed Canadian ports policy. In its consideration of alternative models, the Scott Committee recommended a public service solution, centralizing control of all Canadian ports within Transport Canada. The Scott recommendations found their way into the Canada Ports Act, Bill C-6, introduced in Parliament on July 19, 1977.

The proposed Canada Ports Act included the formation local advisory committees and regional advisory councils appointed by the Minister. All Canadian ports would be administered through a Canadian Ports Commissioner, a career civil servant reporting to the Minister through the Marine Transport Administration Division of Transport Canada. Some twenty ports of national significance were to be administered by local and semi-autonomous port commissions. These local port commissions were to set rates for services, and establish their own bylaws and regulations. In addition, local port commissions were to be financially self-sufficient. The Canadian Ports Commissioner would serve as a "watchdog" to ensure the various ports were not working at cross purposes.

In his condemnation of the proposed Canada Ports Act, Dosman (1978) argues that the outright rejection of the crown corporation model with the alternative internal departmental approach "reflects a public service takeover". The proposed Act strengthened the central ports bureaucracy by providing considerable discretionary powers to the Minister. Dosman's concerns go further as he pointed out that although the legislation had only been proposed in principle in parliament, it was largely implemented by the Ottawa bureaucrats. Most of the positions in the proposed Canadian Ports Commission were filled by 1978. This incredible situation, in which Treasury Board and the Public Service Commission helped senior Transport Canada officials eliminate NHB staff, added to the turmoil surrounding Canadian ports

administration.

The crucial issue was the "politicization" of Canadian ports by bringing them under the public service umbrella. "A crown corporation can say "no"; public servants cannot". The crown corporation model provides a buffer between the partisan politics of the Minister and the commercial needs of Canada's transportation system: "Only a central ports agency with statutory independence, though subject to Ministerial direction, can prevent the total politicization of ports policy, when the political needs of the day will be serviced" (Dosman, 1978).

Despite this flurry of bureaucratic and political activity, in the final analysis, Bill C-6 was not passed by parliament due to delays, lack of interest in matters marine, intervening elections and so on. The conclusion to this continuing drama came with the adoption of the Canada Ports Corporation Act in 1983.

2.7 Canada Ports Corporation

The Canada Ports Corporation Act was adopted in February 1983 forming the Canada Ports Corporation as a crown corporation with subsidiary corporations at the local port level. The legislation sought a balance between national coordination and local responsiveness. A high degree of local autonomy was provided to ports of national or regional significance that achieved financial self-sufficiency, by incorporating them as Local Port Corporations with their own Ministerially appointed Board of Directors. To date, the Minister has granted LPC status to seven ports: St. John's, Halifax, Saint John, Quebec, Montreal, Vancouver, and Prince Rupert. CPC is responsible for 15 commercial ports, including the LPC facilities.

Despite Section 3's definition of a national ports policy, the Canada Ports Corporation Act is silent on the role of the other forms of Canadian ports administration: Harbour Commissions, Public Harbours (Transport Canada ports), and private industrial facilities. Despite the Act's efforts to rectify the problems of the former NHB system, there is still no overall national coordination of Canadian ports.

3. CHANGING PORTS ENVIRONMENT

Legislative changes deregulating the US transportation industry along with increased competition spurred the development of innovative intermodal systems. Enhanced intermodalism can be traced to the deregulated environment created by the Staggers Rail Act of 1980 and the 1984 Shipping Act. The Staggers Act permitted the US railroads to undergo major restructuring within a competitive framework. The Shipping Act similarly permitted the negotiation of favourable rates and clarified the legality of intermodal services tied to shipping lines. Shipping lines used the deregulated environment to negotiate low-rate contracts with railroads to carry containers (both single and double-stacked) to major inland destinations. The rapid increase in the use of double-stack trains in the US (and now increasingly in Canada) during the latter half of the 1980s created significant shifts in tonnage throughput in many US and, indeed, in Canadian ports (Ircha, 1988).

Canada, following the US lead, introduced regulatory reform with the National Transportation Act in 1988. This Act and other accompanying transportation legislation emerged from the federal government's earlier 1985 White Paper on "Freedom to Move".

Canada's "Free Trade Agreement" with the US also has affected the competitive position of ports. Opening the border increased awareness by Canadian shippers of competing US gateways. The Canadian railways also are seeking inroads into the US. The recent purchase of the Delaware and Hudson Railway by Canadian Pacific Railway enables them to serve the US ports of Baltimore, Philadelphia and New Jersey. In turn, this has led to reduced container throughput in Halifax as heavy Canadian-bound cargo can now be railed to Central Canadian destinations from US East Coast ports (Warren, 1991).

The shipping industry has been forced to become more efficient in the increasingly competitive environment of the 1980s. This decade witnessed the introduction of larger container carriers with improved economies of scale but with a need for increased traffic volume and quick port turn-around time. Thus major shipping lines are increasingly seeking hub ports served by efficient intermodal systems. The port of Halifax has recently witnessed a significant drop in its container throughput as its shipping lines select to hub through either New York or Montreal.

4. CURRENT CANADIAN PORT DILEMMAS

Canadian ports, like those in other nations, are in the unenviable position of maintaining fixed capital assets serving a highly mobile clientele (both on the land- and water-side). National and international competitive pressures have effected the viability of ports. Competition between Canadian ports has led to charges of unfair practices and uneven playing fields. For example, Saint John faces competition from the port of Bayside (a Transport Canada Public Harbour). Bayside was developed in 1971 to aid a local fish processing industry as a regional economic development initiative. Over time, however, federal capital investments have expanded the wharf (including $10 million in 1989) and provided cold storage facilities (a further federal contribution of $2.5 million) (Crandall, 1991). The result has been a steady growth in Bayside traffic, some of which would have normally gone through Saint John.

Although one can argue that such competition leads to over-supply of capital facilities, recent work by Porter (1990) shows competition can stimulate innovation and develop a national or regional competitive advantage. Porter argues that a discerning clientele (one which demands high levels of efficient service) coupled with competition inevitably generates creative innovation. A clustering of innovative enterprises leads to a regional or national competitive advantage. Porter's thesis is evident in the rise of intermodalism in the US and its effect on Canadian ports and shippers. Accepting Porter's approach means that competition among ports in itself is beneficial as it will drive these organizations to develop improved efficiencies and productivity; thus, enabling them to compete more effectively.

How can Canadian ports react to these competitive pressures? Within the CPC system, LPCs have the authority to set their own rates. To a degree this has occurred as each port seeks to reflect the requirements of their clientele. Rate setting at the port level, of course, has to be within a framework of continued financial self-sufficiency. But there are other steps that can be taken. For example, the port of Saint John has leased under-used warehouse space for various land-side activities. This approach coupled with improved efficiency through earlier organizational down-sizing and effective aggressive marketing to identify and tap niche markets, has enabled the port to meet its financial commitments.

At the national level, questions can be raised over the integrated ports planning undertaken at CPC headquarters. CPC's approach seems to focus on major studies such as: Competitive Strategies for Canada's Transportation System; "Port Economic Multipliers"; and more recently, Towards a Canadian Intermodal System: Recommendations for Change. In addition, CPC provides quarterly business overviews and sponsors annual Ports Business Conferences. Despite the benefits of these services and studies, the Canada Ports Corporation Act does not provide an integrated ports system perspective (Simms, 1989). Canadian ports are divided into different institutional systems. Although competition among these various ports may be healthy in generating innovation, Canada may have a competitive advantage over the US in its ability to establish a national, integrated ports system.

5. NEED FOR A TRULY NATIONAL PORTS POLICY

The Canadian ports system is unique within federal states in that the responsibility for port and harbour affairs rests solely at the national level. In Australia and the US, two other large federal systems, authority for ports rests at the state level. Despite Canada's uniqueness, ports administration is fragmented amongst various groups: CPC; Harbour Commissions; Transport Canada Public Harbours; and private facilities. To remain competitive in the rapidly changing North American transportation environment, Canadian ports need to be structured in a rational, business-like, integrated fashion.

5.1 Alternative Approaches to an Integrated System

A range of alternative approaches to integrating the national system of ports are available. These alternatives include: increased centralization and control of the various ports and their administrative structures; establishing regional controls; or enhancing local port autonomy through commercialization and privatization.

Placing all of Canada's commercial ports and public harbours under one centralized administration was discussed and almost implemented in the 1970s with the proposed Canada Ports Act. The failure to pass this Act reflected the federal government's concerns about increased bureaucratic control over what should be a strictly commercial activity. In addition, Canada has had a history of significant financial troubles arising from a national ports administration. By 1980, the NHB ports had debts and accrued interest owing to the government of $475 million. This debt

load was suspended in 1980 to enable the eventual passage of the Canada Ports Corporation Act in 1983. Given this background, it is doubtful that the federal government would reconsider centralizing the control of the national ports system.

The middle ground involves the development of regional systems. Such an approach distributes port assets on a regional scale. The authority to establish regional port advisory councils is in place with the Canada Ports Corporation Act. To fully develop a regional coordinating body for Canada's port system, the authority of the regional advisory council would have to be expanded to monitor and regulate all regional port development initiatives. This approach delegates central planning authority to regional bodies. To make the regional advisory council fully viable, the Minister should delegate membership appointments to the various bodies concerned. Local municipalities with a direct interest in port affairs should be invited to appoint a member. To maintain a business-like approach, none of the members should be elected politicians, but rather be representatives of the business and technical community affected by the ports in the region.

At other end of the range of alternatives is the currently popular privatization approach. Many eyes are cast in the direction of the United Kingdom with its current ports privatization initiatives. Britain's success with the privatization of the British Associated Ports coupled with the central government's abolition of the National Dock Labour Scheme in July 1989, opened the doors for other port privatization proposals. A number of container ports are taking advantage of the legislation provided in the 1991 Ports Act (Ports, 1990).

From a Canadian perspective, concerns for equality of regional economic development opportunity make such a rigid approach infeasible. Certain Public Harbours and Port Facilities still have to provide essential transportation linkages and service to isolated industries and communities.

Bennett (1992) suggests that what is really being sought by ports is increased commercialization rather than privatization: "I believe that much could be accomplished, even short of privatization, if governments would grant their port professionals greater responsibility and authority, if they would permit them to operate commercially, and if they would insist that this be done. That is, the ports were commercialized". The creation of LPCs has ensured commercialization is being practised in seven of Canada's major ports. Such commercialization has always been the mandate of Harbour Commission ports. Will further steps towards privatization enhance trade opportunities? What may be more appropriate in the Canadian context is the further commercialization of non-LPC ports and some of the larger commercial Public Harbours and Port Facilities.

5.2 An Alternative National Ports Policy

Canadian ports face increased competitive pressures from the North American transportation system. The currently fragmented institutional structure may not support the future success of Canadian ports. There is a need to blend the competitive

advantage of devising a national coordinated system of ports with the need to ensure adequate access to subsidized port facilities for regional economic development.

One method of achieving this within the current legislative frameworks of all the ports administrations would be to have a national coordinating ports council. However, given the history of animosity among the various port administrations coupled with their relatively independent legislative mandates, it is doubtful such a body would achieve more than mere information exchange.

A better approach might be to subsume all of Canada's commercial ports (CPC, Harbour Commissions, and Public Harbours) into one body. In the current climate supporting commercialization and privatization, an appropriate body would be the Canada Ports Corporation. As a crown corporation, CPC provides adequate distance from the political arena and a commercial orientation.

Under this scenario, CPC headquarters in Ottawa should focus on issues of national significance to ports such as overall system planning, international trade, commercial environmental scanning, ensuring major transportation systems reinforce local ports' initiatives, and so on. The operational aspects of monitoring and regulating the commercial LPC and non-LPC ports and their equivalents among Harbour Commission ports and Public Harbours should be undertaken at a regional level. Regional ports advisory councils could be expanded to include membership from all of the ports involved as well as from affected provincial and municipal governments.

Within the CPC system, former Harbour Commission ports and Public Harbours found to be financially self-sufficient and of regional or national significance should be granted considerable autonomy in managing their day-to-day affairs as separate crown corporations or LPCs. Non-LPC type ports should be administered both locally and at the regional level.

This approach abolishes Harbour Commission ports in favour of their becoming CPC facilities with the likelihood that most, if not all would achieve LPC status. In the case of Transport Canada's Public Harbours and Port Facilities, those which have achieved commercial status should be transferred to the CPC system. Other publically subsidized facilities proving access or regional economic development opportunities should remain within Transport Canada. As these facilities are, by definition non-commercial as they are not financially viable, they should not be included with CPC commercial ports. This ensures these publically supported port facilities are clearly identified as such rather than being a part of a commercial system that would inevitably have to cross-subsidize these non-viable operations.

The next stage might be to privatize the expanded CPC in much the same manner as with Air Canada. This suggested approach to a national ports policy should rectify many current difficulties and enable the Canadian national system of ports to develop a competitive edge over its US counterparts.

6. CONCLUSIONS

The Canadian ports system underwent a major reorganization with the formation of the Canada Ports Corporation in 1983. Although the legislation was progressive by introducing commercialization into the nation's major ports, it did not go far enough. The 1983 Act did not include any requirement to develop and maintain a national ports system perspective. Canada still has a fragmented approach to national ports policy involving three major administrative systems: Canada Ports Corporation ports as semi-autonomous crown corporations; Harbour Commission ports; and, public sector Transport Canada Public Harbours and Port Facilities.

To meet the competitive challenges of today and tomorrow, further rationalization of the Canadian ports system is required. One suggested approach is to consolidate all of Canada's commercial ports into one body; preferably the Canada Ports Corporation to maintain the advantage of its crown corporation status. Ports which are non-commercial in nature should remain within the public sector as Transport Canada Public Harbours and Port Facilities. Once the expanded CPC system has been established, a further step towards privatization could be considered.

There are many questions that can be asked about the current institutional structure of the Canadian ports system. The approach suggested in this paper is merely one of many alternatives to be considered. Further work is needed in devising other alternative approaches to improving our national ports policy and determining their benefits and costs in terms of enhancing the Canada's international trade.

ACKNOWLEDGEMENT

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REFERENCES

Annual Report on Financial Operations 1988-1989, (Ottawa: Harbours and Ports, Canadian Coast Guard).

Appleton, T.E. (1989), "From the Fog and Darkness", Portus, 4 (3), pp. 30-36.

Bennett, M. (1992), "Trade or Treasury: Who Benefits From Port Privatization?", Portus, 7 (1), pp. 10-15.

Crandall, E. (1991), "Cold Storage Facility is Shot in Arm for Port of Bayside", Canadian Sailings, December 2, p. 28.

Dosman, E.J. (1978), "Canadian Ports Policy: The Canadian Ports Act (Bill C-6) - Background and Prospects", Research Seminar Series (Ottawa: Canadian Transport Commission), ch. 1.

Foreman, F.S. (1988), "A Matter of Semantics: The Canadian Port System Defined", Portus, 3 (1), pp. 16-18.

Gibb, Sir Alexander (1932), National Ports Survey 1931/32, (Ottawa).

Goss, R.O. (1990), "Economic Policies and Seaports: 2. The Diversity of Port Policies", Maritime Policy and Management, 17 (3), pp. 221-234.

Heikkila, E.J. (1990), "Structuring a National System of Ports", Portus, 5 (3), pp. 19-23.

Ircha, M.C. (1988), "Canadian Container Ports: Shipping Trends and Policy Issues", Canadian Public Administration, 31 (1), pp. 371-389.

Manning, W.J. (1971), Study of Harbour Administration in Canada, (Ottawa: Information Canada).

Porter, M.E. (1990), The Competitive Advantage of Nations, (New York: The Free Press).

"Ports Ponder on a Private Problem", Container Management, September 1990, pp. 45-47.

Simms, G.C. (1989), "Are There Too Many Ports?", Portus, 4 (1), pp. 46-49.

Starr, J.T. (1991), "The Port of Baltimore: Off the Beaten Track?", Maritime Policy and Management, 18 (3), pp. 171-181.

Warren, W.J. (1991), "CP Rail, Soo and D&H System Integrated", American Shipper, 33 (3), p. 70.

Changes in the Fleet Characteristics of Canadian International Cargo Shipping, 1980-1990: An Application of Correspondence Analysis and Hierarchical Clustering

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Summary

With cargo handling data from Canadian international ports, this paper describes some general features of cargo transport capacity and cargo handling. Correspondence analysis and hierarchical clustering are applied to describing the marine cargo fleet. One benefit of this method is its ability to reveal aspects of the fleet structure that might not be apparent from conventional summaries, particularly in terms of the dynamics of national and open registries. This approach is also fairly robust in situations where complete and pristine data may not be available.

Background

This paper began as an assessment of less frequently used elements of the international marine transportation database at Statistics Canada. For this purpose, the most reliable and detailed data are available for the period from 1980 to 1990. Even in this brief series, a number of serious difficulties were encountered in analyzing and interpreting some key elements of these data. These ranged from minor coding inconsistencies to fundamental changes in some underlying concepts -- including, for instance, the nature of commodity classification systems.

In maintaining large and detailed databases, these situations are not uncommon. There may be, in addition, a number of exacerbating circumstances, ranging from changes in specific information demands, to insufficient and uncertain resource

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The author acknowledges the support of the Transportation Division and the National Accounts and Environment Division of Statistics Canada. However, the author alone bears responsibility for the specific content of this study. All views and opinions expressed in this discussion are strictly those of the author and should be taken to represent those of the Transportation Division, the National Accounts and Environment Division, or Statistics Canada.

commitments, and to a lack of continuity in data management practices. With these operational constraints, it is quite common for analysis and research to resort to the 'top 10' approach to summarizing data. Although it is expedient, this type of analysis leaves too much to the judgment of local experts. Granted, this method makes full use of the knowledge gained by individuals through experience and, as such, the outcome is usually reasonable. However, this tact also precludes the element of surprise. The structural features and change within a system are described and interpreted only within a limited paradigm -- the a priori limits set by the analysts of what should be plausible and what ought to be important. At any rate, the result is the investment of tremendous expense and effort in collecting and maintaining an underused body of data.

This paper is a response to that situation. As such, it focuses primarily on the potential of descriptive statistical techniques as tools for data quality assessment, as well as for data interpretation. Although some passing observations are made with regard to data quality, most of this paper is directed towards revealing some broad summary patterns and elements of the underlying data structure.

Data

This study is based on an eleven-year series of manifest data. With the A6 General Declaration, information is gathered for all international cargo handling transactions at Canadian ports. These documents are collected, through Canada Customs, by the Transportation Division of Statistics Canada for data capture and coding. The database generated by this process does provide an essentially complete profile of cargo handling activity but it should also be recognised that figures based on the A6 may understate the true volume of cargo that is in the Canadian international port system at any time. At any given port of call, vessel movements that are not explicitly involved in loading or unloading cargo are described generically with the term *in ballast*. In other words, the Marine International database at Statistics Canada does not capture information on cargo retained on board. In some applications, such an omission may constrain the interpretation of statistics from this source.

It should also be noted that the core of activity, as it is presented in this paper, does not at all represent the most financially significant cargo movements. In this study, marine cargo handling is weighted by the physical quantities of commodities rather than the value of those transactions. This definition necessarily overstates the role of bulk commodities, which are among the least valuable of all material transported.

Analysis

Within these data limitations, a general framework is constructed from which the fleet structure of Canadian international cargo shipping may be studied. This structure is based on a classification of the total contribution of flag state to cargo

handling from 1980 to 1990. The resulting core-periphery pattern is based on both the magnitude and the consistency of cargo handling during the period of study.

One practical constraint on analyzing these data is the combined effect of coding inconsistencies and the nature of the materials that contribute to the weighting element. With minimal recoding and by eliminating registries that, individually, contributed less that 0.5% of the total cargo handled during the study period were dropped from the study sample. This reduced the original sample of 101 cases to 49, eliminating only 0.63% of the cargo handled over the eleven-year period of study. Such inconsistencies suggest a high level of noise in this particular data element but given the relative ease with which a vessel may change its registry, as certain level of movement in the fleet is also to be expected.

In addition, the absolute sizes of transactions and the scale of differences between groups can become very large when dealing with tonnage figures. This makes it very difficult to discern any general similarities among the registries because even closely ranked fleets may differ in cargo handling by several orders of magnitude. To reduce the effect of these differences, the analysis by correspondence and clustering is done with log-transformed summary data.

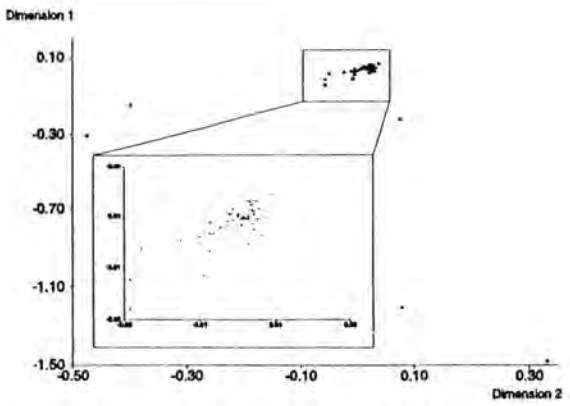


Figure 1. Fleet Structure in the Correspondence-Derived Space, Dimensions 1 and 2.

To classify a set of observations, methods are usually drawn from the family of cluster analysis techniques. In this particular case, the single greatest drawback is that virtually all elements of the cargo transaction records are categorical. Cargo tonnage is, in fact, the only piece of ratio-level data. Thus, a preliminary technique is required in order to transform these univariate data into a quasi-multivariate space and correspondence analysis was applied for this purpose. This is essentially a scaling

technique, which derives for the rows and columns of a contingency table a set of coordinates in an *n* dimensional Euclidean space (e.g. Greenacre, 1984).
The configuration shown in Figure 1 shows the relative positions of flag states in the first two dimensions of the correspondence analysis solution of a flag-by-year tonnage summary. This profile suggests a very wide variance in fleet behaviour, which is related to the magnitude of cargo handled. There are also appears to be a very cohesive central core in the structure.

In this paper, no explicit attempt has been made to define the dimensions derived by correspondence analysis. In other applications of that technique, qualitative interpretations are usually applied. For instance, the vertical axis might be labelled 'consistent prominence,' where the ability of a given fleet to retain market share might decrease as its position shifted from the top to the bottom of the page. This allows the analyst to reconcile the numerical structure of the data to a subject-defined or conceptual base. In that type of exercise, it is important to remember that these coordinates simply denote the relative positions of entities and, thus, they cannot be used in ratio comparisons. That is, although we might say that fleet A appears to be more consistently prominent in cargo handling than fleet B, we cannot say that fleet A is *two times* more consistent in its performance than fleet B. Moreover, in this particular case, additional verification is required to ensure that this configuration reflects genuine shifts in the behaviour of the cargo shipping fleet, rather than inconsistent coding practices.

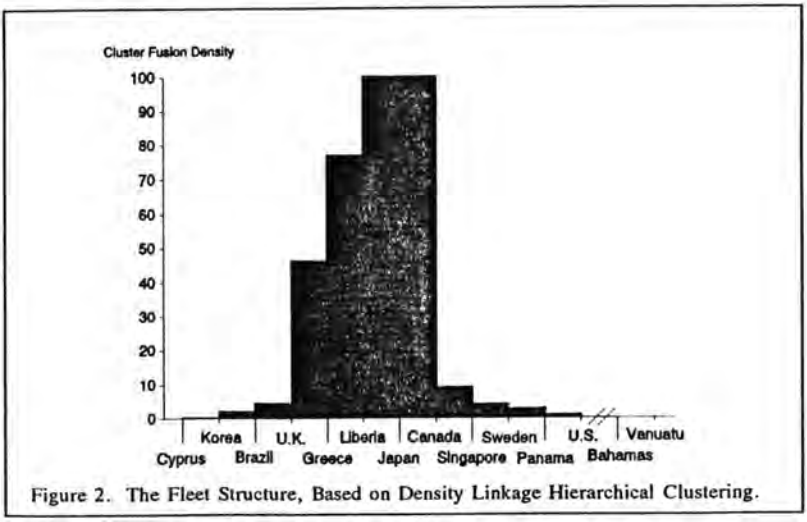


Figure 2. The Fleet Structure, Based on Density Linkage Hierarchical Clustering.

Aside from these interpretive difficulties, these generated coordinates may then be used in a standard clustering method. Because of the exploratory nature of this study, the most important aspect of the clustering algorithm would be its ability to

extract a strongly cohesive and consistent core from the observations. To satisfy this requirement, a *k*th nearest neighbour procedure was chosen (Wong and Lane, 1983). In general, hierarchical clustering begins by treating each observation as a separate cluster and each iteration of the process reduces the number of clusters by one, based on a specified rule. Figure 2 shows the cohesion of the fleet structure that was derived by density linkage clustering. This essentially represents the solution derived with $k=3$; that is, the distance of each observation to its three nearest neighbours. Solutions with lower values of k were not easily interpreted, as they produced many disjoint modal clusters. The cluster configurations are similar at slightly higher values of k, with lower fusion densities for the modal clusters.

Figure 2 graphically portrays the decrease in the cohesion of a cluster as cases are added to it. Thus, we demonstrate the 'relatedness' of the cases as they are presented in the correspondence-derived space. Note that cohesion decreases rapidly after the first few observations are joined, which is consistent with the portrayal in Figure 1.

Table 1. Cargo Handled by Selected Registries

Flag State	Cargo Handled (millions of metric tonnes)				
	1980	1982	1985	1987	1990
Cyprus	0.20	0.32	0.92	0.49	0.64
Korea	1.40	2.37	4.90	6.84	6.47
Brazil	1.28	1.61	2.24	1.36	1.11
U.K.	16.78	8.27	9.63	10.24	6.13
Greece	22.56	13.73	10.91	12.33	11.55
Liberia	36.87	29.09	31.19	32.70	30.33
Japan	15.15	15.03	21.15	21.42	17.31
Canada	51.70	39.44	42.71	44.00	45.34
Singapore	3.36	2.78	3.26	4.14	4.08
Sweden	1.00	1.07	1.25	1.49	0.81
Panama	7.79	13.63	24.03	28.52	19.65
U.S.	7.31	4.01	5.50	4.98	5.10
Bahamas	--[2]	0.12	1.78	5.45	10.78
Vanuatu	-	-	-	-	2.91
Leeward and Windward Islands	0.02	-	0.02	0.37	0.73

The result of this procedure is the identification of a general framework that may be used to discuss some central themes in the changing structure of the Canadian international shipping fleet. This structure is based on the absolute quantity of cargo attributed to each registry over an eleven-year period, as well as the consistency with which these fleets hold their relative positions over that time. Table 1 demonstrates what this means, in terms of cargo handled. From 1980 to 1990, eleven registries

[2]Cases with no records for a given year are represented by '-'. Extremely low values are represented by '--'.

may be taken to represent that core of the international cargo fleet -- Cyprus, Korea, Brazil, the U.K., Liberia, Japan, Canada, Singapore, Sweden, Panama, and the U.S. The changing performance of these flag states throughout the period of study indicates patterns of growth and decline, some of which are consistent with the essential nature of marine cargo shipping. Others demonstrate the effect of administrative changes, as shown in the performance of some peripheral fleets -- Bahamas, Vanuatu, and the Leeward and Windward Islands. These are discussed in the following section.

General Characteristics of the Canadian International Marine Cargo Shipping Fleet, 1980-1990

International marine shipping is principally conditioned by the general economic climate -- this is certainly a truism. In the Canadian context, however, the importance of this relationship is heightened by the magnitude of the role played by resource extraction industries in the national economy. Not only do such industries follow their own dramatic cycles of growth and decline, the flux of their activity also tends to be amplified by changes in the general economy. Through the same period, the international marine cargo handling system was also characterized by capacity flux (Tables 2 and 3). To some extent, this pattern reflects the manner in which, cargo capacity is operationally defined. However, it also bears out the high degree of natural resource dependence in its appearance of response to the business cycle.

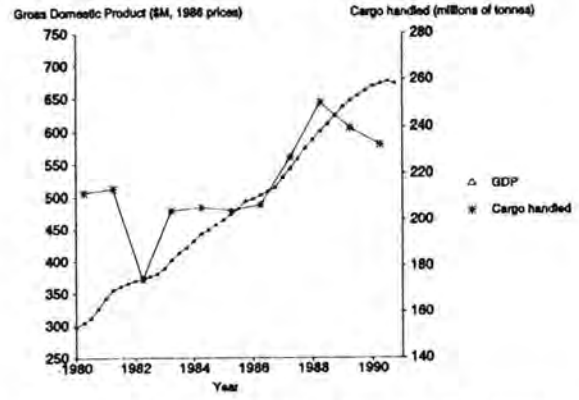


Figure 3. Gross Domestic Product and the Cargo Handled in Canadian International Shipping, 1980-1990.

In themselves, these patterns simply reflect some basic realities of the Canadian economy. A more interesting aspect of cargo fleet activity is its internal flux, which is primarily conditioned by a supranational administrative structure. This is first revealed in the differences in the capacity and cargo handling trends of the core

registries -- specifically, that the trends for each fleet do not strictly follow the overall pattern of cargo handling. Although they represent a very small portion of the total fleet activity, some of the small registries have quite dramatic rates of change.

Table 2. Cargo Capacity[3] of Selected Registries

Flag State	Cargo Capacity (millions of gross tons)				
	1980	1982	1985	1987	1990
Cyprus	0.28	0.54	1.54	6.77	7.23
Korea	2.00	3.14	4.66	5.58	5.56
Brazil	1.44	1.68	2.71	1.43	1.51
U.K.	28.78	13.63	14.24	11.95	10.21
Greece	23.79	15.87	11.47	12.73	9.41
Liberia	31.35	27.40	34.46	36.08	36.21
Japan	21.70	22.54	25.24	24.75	14.88
Canada	45.20	35.39	38.16	38.64	36.97
Singapore	4.60	3.78	6.17	7.37	6.17
Sweden	3.97	4.02	7.28	5.47	7.78
Panama	8.59	13.92	25.27	35.43	25.02
U.S.	8.52	4.17	7.15	4.42	4.56
Bahamas	0.01	0.17	2.25	7.14	17.98
Vanuatu	-	-	-	-	2.78
Leeward and Windward Islands	0.01	-	0.02	0.52	1.48

There are clearly marked differences in the way that each fleet approaches the international cargo shipping market. This diversity is generally related to whether the fleet sails under a true national flag or that of an open registry. National fleets, such as the Canadian and U.S. registries, retain a fairly consistent share of the cargo handled in their home countries through legislation that controls the participants in regional shipping. Other states, however, are active in international shipping more as broad administrative bodies than as transfer points of goods. They have been given various labels, for instance -- open registries, flags of necessity, or flags of convenience.

The distinction between these broad categories is related to long-standing differences in interpretation of the United Nations conventions that govern the registration of marine vessels. Elements of these issues are described in some detail in other publications (e.g. Lloyd's of London 1987; 1988). Essentially, these attempt to prescribe the responsibilities of flag states in the carriage of maritime cargo. Thus, embedded in these is an implied substantive link between the vessel and its flag state. The placelessness of international shipping, however, has long been an established fact. The vessel, its captain and crew, and the origin and destination of its cargo have a multinationality that, on initial inspection, flies in the face of the genuine link

[3]Here, capacity is defined as the product of a vessel's gross registered tonnage and the number of trips recorded on each cargo manifest. This represents the frequency with which certain classes of vessels call at Canadian ports, in addition to their physical capacity.

concept. This circumstance varies in its implications for navigation, trade, and labour practices; thus, a full development of these issues falls beyond the scope of this paper. Nonetheless, very much germane to this study is the imperative to monitor the nature and magnitude of change in the fleets that operate within the Canadian international marine cargo system.

Table 3. Cargo Movements of Selected Registries

Flag State	Cargo Movements				
	1980	1982	1985	1987	1990
Cyprus	52	85	151	543	442
Korea	134	159	203	187	171
Brazil	114	102	143	75	77
U.K.	1,539	740	680	548	470
Greece	4,443	1,023	646	675	409
Liberia	1,566	1,431	1,529	1,649	1,603
Japan	944	918	864	744	341
Canada	6,141	4,990	4,726	4,397	4,099
Singapore	293	199	287	330	248
Sweden	292	281	419	327	174
Panama	843	1,068	1,540	2,115	1,381
U.S.	2,025	1,205	1,775	1,477	1,314
Bahamas	5	9	106	271	751
Vanuatu	-	-	-	-	142
Leeward and Windward Islands	2	-	8	31	168

Even among the flags of convenience, there is evidence of growing challenges to the traditional open registries. The rapid and dramatic emergence of the Bahamian fleet through the 1980's is an especially good example of how a newly created registry haven can quickly divert both capacity and cargo volume in the international shipping market. The flags of Vanuatu and the Leeward and Windward Islands are also good candidates for observation in the coming years, as they have the potential for a similar pattern of growth.

Concluding Remarks

As demonstrated here, a number of descriptive statistical techniques have a great deal of potential in the synthesis and analysis of large datasets. This is related to their ability to produce more expressive representations of those data. This does not, in any way, discount the value of individual experience in interpreting statistical information. In fact, they may be used both to substantiate and to challenge the conventional wisdom in the subject area. They also have some utility in broad assessments of data quality.

The significance of open registries to Canadian international shipping certainly requires further and more rigorous evaluation, particularly given their dynamic nature.

While the policy dimensions must also continue to be explored, the immediate adjunct of this study is the clear need for both raw data and synthesized information. This requirement implies an imperative for dialogue between the industry and its watchers, with regard to clarifying and meeting data requirements. Once gathered, the more important then becomes the subsequent exploitation of a rich source of micro-data, particularly in terms of elaborating the relationships within and between the principal features of international marine cargo transactions.

References

Greenacre, M.J. 1984. *Theory and Applications of Correspondence Analysis.* Toronto: Academic Press.

Lloyd's of London. 1987. *Which Register? Which Flag?* Speakers' papers from the two-day conference. London: Lloyd's of London Press.

Lloyd's of London. 1988. *Which Register Which Flag ... Now?* A two-day conference. London: Lloyd's of London Press.

Wong, M.A. and Lane, T. 1983. A *k*th nearest neighbour clustering procedure. *Journal of the Royal Statistical Society, Series B,* 45:362-368.

Airline Routing Structure Changes in Canada

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Introduction

The Canadian airline industry is under tremendous pressure to become more efficient and competitive. These forces result from both increased domestic and global competition as well as fundamental economic changes worldwide. Deregulation, two recessions, increased operating costs, lowering of trade barriers and the ever-increasing size of the major airlines are among the factors affecting the airline industry.

One of the most fundamental ways to improve efficiency is through modifications to operating characteristics such as frequency, aircraft type and routings. Optimizing the use of aircraft and crew will contribute to lower operating costs. In this context, a major change has been the development of hub and spoke route structures. In order to compete globally, one would assume that the airlines 'own back yard' must be in reasonable order. Thus, this paper will observe the changes that have occurred in domestic air routes in Canada over the last decade. Further, it will examine the changes in actual passenger routing over the same time period as a result of these infrastructure changes.

This paper makes two assumptions:

1) hub and spoke systems are more efficient than other routing structures, and,
2) in order to compete efficiently on a global basis, a carrier must operate efficiently in it's own domestic market.

The first part of the paper will examine changes in the Canadian air network using connectivity matrices. A comparison of these matrices and their powers will show changes which have occurred over the last decade in the manner in which points are linked. Further, these will be constructed on a carrier basis in order to show how Air Canada and Canadian Airlines International (CAIL) have developed their hub and spoke route structure and their feeder networks.

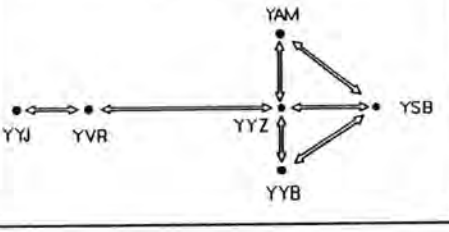
The second part will examine what effects these changes have had on air passenger travel. Two specific results will be examined. One of these is the change in the number of passengers carried intransit by the Level I carriers. The second is the changes which have occurred in passenger routing.

Connectivity Matrices

Example and Definition

The following six airports were chosen to illustrate the concept of the connectivity matrix: Victoria (YYJ), Vancouver International (YVR), Lester B. Pearson (YYZ), Sault St. Marie (YAM), North Bay (YYB) and Sudbury (YSB). The graph in Figure 1 below shows how these are connected by air services.

Figure 1 Graph of Air Service Connections



Each airport is called a node (or vertex) and each line connecting two nodes is called an edge. This is actually a digraph (for 'directed graph') since each edge has a direction associated with it. In this example each pair of airports with service between them has service in both directions. Thus, there are two edges between each pair of points which are connected. However, this need not always be the case. It is possible for two airports to only have service in one direction between them and therefore the digraph would only show one edge connecting the two points.

There are a total of 14 edges in the graph. If each possible city pair combination had non-stop service in each direction, the graph would have 30 edges and would be said to be fully connected. If this were actually the case, it is quite evident that this situation would require enormous resources for an airline. Unless each city pair had a large origin/destination (O-D) market, this would not be an efficient airline operation. In this example, with Lester B. Pearson linking western Canada to eastern Canada, 16 (30 - 14) unnecessary air routes have been eliminated.

This graph can be put into matrix form as shown in Table 1a. Here, a '1' in cell c_{ij} indicates a non-stop air service from point i to point j. A '0' in cell c_{ij} indicates there is no non-stop service in this direction. All the diagonal elements are necessarily 0 and the sum of the off-diagonal elements is equal to the number of edges (air routes) in the graph. Furthermore, the column sums indicate the number of points that are directly connected to that point. Since this matrix is symmetric (all services are in both directions), column sums will equal row sums for a particular airport.

Table 1a. Connectivity Matrix C

	YYZ	YYB	YAM	YSB	YVR	YYJ
YYZ	0	1	1	1	1	0
YYB	1	0	0	1	0	0
YAM	1	0	0	1	0	0
YSB	1	1	1	0	0	0
YVR	1	0	0	0	0	1
YYJ	0	0	0	0	1	0

Table 1b. Squared Matrix C^2

	YYZ	YYB	YAM	YSB	YVR	YYJ
YYZ	4	1	1	2	0	1
YYB	1	2	2	1	1	0
YAM	1	2	2	1	1	0
YSB	2	1	1	3	1	0
YVR	0	1	1	1	2	0
YYJ	1	0	0	0	0	1

Table 1c. Cubed Matrix C^3

	YYZ	YYB	YAM	YSB	YVR	YYJ
YYZ	4	6	6	6	5	0
YYB	6	2	2	5	1	1
YAM	6	2	2	5	1	1
YSB	6	5	5	4	2	1
YVR	5	1	1	2	0	2
YYJ	0	1	1	1	2	0

Table 2. Column Totals

	C	C^2	C^3
YYZ	4	5	23
YYB	2	5	15
YAM	2	5	15
YSB	3	5	19
YVR	2	3	11
YYJ	1	1	5
Total All Airports	14	24	88
Total Non-Zero	14	20	28

Note: diagonal elements are not included in sums

These matrices may be raised to powers to provide additional information about how the set of points are connected. For example, when the matrix C in the example is raised to the second power (C^2), the value of the cell c_{ij} is equal to the number of one-stop (two-stage) routes connecting point i to point j. It is important to note that these are not routes constructed by flight number but rather by squaring the connectivity matrix C. Therefore, an actual connection (change of aircraft) may be required. Column sums (excluding diagonal elements) indicate the total number of one-stop routes to that place from the other points in the set. Another useful statistic is the total number of non-zero elements (excluding the diagonal elements) in column. This provides the number of points which have at least one one-stop route to that airport.

When the matrix is cubed, the cells and column sums have similar meaning as above except that we are talking about two-stop (three-stage) routes. As well, with successive powering of a matrix, we can obtain the first instance for which a cell is non-zero. This will represent the shortest (fewest number of stops) route which will connect the two places. However, care must be taken when analyzing matrices of power 3 and higher. This is because routes become redundant and nonsensical. A redundant route is one in which the same node appears more than once. For example, for two airports A and B which are connected in each direction, we get a three-stage route connecting the points in each direction : A-B-A-B and B-A-B-A.

Matrices are excellent for studying individual city pairs. However, this paper will only deal with the column totals as shown in Table 2. This will provide the best way to observe the overall changes occurring in the connectivity of the points under consideration. The last line in the table provides the number of directional city pairs with at least one one-stop or two-stop route connecting them.

Study Matrix

Using the methodology outlined above, one may examine any set of points to see how they are connected. For example, one may wish to observe how the provinces compare with each other in terms of connectivity, or perhaps, examine how the cities (markets) served by one specific carrier are connected.

Of course, the degree of connectivity in an unregulated environment will, in part, be determined by the demand between the various markets. Thus, this paper will study the linkage between the **'Top 100'** airports in Canada as determined by the total enplaned and deplaned passengers in 1990. The list of these 'Top 100' airports may be found in Table 1.1 of **Statistics Canada** publication **51-005** entitled **'Air Carrier Traffic at Canadian Airports'** (the eight airports in the territories were excluded from this study). The 92 airports analyzed accounted for over 97% of the total scheduled enplaned/deplaned passengers in Canada during 1990.

Three separate sets of connecting matrices were constructed using Official Airlines Guide (OAG) August data for 1979, 1982 and 1990. The first considered services offered by **all** carriers. The second was based on the services offered by the two Level I carriers in 1990 **Air Canada and CAIL**. For this set, the appropriate carriers which have been merged into CAIL were included, if applicable, in earlier years. These were: Eastern Provincial Airlines, Nordair, Pacific Western Airlines and Wardair. For 1990, services offered by

code sharing feeder airlines were omitted. The third set was based on services offered by Air Canada (again, excluding code sharing affiliates).

Table 3 presents column totals for these three sets of matrices. Data for the top six airports and a total for all 92 airports are shown. The 'Total All Airports' represents the sum off all off-diagonal elements while 'Total Non-Zero' represents the number of off-diagonal elements which are not equal to zero.

All Carriers - The matrices for this set show that the number of connections has increased from 1979 to 1990. That is, more city pairs have scheduled non stop service between them. The number of direct connections increased by about 10.8% from 1979 to 1990.

Air Canada and CAIL - These data show how Air Canada and CAIL have cut back on the number of points they serve. The number of direct connections declined modestly from 331 in 1979 to 318 in 1982 but then dropped to 149 in 1990. Many routes are now being served exclusively by the affiliates of the Level I carriers if market size and distance permit.

Air Canada - These matrices show similar results as those of the combined Level I carriers. Air Canada was considered separately since it's case was a little more 'pure' inasmuch as it is not the result of major mergers over the years as is the case with CAIL. For Air Canada, the number of non-stop connections decreased from 176 to 163 to 95 for the years examined.

As stated above, the total number of direct connections has increased while the number of connections has decreased for Level I carriers. It would be interesting to know if the networks of the Level I carriers more closely resemble a hub and spoke type network in 1990 than in 1982 or 1979. Two observations from the Air Canada data seem to indicate this is so.

First, the percentage of the total direct connections which include Lester B. Pearson (Air Canada's main hub) increased from 14.8% in 1979 to 17.9% in 1990. This implies that a smaller percentage of connections are occurring between cities neither of which is a hub. A dramatic increase in this percentage would not have been expected since Toronto, by virtue of it's OD level, has always been an important point in Air Canada's network.

The second point is the change in the number of non-stop, one-stop and two-stop routes. Intuitively, one can see that as a carrier drops points from it's network and moves towards a pure hub and spoke structure, the decrease in the number of one-stop and two-stop connections will be greater than the decrease in non-stop connections. For example, a pure hub and spoke system with only one hub would not have any non-redundant two-stop connections. This is illustrated by the Air Canada matrices. The decrease in the number of non-stop connections between 1979 and 1990 was 46.0%. However, the decreases in one-stop and two-stop routes were 58.0% and 64.0% respectively.

The difference is even greater when one calculates the change in the number of city pairs that had at least one one-stop and at least one two-stop link. For one-stop the decrease was 63.7% and for two-stop the decrease was 69.5% from 1979 to 1990. This is a better measure than the change in the total number of n-stops since it simply measures whether 'you can get there from here' rather than the number of different ways you can do it.

TABLE 3. COLUMN TOTALS FOR CONNECTING MATRICES

1979				
Carrier	Airport	C	C^2	C^3
All Carriers	Vancouver Intl	26	163	1,958
	Calgary	18	155	1,742
	Lester B. Pearson	27	204	2,423
	Ottawa	15	174	1,757
	Dorval	21	180	1,918
	Halifax	15	104	1,300
	Total All Airports	418	3,996	40,976
	Total Non-Zero	418	2,329	5,246
Air Canada and CAIL	Vancouver Intl	25	147	1,725
	Calgary	16	142	1,508
	Lester B. Pearson	26	175	2,100
	Ottawa	14	148	1,467
	Dorval	20	151	1,610
	Halifax	15	97	1,152
	Total All Airports	331	3,206	31,524
	Total Non-Zero	331	1,803	3,532
Air Canada	Vancouver Intl	9	75	666
	Calgary	8	77	638
	Lester B. Pearson	26	114	1,425
	Ottawa	12	89	852
	Dorval	15	94	948
	Halifax	9	68	599
	Total All Airports	176	1,596	13,602
	Total Non-Zero	176	829	990
1982				
All Carriers	Vancouver Intl	24	162	1,846
	Calgary	16	153	1,624
	Lester B. Pearson	29	200	2,555
	Ottawa	16	166	1,745
	Dorval	24	188	2,113
	Halifax	15	108	1,296
	Total All Airports	415	3,947	39,955
	Total Non-Zero	415	2,357	5,385
Air Canada and CAIL	Vancouver Intl	22	143	1,539
	Calgary	14	132	1,344
	Lester B. Pearson	26	164	2,027
	Ottawa	12	133	1,258
	Dorval	22	153	1,665
	Halifax	15	96	1,115
	Total All Airports	318	2,971	28,586
	Total Non-Zero	318	1,731	3,547
Air Canada	Vancouver Intl	9	86	754
	Calgary	9	86	754
	Lester B. Pearson	26	105	1,389
	Ottawa	11	89	815
	Dorval	15	93	940
	Halifax	10	60	568
	Total All Airports	163	1,516	12,569
	Total Non-Zero	163	791	954

TABLE 3. COLUMN TOTALS FOR CONNECTING MATRICES (CONT.)

1990				
All Carriers	Vancouver Intl	28	166	2,066
	Calgary	17	163	1,713
	Lester B. Pearson	27	206	2,442
	Ottawa	18	177	1,891
	Dorval	26	180	2,101
	Halifax	15	120	1,259
	Total All Airports	463	4,424	44,128
	Total Non-Zero	463	2,763	6,502
Air Canada and CAIL	Vancouver Intl	14	74	668
	Calgary	11	72	620
	Lester B. Pearson	17	82	796
	Ottawa	7	68	509
	Dorval	11	63	495
	Halifax	5	38	301
	Total All Airports	149	1,035	8,215
	Total Non-Zero	149	583	1,005
Air Canada	Vancouver Intl	8	57	436
	Calgary	8	57	436
	Lester B. Pearson	17	61	623
	Ottawa	7	54	392
	Dorval	7	45	339
	Halifax	5	33	236
	Total All Airports	95	670	4,898
	Total Non-Zero	95	301	302

Note: diagonal elements are not included in sums

Impact of Hub and Spoke Development

The development and refinement of hub and spoke networks by the Level I carriers has had various impacts on air passenger travel. Two of these will be discussed below. The first is the change in the amount of traffic carried intransit by the Level I carriers. The second is the change in the distribution of directional OD (DOD) traffic according to the number of connections in the DOD routing.

Intransit Traffic

In order to carry traffic intransit, a flight must have one or more stops. In order to operate a multi-stop flight, a carrier may be forced to operate a leg of the flight with unfilled seats in order to accommodate passengers being picked up at one of the subsequent stops. Given Canada's geography and market sizes, it would be impossible (and undesirable) to operate every flight as a non-stop flight - that is, with only an origin and destination point. However, operating many flights with 4,5,6 and 7 points in the itinerary may be inefficient.

An indication of the changes in routing structure may be observed by looking at the flight itineraries for a given carrier in the OAG. Using this method and considering only domestic flights and excluding affiliates, the following was observed. In 1979, Air Canada had 26 different flight numbers which had 4 or more points in the flight itinerary. The comparable figure for 1990 was 12. However, no attempt was made to compare frequency or total capacity on these flights.

In light of the above, total intransit traffic on domestic segments was calculated for Air Canada and CAIL (excluding affiliates) from 1979 to 1990. This was done using data from the Daily Airport Activities Report which these carriers file with the Aviation Statistics Centre. Graph 1 shows the ratio of this intransit traffic to traffic deplaned by these carriers on domestic segments. The ratio was used in order to discount changes in the overall amount of traffic carried in any one year.

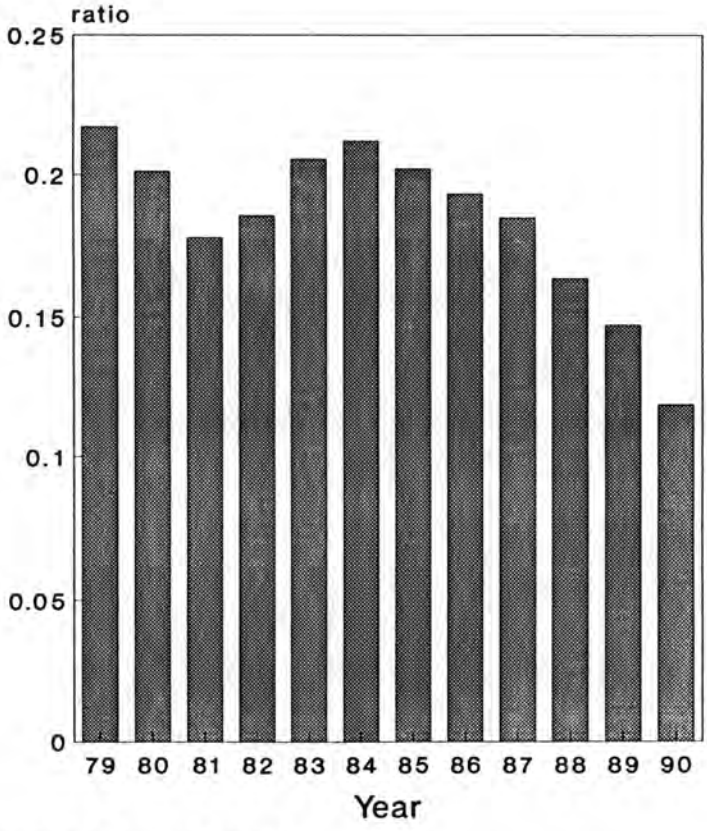
The graph shows that the proportion of intransit traffic has been declining since 1984 with a more rapid decrease beginning in 1988. The average annual decrease for 1984 through 1990 was 7.5%, while the average annual decrease for 1988 through 1990 was 13.7%. This increased rate of decline was caused by both increased competition and the facilitation of market exit (and entry) brought about by deregulation in 1988. The Level I carriers were able to drop less dense routes or continue these routes with their affiliate carriers using smaller aircraft.

From 1979 to 1990, the amount of intransit traffic on domestic segments declined by 54% while, the amount of domestic segment traffic deplaned declined by only 16% over this same period. Thus, the decline in intransit passengers was not merely a result of lower traffic levels.

Connecting Traffic

When a route structure moves closer to a pure hub and spoke system, the number of connections a passenger must make will necessarily increase. The Aviation Statistics Centre collects OD data on a ticket basis which shows all the coupons for a particular

Graph 1 Intransit / Deplaned Passengers
Domestic Segments - Air Canada and CAIL



Source : Statistics Canada

journey. Thus for a given passenger trip, the number of connections which the passenger must make can be easily determined. The distribution of the number of stages (coupons) on domestic OD trips was compared for 1982 and 1990. (Due to format changes in the raw data, 1982 was the oldest year able to be analyzed.)

In order to accentuate the change in the number of connections due to refinement of hub and spoke route structure, three OD pairs were excluded from the analysis: Montreal-Toronto, Ottawa-Toronto and Calgary-Edmonton. These were excluded because regardless of route structure changes, they would be virtually 100% non-stop trips which, due to their high volume, would tend to overshadow routing changes in other OD trips. Thus, with these removed, any differences in the number of connections occurring in the remaining OD trips would be more pronounced.

In light of the above, the distribution (in percent) of the remaining domestic OD passenger trips for 1982 and 1990 is shown in Table 4.

Table 4. Distribution of Domestic OD Passenger Trips *

Number of connections	1982 %	1990 %
0	79.4	74.5
1	18.1	22.0
>1	2.5	3.5

Source : Statistics Canada, Revenue Passenger Origin and Destination Survey

* Excluding Montreal-Toronto, Ottawa-Toronto and Calgary-Edmonton

The number of passenger trips in 1982 with no connection is about 5 percentage points higher than in 1990. Assuming that the relative size of the OD markets remained constant this means that over 500,000 passengers had to make a connection in their trip in 1990 which would not have been necessary in 1982. Of course, it should be noted that these 500,000 trips (under the 1982 distribution) would not necessarily have been non-stop trips but only that the passenger would not have had to change aircraft.

Another statistic which illustrates this point is the increase in the amount of connecting traffic at Lester B. Pearson. From 1982 to 1990, the total number of OD passenger trips (domestic, transborder and other international) in Canada increased by 34.9%. However, during this same time period, the number of passengers making a connection at Lester B. Pearson increased by 44.3%. Therefore, Lester B. Pearson is becoming even more important as a hub in Canadian air passenger travel.

Conclusions

For the 92 cities analyzed, the total number of city pairs with non-stop scheduled service increased 10.8% from 1979 to 1990. However, the number of city pairs served by Air Canada and CAIL (excluding their affiliates) decreased by 55.0% over this same period. Further Air Canada's network was used to illustrate how the Level I carrier's routes are now more concentrated at their hubs and that they are now operating fewer multi-stop flights than in the past. They are using affiliate carriers to operate less dense routes and to feed their hubs.

Two impacts of these route structure changes were determined. First, the amount of intransit traffic carried on domestic segments by Air Canada and CAIL decreased 54% from 1979 to 1990. Second, the number of total domestic OD passenger trips with no connection in the itinerary decreased from 79.4% in 1982 to 74.5% in 1990.

Note

The views and opinions expressed in this paper are those of the author and do not necessarily reflect those of Statistics Canada.

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References

Air Canada, Air Canada 1990 Annual Report

R. Erickson, Canada's Air Carriers, WINGS Newsmagazine Issue 5 1991

OAG Official Airline Guide, North American Edition, August 1, 1979, August 1, 1982, August 1, 1990, (Official Airlines Guides Inc., Oak Brook IL)

F. Petrie, Top Ten Characteristics of Canada's Deregulated Airline Industry, Air Transport Management, Vol 3 No. 6 Statistics Canada, Air Carrier Traffic at Canadian Airports, (Supply and Services Canada), Statistics Canada catalogue no. 51-005

Statistics Canada, Air Passenger Origin and Destination, Domestic Report, (Supply and Services Canada), Statistics Canada catalogue no. 51-204

"Values of Travel Time Savings and the Link with Income"

by

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I. Introduction

The value of travel time savings (VTTS) is a major component of almost all economic evaluations of transport infrastructure investments. Its importance for transport project evaluation has been recognized explicitly at least since 1950 and numerous empirical studies have been conducted since the early 1960s, i.e., since the first application of social benefit cost analysis (SBCA) to evaluating public investments in transport infrastructure.[2] Typically, the value of time savings constitutes the majority of economic benefits from transport projects.[3]

Despite long interest in the subject and numerous empirical investigations, the appropriate values for VTTS in project appraisal remain unsettled. In the last few years, major new empirical investigations have been commissioned along with extensive literature reviews. Unfortunately, precise measures of the VTTS remain elusive. This is inevitable. The VTTS is not some universal constant; rather it is a value which can and will vary from place to place, under different circumstances and travel situations. Nonetheless, government agencies need to adopt some figures in order to carry out consistent economic evaluations of transport projects.

This paper reports on a survey of empirical studies of VTTS, including drawing on the findings of other recent reviews of this literature.[4] Over 35 empirical studies were reviewed, and these were supplemented from reviews by other authors.[5] The present paper reports only on the values for non-work travel time, primarily the value for commuting time.

There are many issues in valuing travel time savings. This paper limits comment to one of the on-going issues in valuing travel time: the links between VTTS and levels of income.

II. Does Time Have a Value?

Except to theoretical physicists, time is fixed. There are only 24 hours per day in which to live, work and play. Strictly speaking, it is not possible to save time literally, but time can be reallocated. Reducing time spent in one activity enables that

time to be put to other uses.

There are potential theoretical reasons to link VTTS with income (wage rates). The original theoretical approach grew out of labour market models in economics. Householders face an income-leisure tradeoff: leisure time must be sacrificed in order to work to generate income. The wages received are compensation for the loss of time. In a simple model where people are free to choose the number of hours worked, and the work is not distasteful (no disutility of work), the wage rate would be a measure of the marginal value of time. An incremental reallocation of time to work longer would, in theory, produce an incremental value of output sufficient to pay the wage. If instead, a marginal amount of time would be allocated to leisure instead of production, the wage would still be a guide to the marginal value of time to the worker. In this simple example, there is a direct link between the value of time and the wage rate, and the value is the same whether the bit of time saved is allocated to work or leisure.

But the world is not so simple. People do not necessarily control their hours of work, and there is disutility associated with at least the last increment of hours worked. Wage rates and values of leisure time do not equate. More general theories of the allocation of time recognize that activities consume time, and households must budget time as well as money. Households organize activities in time and space subject to an income and time budget, and subject to time (and money) requirements of various activities. While it is possible to derive a shadow price of a hypothetical increase in a time budget (e.g., increasing the day to 24.5 hours), the relevant time tradeoffs are those which arise given the fixed amount of time available. There are values of time implicit in the tradeoffs between householders' activities. These are the relevant basis for valuing time, but these will vary with specific circumstances.[6]

Thus, it is not surprising that VTTS will differ from one study to another. Each will reflect characteristics particular to the circumstances surrounding that study. Nonetheless, some central tendencies may exist. In any case, purely theoretical approaches cannot generate specific recommendations for a VTTS for practical project evaluation. Empirical studies are necessary.

III. Evidence on the Value of Travel Time Savings

Empirical Approaches

Empirical studies consist largely of two approaches: (1) direct interview or questionnaire methods; and (2) "revealed preference" studies which infer implied values of time from situations where people make economic choices involving travel time and other decisions.

Until relatively recently, questionnaire methods have not been popular among economists studying VTTS (or many other consumer issues) because of the danger of biased responses by those interviewed. However, questionnaire design and administration have become more sophisticated and reliable. "Stated preference" studies emphasize developing questions and hypothetical time tradeoffs which can be

readily understood by interviewees, and build in cross-checks or feedbacks to check the reliability of the stated preferences.[7] Questionnaire methods have the advantage of directly posing questions of interest to researchers, and for being able to isolate the importance of different influences on a decision. In contrast, multicollinearity among influencing variables is a persistent problem encountered by empirical revealed preference studies. Many of the more recent empirical studies of VTTS use the stated preference approach.

The more traditional empirical approach to VTTS consists of identifying situations where people are thought to be making choices which involve time tradeoffs, e.g., people's willingness to pay for time-saving devices. Typical examples include: route-choice decisions (people choose different routes, such as toll roads, which save time but are more costly); mode choice (faster travel costs more but saves time); location choice (urban land values reflect, in part, a premium for reduced commuting time); and speed-choice (driving faster saves time but increases operating costs). Statistical estimation can infer implied values to the time savings of travellers in these situations.

The empirical studies cited below include both types of empirical approaches.

Measures of the Value of Travel Time Savings

Exhibit 1 presents the estimates of VTTS from a number of studies, listed in chronological order. The VTTS is expressed both in 1990 $CDN as well as a percent of the average wage.[8]

The figures reported in Exhibit 1 are from studies which include a number of countries, modes and travel circumstances. One must be cautious in making comparisons across diverse studies. Nonetheless, it is a useful summary of the variation in VTTS. The VTTS ranges from $0.38 to $35.88, almost a 100-fold variation. Deleting the lowest and highest estimate gives a range from $1.84 to $24.10, still over a ten-fold variation. While part of the variation among VTTS will be random, many of the differences can be explained by the different circumstances which underlie various VTTS studies. It is necessary to look at selected VTTS studies which are relevant to specific questions about the value of time savings; e.g., work time versus non-work time, commuting versus leisure travel, congested versus uncongested conditions, etc.

This paper focuses only on automobile commuting studies. Exhibit 1 contains 23 studies based on commuting trips. To look for a representative value for automobile commuters, we first eliminate five studies which do not involve automobiles. Next, we arbitrarily eliminated the highest and lowest VTTS estimate (170 percent and 12-14 percent, respectively), and used a middle value for those studies reporting a range for the VTTS. The calculated mean was 54.5 percent of the wage. However, the mean has an upward bias in this type of calculation. The median value is 39 percent.

Also note that there is some indication that the VTTS tends to be a higher

percent of the wage in more recent studies.

Miller (1989) also compiled and examined the reported VTTS for commuting. His table is reproduced as **Exhibit 2**.

> "The first section [of Exhibit 2] summarizes the auto travel time values from route choice studies.... Although the values range from 39% to 102% of the wage rate, they have a central tendency. Six include a value between 60% and 75% of the wage rate, two fall below that range, and three fall above it. Some of the high values may reflect differences in route congestion.
>
> Further evidence on the value of auto travel time in commuting comes from surveys. Again a central tendency appears, with five of seven surveys yielding values between 60% and 75% of the wage rate, with one value above this and one below.....
>
> Thus, the values for auto travel time cluster ... suggesting a value around 60-65% of the wage rate. Based on these studies, a value of 60% of the wage rate...seems appropriate for valuing travel time during the commute to work. (Miller, 1989, pp.8,9)

A comparison of Exhibits 1 and 2 indicates that Miller included 10 studies not in our list. The VTTS as a percent of the wage for the 10 additional articles in Miller (Exhibit 2) ranges from 36 to 102 percent (with a simple mean of 64.8%). Our list (Exhibit 1) contained 11 studies not included in Miller. These ranged from 22.5 to 93 percent (excluding the lowest and highest figures which were not included in the calculation) with a simple mean of 47.0 percent.

Exhibit 3 plots VTTS as a percent of the wage for auto commuting from both Exhibit 1 (shown as solid dots) and Exhibit 2 (open dots). Miller's list tends to be higher on average. He recommends 60% of the wage as a guide to the VTTS. Looking over both Miller's (1989) list (Exhibit 2) and that in Exhibit 1, it appears that a representative VTTS for auto commuting would be in the 40 to 60 percent range, possibly at the upper end of this range for North America.[9] Nonetheless, on the basis of this review, a figure of 50 percent of the wage was recommended to British Columbia as a base VTTS for evaluating highway transport projects.[10]

The VTTS in Practice

Different countries and decision-making agencies have adopted different values for VTTS in project evaluation. The U.K. sponsored extensive studies of VTTS (MVA Consultancy, et al., 1987) and ultimately raised their base VTTS from 25 percent to 40 percent of the wage (Sharp, 1988). New Zealand reviewed the evidence on VTTS (Miller, 1989 and Bone, 1991). A value of 60 percent of the wage was suggested by Miller while Bone recommended 40 percent; ultimately 40 percent was the figure chosen. The U.S. Federal Highway Administration is using 60 percent as a VTTS for highway evaluation. Chui and McFarland (1990) reviewed the VTTS used in the

AASHTO "Red Book" (AASHTO, 1977) for evaluating highway projects in the U.S. Chui and McFarland recommend a VTTS of about 80 percent of the wage.

Transport Canada has been reviewing the VTTS to be used for transport project appraisal. Drawing on the review by Lawson (1989), Transport Canada's (1990) draft report is recommending 50 percent of the average wage as the VTTS for non-work time savings. The same VTTS for non-work time would be used for all modes.

A review for the Government of British Columbia has also recommended 50 percent of the wage as a base VTTS for the evaluation of highway projects, but with an upward adjustment for the VTTS during congested conditions (Waters, 1992).

The practice in valuing travel time savings varies considerably across other provinces and states (a review is in Waters, 1992).

IV. The Value of Time Savings in Relation to Income

The link between values of time and income levels is a persistent issue in the value of time literature. There are three basic questions:

(1) does the value of time vary with a person's income?
(2) by how much?
(3) does this make any difference for project evaluation?

The first two are empirical questions; the third is partly a policy question which is addressed after the others.

The VTTS and the Level of Income.

There may be theoretical reasons for expecting the value of time to differ with income levels. Since time is fixed at 24 hours per day, rising wages imply increased opportunity cost of time, although more complex tradeoffs can be involved; e.g., greater use of time-saving devices are possible, the number of working hours can be reduced. In comparing major income differences across countries or income groups, it is likely that their respective values of time will differ. But it is less obvious when comparing time values for people with similar cultural backgrounds and relatively modest differences in incomes. Other variables or trip or person characteristics could offset income differences. Nonetheless, most empirical studies which have investigated the value of time with income have concluded that there is a connection, although it is not necessarily a simple proportion.

The most recent major studies of the link between incomes and values of time are the UK and Dutch studies.[11] The U.K. results are shown graphically in **Exhibit 4**. The UK results involved several studies which produced different results. Some studies showed sharper responses to income differences than in other studies, but there is a positive relationship in all the studies in Exhibit 4. All but one of these results show VTTS rising less than proportionately with income.

Other studies find differing links between VTTS and income levels. Stopher

(1968) also found VTTS increasing less than proportionately with income. McDonald (1975) shows VTTS increasing with income in one of two models investigated; the increase appears less than proportional with income increases. Deacon and Sonstelie (1985) found VTTS to first fall and then rise as average income increased; the rise with income is less than proportionate. McFadden's (1974) results show low but positive correlation between VTTS and income. Thomas and Thompson (1970) found VTTS to be directly proportional to increases in income. Beesley (1965) and Mohring, *et al.* (1987) show VTTS rising more than proportionately with income.[12] In contrast, Quarmby (1967) and Heggie (1976) did not find a link between incomes and values of time.

The evidence for a link between income levels and values of time is compelling, but the exact relationship is not so clear. Some judgement must be involved in recommending how to vary VTTS with income for particular situations. On balance, the evidence suggests that the VTTS increases but less than proportionately with income. One suggestion is advanced here and is illustrated by the dark line in Exhibit 4. It is an arbitrary choice of a formula, but it is relatively easy to work with and has a conservative rate of increase in the VTTS with income. A $VTTS_Y$ which varies with income Y of the traveller can be written:

$$VTTS_Y = (Y/\overline{Y})^{.5} \cdot \overline{VTTS} \quad \text{or} \quad \sqrt{(Y/\overline{Y})} \cdot \overline{VTTS}$$

where $\overline{Y}$ is the mean income level and $\overline{VTTS}$ is the VTTS for average income. This formula has the property that as income increases four-fold, the VTTS increases only twice. Similarly, for incomes which are only half of the average, the VTTS is .71 of that for average incomes, rather than .5. Exhibit 4 shows that this formula fits reasonably well, although note that it is an imposed formula and not fitted statistically (calibrated for an assumed mean income level of £10,000).

Another issue in linking VTTS with income levels is the definition of income. The UK studies generally relate VTTS to household income rather than personal wage levels. The rationale is that household income may be the more relevant influence on time tradeoffs of an individual. Low income earners in a high income household will not be constrained by their personal income in making time-money tradeoffs; conversely, single wage earners in large households do not necessarily have high discretionary income.[13]

Unfortunately, many studies of VTTS are not clear on the definition of income used. Absolute estimates of VTTS might be compared to statistical average wages rather than incomes of those actually sampled. Studies which do include income in the data set often use personal incomes rather than household incomes. In brief, not only is there uncertainty about the links between VTTS and income, it is compounded by different concepts of income referred to in different studies. The meaning of income must be scrutinized carefully to ensure comparability across studies.

Should VTTS Be Allowed to Vary with Income?

Despite evidence that values of time vary with income, this is often ignored in valuing time for urban and highway project evaluation. (It is common to use very different values of time for aviation projects than for land transport modes; more on this shortly). There are practical reasons for ignoring the relationship between income and values of time, as well as questions of principle. There are significant practical difficulties in working with time values which vary with income. It requires a level of detail for traffic flow data which almost never exists; it is rare to know income levels of travellers with accuracy, even if we agree on exactly how time values vary with income.

Another practical reason for ignoring variations in values of time with income is that, in many cases, differences in income are not likely to matter much. Although the very lowest income groups might not have access to a car, most income groups in North America do. Thus the traffic on any given road is likely to include a wide cross-section of income levels. If so, use of uniform values of time might be reasonable.

However, there are situations where the differences can be substantial. Lawson (1989) notes the dilemma of comparing highway investments with aviation investments, where the differences in income and values of time can be substantial. There are both efficiency and equity issues involved. In terms of economic efficiency, there is greater willingness to pay (value of benefits to be gained) from aviation users. Not recognizing this in public investment decisions is a move away from the efficient allocation of resources.

Ultimately, the choice of whether or not to incorporate an adjustment in the VTTS for income levels requires a public policy decision. The evidence is there that VTTS does differ with income levels, and benefit cost principles focus on net benefits to society regardless of who gains and who loses. Deviating from projects with highest net benefits because of who receives them reduces the overall level of wealth in the economy. The traditional textbook argument is that since there are separate policies to deal with income distributions, one does not need to constrain every project decision to adjust for all income distribution effects. The opposing concern is the possibility that government projects could, cumulatively, aggravate income distributions over time and not be corrected by other government policies.[14] This is possible but not necessary outcome; it is influenced by how projects are financed and what mix of projects are carried out over time.

Governments may be subject to popular political pressures to adopt evaluation criteria which are seen to be more egalitarian in nature. As a matter of principle, governments may elect to use a common value of time for project evaluation to avoid charges of favouring groups according to their wealth position. The UK government has maintained this policy for many years, and it was reaffirmed following the results of their review of valuation of travel time (Sharp, 1988). New Zealand has followed the same policy. Transport Canada (1990) also takes this approach; they recommend a uniform value for non-work time for all transport projects including aviation. (They

do recommend a higher value for work travel on airlines).

There is no definitive guideline for governments here, but it is an important issue with some worrisome implications. There is a pure economic efficiency case for incorporating different values of time with income. The marketplace responds to different willingness to pay, and efficiency principles call for a similar response by governments. But public investment decisions are also subject to political will which could conflict with efficiency considerations in this instance.

This leaves a worrisome issue in project evaluation as it has been practiced. If we accept that VTTS does vary with income, then using a uniform VTTS in project evalution is implicitly applying an income adjustment to this category of benefits (or costs). Consistent treatment requires that a similar income adjustment be applied to non-time benefits and costs.[15] Otherwise, this equity or income adjustment is being applied to only part of the benefits and costs of a project. This could distort project ranking depending on the relative importance of time versus direct monetary benefits and costs, and/or the mix of income- and time-constrained travellers affected by the project. Since the vast majority of transport benefit cost studies use uniform values of time and no income adjustment for other benefit and cost categories, this suggests that there is a potential inconsistency in valuation in practically every benefit-cost study which has been carried out. For projects with a random sample of different income groups, this probably will not matter (a uniform average value of time will give about the same results as one weighted by income groups). But in comparing projects across income groups, this inconsistent treatment of time and other benefit/cost categories could be important.

VI. Conclusion

The literature concerning VTTS for evaluating transport investments is voluminous and complex. The VTTS, by whatever mode, is not a single-valued function, but is influenced by a number of considerations. Nonetheless, the practical necessity of workable figures for conducting evaluation studies necessitate using relatively simple measures with the implicit assumption that the factors and complexities overlooked will cancel out.

This paper reviewed the results for only one (albeit important) type of time saving: commuting by automobile. The VTTS from different studies varies over 10 to one. There is a central tendency around 40 to 60 percent of the wage; this paper recommends 50 percent of the wage as a working value for VTTS in highway projects. But it is evident that figures could be above or below this convention.

There is evidence that the VTTS varies by income level, although not necessarily in strict proportion. A simplied formula for an income adjustment is introduced. But it appears that government agencies tend to avoid such adjustments, presumably because of potential controversy over perceived equity issues. But strictly speaking, this means that standard practice in transport project appraisal is deviating from the economic efficiency criteria that provide the foundation of social benefit cost

analysis. Of course, it is appropriate to incorporate non-efficiency objectives into project evaluation, but this appears to be an implicit rather than explicit decision. Further, it raises resource allocation questions across sectors of the economy where time benefits are compared with different types of benefits.

References

note: not all references cited in Exhibits are listed here; see Waters (1992) for the complete list of references.

AASHTO (American Association of State Highway and Transportation Officials (1977), *A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements*, (Washington, D.C.).

Bates, J. and Glaister, S. (1990), "The Valuation of Time Savings for Urban Transport Appraisal for Developing Countries: A Review," report prepared for the World Bank, Washington, D.C.

Bates, J., et al. (1988), "Stated Preference Methods in Transportation Research," A special issue of *J.of Transport Econ. and Policy* (January).

Becker, G.S. (1975), "A Theory of the Allocation of Time," *Economic Journal*, Volume 75, pp. 494-517.

Beesley, M.E. (1965), "The Value of Time Spent in Travelling," *Economica*, Volume 32, pp. 174-185.

Blauwens, G., and Van De Voorde, E. (1988), "The Valuation of Time Savings in Commodity Transport," *International Journal of Transport Economics*, Volume 15, Number 1, pp. 77-87.

Bone, L.H. (1991), "The Value of Travel Time Savings" a working paper prepared for Transit New Zealand.

Bruzelius, N. (1979), *The Value of Travel Time*, Croom Helm, London.

Chui, M. and McFarland, W. (1990), "Value of Time and Discomfort Costs, Progress Report on Literature Review and Assessment of Procedures and Data," Texas Transportation Institute, Technical Memorandum for NCHRP Number 7-12.

Coburn, T.M., M.E.Beesley and D.J.Reynolds (1960) "The London-Birmingham Motorway," Technical Paper No.46, Road Research Labouratory.

Deacon, R. and Sonstelie, J. (1985), "Rationing by Waiting and the Value of Time: Results from a Natural Experiment," *Journal of Political Economy*, Volume 93, pp. 627-647.

DeSerpa, A.C. (1971) "A Theory of the Economics of Time," *Economic Journal* (December).

DeSerpa, A.C. (1973), "Microeconomic Theory and the Valuation of Travel Time: Some Clarification," *Regional and Urban Economics*, Volume 2, pp. 401-410.

Foster, C. (1966) "Social Welfare Functions in Cost-Benefit Analysis," in J. Lawrence, ed.

Operational Research in the Social Sciences (London: Tavistock Pub.).

Foster, C., and M.E.Beesley (1963) "Estimating the Social Benefit of Constructing an Underground Railway in London," *J.Royal Stat. Soc.* 46-79.

Hau, T. (1986), "Distributional Cost-Benefit Analysis in Discrete Choice," *Journal of Transport Economics and Policy*, Volume 20, Number 3, pp. 313-337.

HCG Hague Consulting Group (1990) *The Netherlands 'Value of Time' Study*, Final Report to Dienst Verkeerskunde, Rijkswaterstaat Netherlands; cited in Bates and Glaister, 1990.

Heggie, I., (1976), "A Diagnostic Survey of Urban Journey to Work Behaviour," in Heggie, I. *Modal Choice and the Value of Travel Time*, Clarendon Press, Oxford, England.

Lawson, J.J. (1989), "The Value of Passenger Travel Time for Use in Economic Evaluations of Transport Investments," *Economic Evaluation and Cost Recovery*, Transport Canada - Finance and Administration.

McDonald, J. (1975), "Variations in the Value of Reductions in Commuting Time," *Journal of Urban Economics*, Volume 2, pp. 267-277.

McFadden, D. (1974), "The Measurement of Urban Travel Demand," *Journal of Public Economics*, Volume 3, pp. 303-325.

McFadden, D. and Train, K. (1978), "The Goods/Leisure Tradeoff and Disaggregate Work Trip Mode Choice Models," *Transportation Research*, Volume 12, pp. 349-353.

Miller, T.R. (1989), "The Value of Time and the Benefit of Time Saving," presented to the National Roads Board, New Zealand and the Federal Highway Administration of the U.S. Department of Transportation, Urban Institute, Washington, D.C.

Mohring, H., Schroeter, J. and Wiboonchutikula, P. (1987), "The Values of Waiting Time, Travel Time, and a Seat on a Bus," *Rand Journal of Economics*, Volume 18, Number 1, pp. 40-56.

Moses, L. and Williamson, H. (1963), "Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation," *Journal of Political Economy*, Volume 71, pp. 247-264.

MVA Consultancy, Institute of Transport Studies University of Leeds and Transport Studies Unit University of Oxford (1987), "The Value of Travel Time Savings," *Policy Journals*, London, England.

Nash, C.A. and D.W.Pearce (1981) *The Social Appraisal of Projects* (London: Macmillan Press).

Nash, C.A., D.W. Pearce and J.K. Stanley (1975) "An Evaluation of Cost-Benefit Analysis Criteria," *Scottish Journal of Political Economy*.

Oort, C. (1969), "The Evaluation of Travelling Time," *Journal of Transport Economics and Policy*, Volume 3, pp. 279-286.

Pearce, D.W. (1983) *Cost Benefit Analysis* 2nd ed. (London: Macmillan).

Quarmby, D. (1967), "Choice of Travel Mode for the Journey to Work," *Journal of Transport Economics and Policy*, Volume 1, Number 3, pp. 273-313.

Stopher, P. (1968), "A Probabilistic Model of Travel Mode Choice For the Work Journey", *Transportation Research Record 283*, pp. 57-65.

Thomas, T.C. and Thompson, G.I. (1970), "The Value of Time for Commuting Motorists as a Function of Their Income Level and Amount of Time Saved," *Highway Research Record 314*, Highway Research Board, Washington, D.C., pp. 1-19.

Transport Canada (1990) "Valuation of Passenger Travel Time," Economic Evaluation Branch, October.

Waters, W.G.II, (1992) "The Value of Time Savings for the Economic Evaluation of Highway Investments in British Columbia," Vancouver: UBC Centre for Transportation Studies.

Endnotes

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2. The first large scale SBCA study of transport infrastructure was for England's M-1 motorway, Coburn, et al. (1960); the second major example is the economic appraisal of the Victoria Line underground railway in London, Foster and Beesley, 1963.

3. For example, almost 50 percent of total net benefits of the Victoria Line study (Foster and Beesley, 1963) were attributable to the value of time savings, including benefits of reduced congestion to those not using the facility. The value of time savings for highway projects generally is higher than this, on the order of 80 percent of total benefits (Waters, 1992).

4. This paper draws from a more extensive report prepared for the B.C. Ministry of Transportation and Highways, see Waters (1992).

5. Recent surveys of VTTS which were valuable include Bates and Glaister (1990), Chui and McFarland (1990), Lawson (1989), Miller (1989) and MVA Consultancy, et al. (1987).

6. A concise review of a general theory of the value of time is in Bates and Glaister (1990); this is drawn from the discussion in Chapter 3 of MVA Consultancy, et al. (1987). These, in turn, build on various theoretical contributions including Moses and Williamson (1963), Becker (1965), DeSerpa (1971), McFadden and Train (1978) and Bruzelius (1979).

7. A useful review and application of "stated preference" (SP) methods is the special issue of the *Journal of Transport Economics and Policy*, Bates et al. (1988).

8. Where the original articles expressed the VTTS as a percentage of the wage rate, they were multiplied by the 1990 average wage for B.C. Where the original articles were expressed in absolute currency units, they were converted to CDN$ at the exchange rate when the study

was carried out, and then indexed to 1990 CDN$.

As a cross check, some articles reported VTTS both in absolute currency units and as a percentage of the wage. We updated both figures to see how they compared. The results were very disappointing, since differences of 50 to 100 percent emerged in some instances. One must be very cautious and even sceptical in comparing the results from different countries and time periods.

9. Limiting the analysis to automobile commuting studies in North America, Exhibit 1 contains 7 studies (with 8 estimates). The VTTS as a percent of the average wage varies from about 13 to 170 percent. The high estimate can distort a mean, which is 73.5 percent over the eight studies or 59.7 percent if the highest figure is omitted.

10. Transport investment projects do not only affect automobile commuters. They affect business travel and commercial vehicles (delivery vans and trucks), commuting trips on public transit, and other types of non-work travel including shopping trips, school and leisure travel. The VTTS for these other trips -- especially work trips -- may be valued differently. This paper does not review these other travel situations. (The larger study which gave rise to this paper does look at the VTTS for other travel situations, Waters, 1992).

11. MVA Consultancy, et al. (1987), and HFC Hague Consulting Group (1990), respectively. The Netherlands study found a slight increase in VTTS with income for business, commuting and "other" travel, with a significant jump in the VTTS for high income business travel (summarized in Bates and Glaister, 1990).

12. Hau (1986) also shows VTTS increasing more than proportionately with income. However, he has only three income categories and he noted that higher income groups tended to travel greater distances, which could affect the imputed value of time savings.

13. Heggie (1976) noted this possible explanation of the lack of correlation of values of time and income levels found in his sample of university employees.

14. Benefit cost analysis calculates benefits on the basis of potential compensation, i.e., those who gain can, in principle, compensate those who suffer so all parties can be better off. But compensation normally is not paid. Therefore, governments following benefit cost criteria could carry out a sequence of projects which benefited upper income groups at the expense of lower income groups, but because compensation was never paid, the net result would be to aggravate the distribution of income.

15. Adjusting benefits and costs for income levels has been proposed and applied. Foster (1968) proposed weighting benefits and costs by $Y/\underline{Y}$ where $\underline{Y}$ is the mean income; Nash, Pearce and Stanley (1975) proposed a weighting procedure of $(Y/\underline{Y})^b$ where b is the income elasticity of demand. For further discussion, see Nash and Pearce (), pp. 31-33 and Pearce (1983) pp. .

Exhibit 1
Value of Travel Time Savings from Various Studies
By Percentage of Wage Rate and by 1990 $CDN Per Hour

Author	Country	VTTS $ CDN Per Hour	VTTS as a % of Wage Rate(s)	Trip Purpose	Mode
Beesley, M. (1965)	UK	4.67 - 7.08	33% - 50%(b)	Commuting	Auto
Quarmby, D. (1967)	UK	2.83 - 3.54	20% - 25%	Commuting	Auto, Transit
Stopher, P. (1968)	UK	2.97 - 4.53	21% - 32%(b)	Commuting	Auto, Transit
Oort, C. (1969)	USA	4.67	33%	Commuting	Auto
Thomas & Thompson (1970)	USA	12.10	86%	Interurban	Auto
Lee & Dalvi (1971)	UK	4.24	30%	Commuting	Bus
		5.66	40%	Commuting	Auto
Wabe, J. (1971)	UK	6.04	43%	Commuting	Subway, Rail
Talvittie, A. (1972)	USA	1.84	12% - 14%	Commuting	Auto, Transit
Hensher & Hotchkiss (1974)	Australia	0.38	2.7%	Commuting	Hydrofoil, Ferry
Kraft & Kraft (1974)	USA	5.36	38%	Interurban	Bus
McDonald, J. (1975)	USA	6.38 - 11.06	45% - 78%(b)	Commuting	Auto, Transit
Ghosh, *et al.* (1975)	UK	10.32	73%	Interurban	Auto
Guttman, J. (1975)	USA	8.87	63%	Leisure	Auto
		20.56	145%	Commuting	Auto
Hensher, D. (1977)	Australia	5.52	39%	Commuting	Auto
		4.95	35%	Leisure	Auto
Nelson, J. (1977)	USA	4.67	33%	Commuting	Auto
Hauer & Greenough (1982)	Canada	9.49 - 14.25	67% - 101%(f)	Commuting	Subway
Edmonds, R. (1983)	Japan	5.95 - 6.94	42% - 49%(c)	Commuting	Auto, Bus, Rail
Deacon & Sonstelie (1985)	USA	7.31 - 35.88	52% - 254%(b)	Leisure	Auto
Hensher & Truong (1985)	Australia	14.86	105%	Commuting	Auto, Transit
Guttman & Menashe (1986)	Israel	8.35	59%	Commuting	Auto, Bus
Fowkes, T. (1986)	UK	3.82 - 8.34	27% - 59%(d)	Commuting	Rail, Coach
Hau, T. (1986)	USA	6.51	46%(e)	Commuting	Auto, Bus
Chui & McFarland (1987)	USA	11.56	82%	Interurban	Auto
Mohring *et al.* (1987)	Singapore	8.49 - 16.98	60% - 120%(b)	Commuting	Bus
Cole Sherman (1990)	Canada				
Comparison Model		13.20	93%	Commuting	Auto
		16.40	116%	Leisure	Auto
Logit Model		24.10	170%	Commuting	Auto
		23.40	165%	Leisure	Auto

a - Average wage rate per hour in B.C. is $14.15 for 1990.
b - Varies with income of the traveller.
c - Estimates are sensitive to data selected.
d - Varies with income of the traveller and the model used.
e - Paper used 5.71% of daily income in its model (an 8 hour day is assumed)
f - Inferred values (study actually valued waiting time).

Exhibit 2
Values of Auto Travel Time on the Trip to Work
Expressed as a Percentage of the Wage Rate
(Source Miller, 1989)

Study	Location	Value
Route Choice:		
Bates *et al.* (1987)	Tyne, UK	43%[a]
Atkins (1983)	Southampton, UK	38-61%[a,b]
Guttman (1975)	USA	97-100%
Hensher & Delofski (1974)	Australia intercity	39%[c]
Dawson & Everall (1972)	Italy intercity	60-89%
Howe (1971)	Kenya	102%
Thomas & Thompson (1970)	USA	60-63%
Thomas (1967)	USA	72%
Claffey, St. Clair & Weider (1961)	USA intercity	65%[d]
Claesson (1961)	Sweden	64%
Dawson & Smith (1959)	Queensferry, UK intercity, per vehicle	86%[e]
Survey:		
Hensher (1989)	Australia driver	36%
	passenger	25%
	company car driver	61%
Winston & Associates (1987)	USA per vehicle	112%
	per person	75%[f]
Bates *et al.* (1987)	Tyne, UK	62%[a]
Hensher & Truong (1985)	Australia	60-105%
Kentner (1973)	Germany	91%
Kentner (1973)	Germany	40%[c]
Lee & Dalvi (1971)	Manchester, UK	71%
Speed Choice:		
Chui & McFarland (1987)	Texas per vehicle	110%[c]
	per driver	87%
Ghosh, Lees & Seal (1975)	UK	73-89%[c]

[a] Wage rates are rough approximations.
[b] Estimates are sensitive to the data used.
[d] Study uses a statistical model that Harrison & Quarmby (1969) suggests is faulty. A reanalysis showed the value of time was insignificant, but the reanalysis inappropriately used a linear regression (discrete choice models were not available at the time). A known hazard of using linear regression to model discrete choices is reduced significance on predictive variable, so the original findings may be correct.
[e] Value presented is from a reanalysis reported in Harrison & Quarmby (1969).
[f] Vehicle loading is a rough approximation.

Exhibit 3

Scatter Plot of Values of Commuter Time Savings Involving Auto Travel
(from Exhibits 1 and 2; • from Exhibit 1, o from Exhibit 2 not included in Exhibit 1)

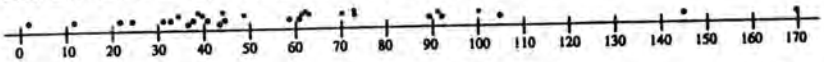
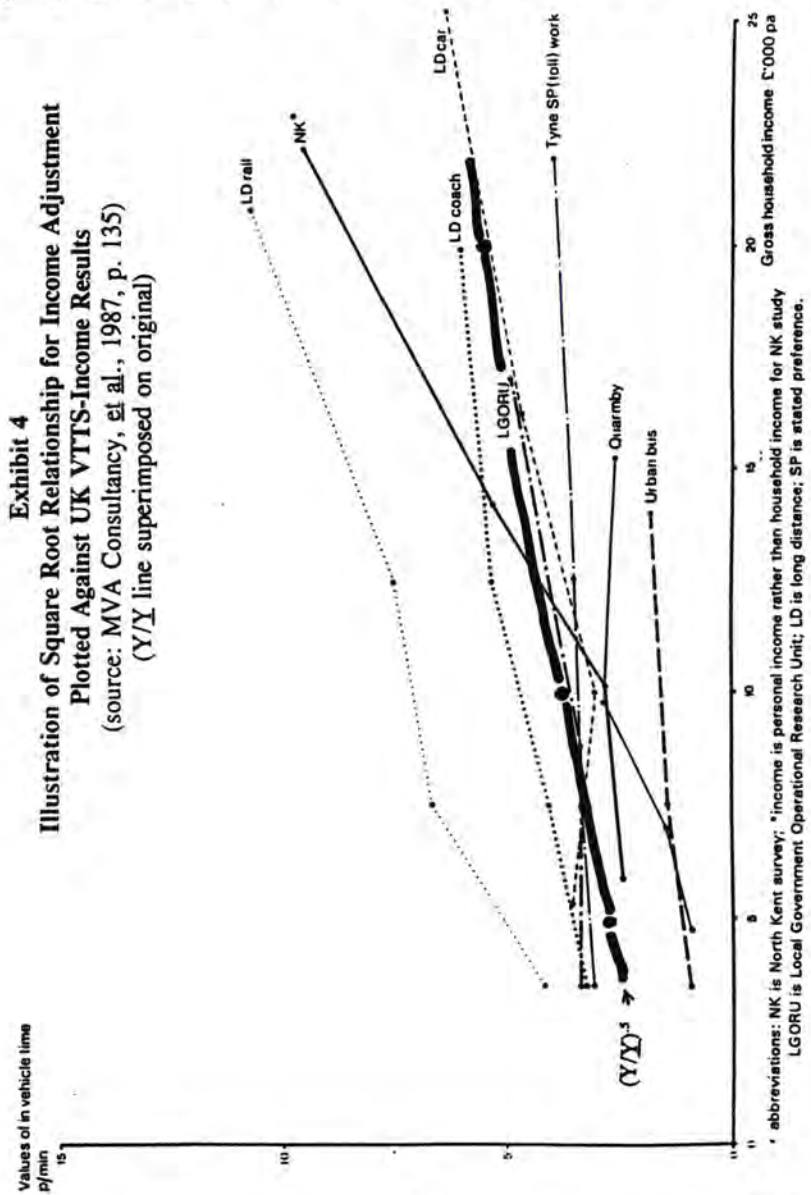


Exhibit 4
Illustration of Square Root Relationship for Income Adjustment Plotted Against UK VTTS-Income Results
(source: MVA Consultancy, et al., 1987, p. 135)
(Y/Y line superimposed on original)



The Québec Intercity Bus Industry: An Economic Analysis

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1. Introduction

The Québec intercity bus industry continues to be regulated by the Québec Transport Commission, although it operates within an economic environment that has witnessed tough intermodal competition over the years. As a matter of fact, this intercity passenger industry is actually at a crossroads. It must define its role, not only in relation to the passenger rail industry, namely the state-owned monopoly, Via Rail, but also in relation to the automobile. Intermodal competition for passengers, combined with an increase in consumer income, has led to a slow and progressive abandonment of this form of intercity transportation.

This paper outlines the regulatory status of this industry at the present time and analyzes the impact of existence regulations on its practices and its overall economic performance. It is organized as follows: In section 2, the main elements of the regulatory regime are presented with a view to emphasizing the role played by the Québec Transport Commission. Section 3 discusses the consequences of regulation on the performance of the industry, including: the barriers to entry, the fare structure which is now filed in with the regulatory board, the rate of return on owner equity, the industrial structure and the economic performance itself. Section 4 deals with the future of this industry, by drawing comparisons with foreign firms and their adjustment to similar changes in the last decade.

2. The Nature of Regulation

The main elements describing the Québec regulatory regime are respectively the barriers to entry, explicitly incorporated into the criteria which must be met by would-be bus owners to obtain a permit authority, and the fare regulation exerted by the Board.[1]

2.1 Entry Regulation: Criteria

A study of a sampling of the decisions of the Board over the years reveals that an intercity bus permit authority issued by the regulatory agency always contains five general components. These constituent elements include: the places authorized to serve and the approved routes; secondly, the schedules and frequency of trips; thirdly, the customers who use the service (the general public and/or charter operations); fourthly, the capacity and the category of the intercity bus; finally, other operating conditions and restrictions (particularly the right to carry freight and the number of stops over the approved route). In other words, the regulation clearly refers to the inputs that an intercity bus firm uses to produce a service between two points.

The Bus Transport Regulation order in council of 1986[2], which incorporates all the former regulations from 1973 to 1985, also makes legal, implicit practices developed by the regulatory agency over the years and defines the rules applying to the Québec intercity bus industry. It specifies, among other things, the broad content of an application. Moreover, articles 12 and 13 of that order in council describe seven specific criteria that have to be taken into account by board members when applying the public convenience and necessity test. A review of the most relevant decisions since its implementation shows evidence that board members systematically and continuously consider each of these criteria in a public hearing and that each potential newcomer has to meet all of the them in order to be granted a permit authority by the regulatory agency.

The consequences of this narrow definition of the "public interest test" are the following; first of all, only one bus firm is allowed to serve a regular-route and freight service, clearly defined by his origin and destination and by his time schedule. Secondly, a newcomer within a coveted market segment must necessarily purchases the permit of an existing firm in order to offer a regular scheduled service. Thirdly, established firms are always able to obtain permissions from the regulatory board for modifications in their day-to-day scheduled activities, when underlying market conditions change. Fourthly, intercity bus firms offering charter and special service may now do so everywhere in the province, as long as their service starts from their specified basic points of service. Fifthly, because regular scheduled route and charter services are now considered as two distinct and independent activities, Québec intercity bus firms may specialize by finding themselves special niches. For instance, an existing firm wishing to offer only charter and tour services or to expand their actual charter operations to new markets may buy the necessary charter operating rights from established firms.[3]

2.2 Rate Regulation

The current fare structure reflects the fact that fares are set both collectively and independently. The collective structure refers to joint-line service or interlining which takes place when passengers or small parcels travel over the lines of two

or more carriers. The term «collective ratemaking» generally embraces not only agreements between two or more intercity bus firms concerning fares and the division of fares, but also all the procedures leading to such contractual arrangements. Independently set fares are submitted by bus carriers for their point-to-point or single-line service and/or their charter and tour operations. For instance, the Autocars Orléans Express, one of the five independent new firms formed from the sale of Voyageur Inc., has the following fare structure for the Montréal-Québec corridor: a general daily fare, specific discounted fares for children under 12 years of age and senior citizens, a ten day special fare and a Friday fare.

Uf until 1986, the Québec regulatory agency was engaged in rate regulation. The Commission analyzes and sets up fares to make them "just and reasonable", as required by the Transport Act and its regulations. Therefore, no bus operation is legally able to charge fares other than those which are in effect. However, the regulatory board formally sets up the fare structure and approves nearly all applications for fare amendments submitted later. Although the Québec Transport Commission has effective powers to alter submitted fares, it does so only infrequently. Since the 1986 new order in council, only the filing of fares is required by the board. A careful analysis of decisions of the Commission regarding fares, based on the approval and denial of requests by intercity bus firms shows clear evidence that no shift occurs when the new procedure is introduced. In other words, over a fifteen year period, which includes the old and new regulatory regimes, the decision-making process pattern by the board members does not change. Thus, fare regulation continues to be a pure formality.[4]

3. The Economic Consequences on the Industry

In this section, we shall determine the effectiveness of a set of contraints imposed by the Québec Transport Commission on the allocation of resources. However, before dealing with this question, we should examine briefly the trends in total intercity travel over the last fifteen years.

Among the intercity modal choices composed of air, automobile, rail and intercity bus, the relative share of the latter, measured by passenger-kilometres, is usually negligeable. Morever, it is steadily declining over time, although it has reached a plateau lately, namely ground 1.2 percent in 1990. As the number of passengers decreases over time, one might wonder just who are the users of the intercity bus service. Canadian and American studies[5] reveal that bus travelers generally do not own an automobile, have low incomes and travel alone. Intercity bus riders also tend to be either old or young, disproportionately students, housewives, blue-collar workers and unemployed persons. Most travel short distances, generally less than 400 kilometres. Moreover, they generally travel for recreational and social purposes and not at all for business activities. Expressed in economic terms, the income elasticy of demand is negative and this service is considered by

consumers to be an inferior good. An American study, using discrete modal choice models, shows that intercity bus riders are very sensitive to their valuations of time which roughly increase in proportion to their income. However, it must be noted that Canadian results, obtained by Oum and Gillen, are ambiguous on that topic.[6] On the other hand, the demand for intercity bus service is elastic, regardless of the econometric models considered.[7] Obviously, there are substitutes to the bus industry which come from rather intensive intermodal competition for passenger travellers.

3.1 The Cost Structure of the Industry

In several studies, conducted mainly in the United kingdom and later in Canada and the United States, the cost structure of the intercity bus industry was analyzed to learn more about the behavior of a typical firm. The studies generally reached the same conclusion, although they used various methodologies: they noted an absence of major economies of scale, or fairly constant average costs. Under these conditions, small intercity bus firms can therefore operate just as efficiently as large firms. A brief review of the major studies is necessary to understand the process leading to this conclusion.

The first set of empirical studies[8] is based on the theoretical relation between the cost structure and the firm's output. Their statistical analyses reveal that there are no strong economies of scale and that the short-run average cost curve is an U-shape form type. When a Cobb-Douglas cost function is used[9], the conclusion is still the same, namely constant returns to scale in that industry. A second step takes into consideration new developments in economic analysis and in econometric methods. Empirical results are obtained by modelling the production function of an intercity bus industry in a multiproduct framework. In other words, a traditional intercity bus firm produces more than one output, namely regular route, charter and tour, local, school bus and package services. Their main conclusions are the following: that the economies of scale in the production of intercity bus-miles or passenger-miles are exhausted at an output level which is a very small fraction of total industry output, between 2 to 15 million bus-miles.[10] Therefore, a former firm like Voyageur Inc., now dismantled, was operating on the right hand side of his average cost curve; secondly the total costs of a firm depend on the level and the combination of outputs offered because marginal costs of various services are not identical[11]; thirdly Oum and Gillen show that there are no economies of scope nor product-specific economies, meaning that it would be cheaper in Canada to produce regular route service, charter and tour service and small packages separately rather than to produce them jointly[12]. To conclude, the number of operating firms is indeterminate as well as their relative size. Therefore, there is no minimum optimum scale in that particular industry.

3.2 Barriers to Entry and Value of Operating Rights

Regulatory control over entry into the Québec intercity bus industry may create an artificial scarcity of permit authorities. If such is the case, operating rights have a market value which constitutes an indication of fully discounted future excess profits created by the regulatory regime. As financial statements filed in at the Commission are not available to the general public, we cannot directly assess their real values. Our unique source of information used to estimate an indirect measure is a Statistics Canada catalogue entitled Passenger Bus and Urban Transit Statistics. First of all, a quick look at two computed ratios, the value of other assets (investments, intangibles) on total assets and on total operating revenues shows evidence of a steady decline over the years. Next, in order to evaluate the magnitude of these market values, one must use a methodology developed by American economists to assess them in the trucking industry[13]. In short, it is assumed that the value of other assets in the financial statements truly represents the market values of operating rights and, secondly, that this amount is a perpetual annuity yielding 10 per cent per year. The annual flow coming from this annuity is then divided by the annual operating revenues earned by class I and class II firms. The share of revenues coming from the market value of permit authorities would have dropped from 10.6 percent in 1974 to 3.18 percent in 1987. This last percentage will be used as the measure of distortion introduced by the regulatory regime. The consequences on the allocation of resources should actually be minor, the intermodal competition having gradually eroded those rents or transfers throughout a period of time.

3.3. Fare Level

The second expected consequence of a policy of entry control and fare regulation is an increase in the price of service at a level higher than its marginal cost of production. However, it becomes extremely difficult to test precise hypotheses because the nature of regulation does not differ across Canadian provinces. For instance, even if the Ontario Highway Transport Board allowed Greyhound and Gray Coach to compete on some routes, their fare structure was effectively similar. The actual pricing done by intercity bus firms is mainly based on average costs, which take into account of historical passenger load factors observed on each route approved. The underlying philosophy is that firms adjust to time changes in demands, mainly in peak periods, by increasing their capacity, namely by adding new buses rather than having an elaborate multipart pricing system. For example, it may be argued that such a differential pricing system would eventually reduce the number of buses owned.

As deduced by economic theory, the highest gap of fare levels over their marginal costs of production will naturally occur on routes where passenger demand is inelastic, few substitutes being present, and the lowest differentials between fares and their marginal costs will be seen on the corridor, where the passenger demand is elastic. Our estimate of the difference between price and marginal cost should be at least equal to the height of the barriers to entry. Thus, a five per cent

differential is arbitrarily set up for the entire industry.

3.4 Rate of Return on Owner Equity

The third analytical measure used to assess the impact of a regulatory regime is the rate of return on owner equity. The theoretical prediction that generally emerges from an analysis of regulation is that a reduction in competition induces an increase in the level of profits and the rate of return. However, empirical studies indicate that regulation appears to exert an unspecified influence on the profitability of a sector because of certain ambiguous factors. As a matter of fact, a comparison with the manufacturing sector, retail trade and construction shows that the Canadian intercity bus rate of return is not only inferior to these three benchmarks, but that this rate is even more volatile over time. As a matter of fact, the respective average rates of return are for the 1965-1987 period, respectively 15.27%, 16.75% and 22.49% as compared to 13.15% for the intercity bus industry and their coefficients of variation, defined as the ratio of the standard deviation on the mean, are, in the order of 25.1, 20.8 and 24.2 against 81.1 for the intercity bus industry. A given percentage of that decrease over the period considered can be explained by the consumer income effect, this service being an inferior good. The remaining drop, which is endogenous to the industry, can be explained by the following two types of causes. The first one is internal, found within the firms and therefore related to the conduct of their general operations in a regulated environment; the second type is external to them, and consequently linked to their relationship with the regulatory agency.

3.4.1 Internal Elements of a Firm

Among the internal causes which induce an intercity bus firm to bear additional and supplementary costs, the first one is naturally the content of the permit authority that does not strictly correspond to a choice which a firm would have made under competitive forces. As a matter of fact, an operating right clearly specifies not only the different inputs composing the production function, but also contains various restrictions. A second element is the rent-seeking activities by production factors which takes place within the firm itself. For instance, the former Voyageur Inc. had to share the regulation rent gained on the political market with its unionized employees. Because regulation reinforces the bargaining power of the trade union, former Voyageur employees were able to obtain wages higher than their marginal productivity. Voyageur Inc. had to go back to the regulatory agency to ask for an increase in fares to get back to the required operating ratio, the basic criterion used by the board to assess the financial health of a firm.[14] A third possible explanation is that intercity bus firms can engage in quality competition by having more scheduled services on a given route. The consequence would be a reduction in the load factor and therefore an increase in operating costs. A fourth element is the supposed cross-subsidization from low-cost routes to high-cost routes. This term designates the arrangement whereby authorization to provide a profitable service is made fairly explicitly conditional to the extension of service to customers unable to meet their costs. First of all,

this situation could have only been possible when intermodal competition was weak. We therefore share Reschenthaler's serious doubts that they could not have been important, if the Alberta industry is representative of the Canadian situation. Added to his research is a study done in the United States after the 1982 deregulation. This study concludes, after analyzing 205 intercity firms offering both scheduled and tour services, that "only six per cent of the mileage examined could represent potential cross-subsidization".[15]

3.4.2 External Elements

Intercity bus firms must also bear additional costs when implementing and operating in a regulatory regime. Of particular interest are the costs associated with public hearings and a staff whose time is devoted to the Commission's rather than the firm's daily business as well as those costs inherent in the industry's reduced flexibility and expertise when supplying its service to customers. The most important of these supplementary costs is naturally the obligation to invest time, energy and money to protect those quasi-property rights against eventual newcomers in public hearings. For instance, Voyageur Inc. challenged in Superior Court a 1985 regulation whose real intentions were to open up routes and allow competition on the high density corridor of Québec-Montréal.[16] In 1988, a new firm, Les Autocars des Manoirs Inc., tested the 1986 order in council by requesting a permit authority to serve the Québec-Montréal route. After a ten day public hearing, the Québec Transport Commission rejected the request.[17] Because property rights created by the Quebec Commission are valuable, existing producers will rationally commit resources to entry restricting activities up to the point where the marginal cost of these activities is equal to the marginal benefit. However, Voyageur Inc., as an inframarginal actor, consistently challenged applications through the public hearing because of the potential heavy losses. The continuous, cantankerous and pugnacious actions undertaken by Voyageur Inc. to oppose any intrusion in their market share deterred not only actual newcomers who dared try, but also sent a strong signal, dissuading any eventual application in the future.

By increasing firms operating costs in many various ways, regulation reduces the rate of return on owner equity. Our research shows clear evidence that the main cause of that decrease is that Voyageur Inc., representing around 80 per cent of the industry, had to share the regulation rent with the trade union. The latter was therefore able to obtain non-competitive wages for its members. In 1988, Voyageur Inc. obtained some concessions, namely a wage freeze. But it was already too late, the rate of return was in the process of sliding downward. When Voyageur Inc. was broken up and sold in 1990, the five new owners requested major concessions, including not only a decrease in wages, but also radical changes in work rules and a decrease in the number of drivers and maintenance workers.

3.5 The Industrial Structure

Regulatory control over entry can influence the structure of an industry, namely the number of firms and their relative size. If a typical intercity bus firm has approximately constant average costs, then the number of firms as well as their relative size is indeterminate. On the one hand, a fairly constant average cost does not necessarily mean that the firms are of equal size. Moreover, it is well known that the regulation board allows only one firm on a regular route between two specific origin and destination points and rejects all requests for new permits since its creation in 1973. Because, the Commission rarely refuses to transfer permits held by operating carriers, the quickest and surest way of becoming a bus carrier appears to be the acquisition of an existing firm. In a regulated environment of entry control, mergers, acquisition and take-overs constitute the main instruments of expansion. For this very reason, American economists analyzing the trucking industry can demonstrate empirically that regulation has increased the level of concentration in that industry.[18] The picture of the Québec industry is one of local monopolies and a large incumbent firm, the former Voyageur Inc. which had been the first to get started and to expand its network.

The measurement of concentration adopted is the Herfindahl index $(H)^2$ which is defined as the summation of the squared share of firm$_i$ (s_i), namely $H = \sum_i s^2_i$. The minimum value of H occurs when all competitive firms are of equal size and the maximum value is 1 000 in a monopoly situation. This concentration index is computed for total revenues starting in 1980 to 1984. Table I presents the number of firms in the data bank, their total revenues and the Herfindahl measure of concentration. This high concentration index is mainly due to Voyageur Inc. operating in an industry which does not have large economies of scale. The concentration index decreases over the period by 651.3 points or 12.7 per cent. The major reason for this relative decline is the following: Voyageur Inc. starts to reduce its level of services and also sells some marginal regular routes to many local and regional firms to get back to former rates of return. In 1990, the company sells the main parts of its network to five different regional firms, keeping only two interprovincial corridors, Montréal-Hull and Rivière-du-Loup - New Brunswick. In a simulation based on what should be the total revenues for each of these five new firms, the Herfindahl index could be arount 1900 in 1990, a sharp decline of 63 percent in comparison to 1984.

TABLE 1

The Industrial Structure measured by the Herfindahl Index			
Years	**Number of Firms**	**Revenues $ (million)**	**Herfindahl Index**
80	27	59,6	5 121,9
81*	28	54,9	4 086,8
82	30	77,2	4 650.7
83	30	80,0	4 684,6
84	29	83,9	4 470,6

Source: Computations from the author's data set
N.B. * Voyageur Inc had a four month strike in 1981.

Regulation allows an inefficient firm, Voyageur Inc., to operate on the rising side of the average cost curve. The latter would have been in jeopardy earlier in a competitive market. However, the exiting of Voyageur Inc. is caused by two factors, the first being that it had to share its rent with organized labor and secondly, it capitulated to the forces of intermodal competition for passenger travellers.

3.6 The Industry's Performance

The overall conclusion of this analysis of the main consequences of regulation clearly shows that there exist inefficiencies caused by the intercity bus regulation. However, those social costs decrease over the years, because of the intermodal competition for travel consumers. The central element of those inefficiencies is the market value of permit authorities. Although the Statistics Canada official catalogue allows us to deduce the approximate book value of these operating rights at around $ 25 million, our personal investigation regarding the sale of Voyageur leads us to believe that the realistic real value is closer to $ 12 millions. The second element is naturally the welfare losses borne by consumers because fares are higher than their marginal costs. A five percent differential is arbitrarily chosen as a measure of distortion introduced by regulatory measures. Figure I reproduces the argument, the triangle (L) being the welfare losses incurred because consumers reduce their consumption of intercity bus service and the rectangle (D) representing the regulation rents obtained by firm owners. Table 2 presents some estimates of the welfare losses based on two assumptions of total revenues, $80 and 100 million, two price elasticity values, 1.5 and 2.0 and four non-competitive price increases induced by regulation, namely 3, 5, 10 and 20 percent. For instance, if the price increase over marginal cost implicitly authorized by the regulatory agency is 5 per cent a year for all scheduled routes, the welfare losses are between $ 150 000 to $ 250 000 a year, depending on the total revenues earned by intercity bus firms.

Figure I
The Social Costs of Intercity Bus Regulation

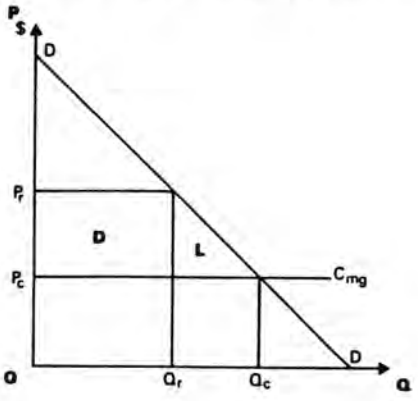


TABLE 2

Welfare Losses Borne by Consumers (million $)					
Revenues (million) $	**Price Elasticity**	**Price Increase in Percentage**			
		3	**5**	**10**	**20**
80	1.5	0.054	0.15	0.6	2.4
80	2.0	0.072	0.2	0.8	3.2
100	1.5	0.068	0.19	0.75	3.0
100	2.0	0.09	0.25	1.0	4.0

In conclusion, the 1990 social cost of regulation is estimated, in a realistic manner, from $ 12.2 million to a upper bound of $ 25.2 million, if firms are able to sell their permit authorities at the value contained in their financial statements.

4. The Future of the Industry: A few Possible Scenarios

The real question raised by this research is naturally the following: how is the industry going to put on the brakes and halt its gradual decline? One scenario could be a simultaneous implementation of two policies, the first being a complete deregulation of the industry and secondly, a marginal pricing for all passenger transportation modes. Even if these two changes could be profitable to the intercity bus industry, American simulations showing clear evidence of an increase in customers,[19] this scenario is really in appropriate for the Canadian environment in the near future.

A second scenario could be to attract new customers by increasing the demand and/or the quantity demanded. A shift in the demand curve could be realized, if

intercity bus firms find new niches. One possibility is to specialize in charter service which is clearly expanding. Another possibility could be to look outside their actual regulated activities in much the same way as the American industry did after the 1982 deregulation. Becoming a tour operator, a feeder for air carriers or increasing its activities as a parcel carrier are some examples of the moves made recently by actual Canadian firms. A last one could be a more attractive fare structure for off-peak periods and better express services on main routes.

A third scenario refers to supply side considerations. Among the different possibilities, the most important ones are to contract out for maintenance services, to use more efficient buses, either in terms of capacity or operating costs, to obtain better planning of daily activities. In a word, firms have to be more efficient and customer-oriented. However, it does not imply that they will eventually see the «light at the end of the tunnel». However, they can probably avoid the mistakes made by Greyhound in the past.

NOTES AND REFERENCES

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1. The Québec regulatory system, as the well as one existing in each Canadian province, is generally similar to the one which was put in place by the Interstate Commerce Commission before the Bus Regulatory Reform Act of 1982. See Pinkston, E.A. "The Rise and Fall of Bus Regulation "Regulation Sept./Dec. 1984, pp. 45-52; Palmer, J., Quinn, J. and Resendes, R. "A Case Study of Public Entreprise: Gray Coach Lines Ltd", Prichard J.R.S. editor, Crow Corporations in Canada, Butterworths & Co., Toronto, 1983, pp. 369-436 and Reschenthaler, G.B. Performance Under Regulation: The Canadian Intercity Bus Industry, Consumer and Corporation Affairs, Bureau of Competition Policy, Ottawa, 1981.

2. Bus Transport Regulation, O.C. 1991-86, Québec Official Gazette, January 7, 1987, Vol 119, No 1, Part 2, pp. 24-29.

3. These five consequences stem from a qualitative analysis of many written decisions emanating from the Commission and from a quantitative analysis of the published data on the approval and denial of applications contained in his annual reports. Exhaustive empirical evidence is given in Boucher, M. "L'industrie québécoise du transport par autocar: réglementation, pratiques et performance". Centre de recherche en économie publique, cahier 90-21, École nationale d'administration publique, pp. 3-19.

4. The rate approval for fare increases is always higher than 90 per cent. In 1986-87, it reaches 100 per cent.

5. Reschenthaler, G.B. Performance Under Regulation: The Canadian Intercity Bus Industry, op.cit., pp. 19-12; Intercity Multi-Modal Travellers Survey, Some Preliminary Tables, Ministry of Transportation and Communications, Toronto, September 1984 and "A Report on the Bus Regulatory Reform Act of 1982", Motor Carrier Ratemaking Study Commission, Washington May 15, 1984, pp. 20-22 and pp. 59-62. Marketing surveys done over the years by Voyageur Inc. confirm these results for the province of Québec. Bits and pieces of evidence are found in the following decisions: Les Autocars des Manoirs Inc. v. Voyageur Inc. et al. decision QPV89-00010, January 24, 1989; Voyageur Inc., decision MPV88-00071, May, 13, 1988; Voyageur Inc., decision MPV86-00195, January 22, 1986 and Voyageur Inc., decision MPV86-00194, January 22, 1986.

6. Meyer, J.R. and Oster Jr, C.V. Deregulation and the Future of Intercity Passenger Travel, MIT Press, 1987, pp. 183-203 and pp. 249-260; Oum, T.H. and Gillen, D.W. "The Structure of Intercity Travel Demands in Canada: Theory Tests and Empirical Results", Transportation Research, vol. 17-B, no 3, 1983, pp. 175-191.

7. Meyer, , J.R. and Oster Jr, C.V. Deregulation and the Future of Intercity Passenger Travel, op. cit., pp. 254-260; Winston, C. "Conceptual Developments in the Economics of Transportation: An Interpretive Survey", Journal of Economic Literature, vol. 23, March 1985, p. 69-78; Babcok, M.W. and German, H.W. "A Model of the Demand for Intercity Bus Travel" Transportation Research Forum Proceedings, vol. XXV, no 1, 1984, pp. 187-193; Douglas, N.J. "An Econometric Investigation into the Demand Function for U.K. Express Coach Travel During a Period of Deregulation", Transportation Research Forum Proceedings, vol. XXV, no 1, 1984, pp. 194-203; Intercity Passenger Transport Study, Canadian Transport Commission, Ottawa, 1969, p. 30.

8. Johnston, J. "Scale, Costs and Profitability in Road Passenger Transport", Journal of Industrial Economics, vol. 4, 1955, pp. 207-223; Beesley, M.E. and Politi, J. "A Study of the Profits of Bus Compagnies, 1960-1966", Economica, N.S., vol., 36, no 142, May 1969, pp. 151-171 and Koshal, R.K. "Economies of Scale in Bus Transport", Journal of Transport Economics and Policy, vol. 4, 1970, pp. 29-36.

9. Fravel, F.D. "Returns to Scale in the U.S. Intercity Bus Industry", Transportation Research Forum Proceedings, vol XIX, 1978, no 1, pp. 551-560.

10. The American studies are the following: Tauchen, H., Fravel, F.D. and Gilbert, G. "Cost Structure of the Intercity Bus Industry", Journal of Transport Economics and Policy, no 1, January 1983, pp. 31 and 40-41; and William, M. Hall C. "Returns to Scale in the United States Intercity Bus Industry", Regional Science and Urban Economics, vol. 11, 1981, pp. 581-582. The Canadian study is that of Gillen, D.W. and Oum, T.H. "A Study of the Cost Structure of the Canadian Intercity Motor Coach Industry", Canadian Journal of Economics, vol. 17, no 2, May 1984, p. 318.

11. Taucher, H., Fravel and F.D. Gilbert, G. "Cost Structure of the Intercity Bus Industry", op. cit., pp. 31-32 and 39; Gillen, D.W. and Oum, T.H. "A Study of the Cost Structure of the Canadian Intercity Motor Coach Industry", op.cit., pp. 381-382.

12. Taucher, H., Fravel, F.D. and Gilbert, G. "Cost Structure of the Intercity Bus Industry", op. cit., pp. 35 and 40: Gillen, D.W. and Oum, T.H. "A

Study of the Cost Structure of the Canadian Intercity Motor Coach Industry" op. cit., p. 387.

13. Boucher, M. "L'inspiration américaine de la déréglementation américaine en transport routier", Canadian Public Policy, Vol 12, March 1986, p. 189-201; Frew, J.R. "The Existence of Monopoly Profits in the Motor Carrier Industry" The Journal of Law and Economics, vol. 24, October 1981, pp. 289-316 and Moore, T.G. "The Beneficiaries of Trucking Regulation", The Journal of Law and Economics, vol. 21, October 1978, pp. 327-344.

14. For instance, Voyageur was able to increase its fares 17 times between February 1980 and May 1984.

15. "A Report on the Bus Regulatory Reform Act of 1982", Motor Carrier Ratemaking Study Commission, Washington, May 15, 1984, pp. 40. The relevant information on Reschenthaler's demonstration are in Reschenthaler, G.B. Performance Under Regulation: The Canadian Intercity Bus Industry, op. cit., pp. 107-126 and Reschenthaler, G.B. "Measuring the Extent of Cross Cubsidization by Intercity Bus Lines: A Canadian Case Study" The Logistics and Transportation Review, vol. 17, no 3, 1981, pp. 313-326.

16. Les Autobus Deshaies Ltée v. Voyageur Inc., decision QPV85-00058, April 29, 1985 and Voyageur Inc., et al. v. Commission des Transports du Québec et al, Québec Superior Court, decision 200-05-000321-864, August 19, 1986, in R.J.Q., 1986, pp. 2577-2585.

17. Les Autocars des Manoirs Inc. v. Voyageur Inc. et al, decision QPV89-00010, January 24, 1989.

18. Nelson, J.C. "The Effects of Entry Control in Surface Transportation", Transportation Economics, National Bureau of Economic Research, Columbia University Press, 1965, pp. 381-422.

19. Meyer, J.R. and Oster Jr, J.V. Deregulation and the Future of Intercity Passenger Travel, op. cit., pp. 190-192; Andriulaitis, R.J. "Economic Efficiency Losses Pricing for Subsidized Intercity Rail Passenger Movements in Canada", Unpublished master thesis, The University of British Columbia, Vancouver 1987, ch 7, p. 229 and "Voyageur maintient son intention de vendre malgré les diminutions chez Via", Le Soleil, October 14, 1989.

Employee Citizenship Behaviour and Quality of Service in Transportation

by

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Introduction:

Transportation is a service industry, where production and consumption occur simultaneously. Because of this, close supervision of front-line employees is difficult. Moreover, it is almost impossible for managers to specify exhaustively how activities involving customers are to be carried out. A great deal of discretion and responsibility must often be left in the hands of the front-line employee.

Established paradigms of management often fail to capture this reality adequately. They may be entirely suitable for prescribing managerial behaviour in production-line settings, where supervisors are able to ensure that quantity and quality of output is adequate. Here, when deficiencies are observed, production can be stopped and the faulty units recalled. Inappropriate behaviour of the front-line employees (who rarely, if ever interact with the customer) can be corrected away from public view if it has occurred.

In contrast, the transportation service cannot be recalled once it has been produced. There is a clear and unmistakably direct relationship between front-line employee and the customer. Virtually every writer on the theme of "excellence" has demonstrated a keen sensitivity to the importance of "critical incidents", where very ordinary employees performed their responsibilities in a way that had an immediate and dramatic impact upon customer satisfaction (or dissatisfaction).[1]

It is important, then, that transportation managers incorporate the front-line employee into strategies for enhancing competitiveness. The urgency of this need becomes evident in looking at recent U.S. studies which indicate that on average, only one dissatisfied customer in seven will ever get around to formally filing a complaint, and that the average dissatisfied customer tells ten other people about their displeasure. While not all of the latter will act on the basis of negative word-of-mouth advertising, some will. In a recent article, Luecke and his associates applied these assumptions and

[1] See, for example, T. Peters and N. Austin, A Passion for Excellence (New York: Random House, 1985), pp. 41-50.

demonstrated that what might appear to be a $10,000 lifetime loss from one lost customer easily translates into a real loss of about a quarter of a million dollars, once the invisible "soft costs" are added.[2]

Organizational citizenship behaviour (OCB):

A survey done at British Airways some years ago revealed four factors found to be critical in influencing customer goodwill:

1. Care and concern on the part of front-line contact people;

2. Problem-solving capability in front-line personnel;

3. Spontaneity or flexibility in the application of policies and procedures, and

4. Recovery, or the ability of front-line people to make things right for the customer when they have somehow gone astray.[3]

Each of the four factors appear to involve the use of employee discretion to the benefit of customer satisfaction (and hence, the effectiveness of the organization). None can be exhaustively described in policy manuals, rules or regulations.

The broader phenomenon captured in the British Airways survey appears to be organizational citizenship behaviour (OCB). OCB may be defined as behaviour which is discretionary and not directly or explicitly recognized by formal reward systems.[4] The following are typical examples:

a shipping clerk who "bends the rules" to get an important customer's shipment delivered on time;

a bus driver who leaves for work an hour early following an all-night snowstorm, in order to be sure that his/her run departs on schedule;

a ticket agent who is unfailingly courteous in accommodating the needs of a demanding handicapped customer; or

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[2] R. Luecke, V.R. Rosselli, and J.M. Moss, "The Economic Ramifications of 'Client' Dissatisfaction," Group Practice Journal, 40, no. 3 (1991), pp. 8-18.

[3] K. Albrecht and R. Zemke, Service America (New York: Dow-Jones Irwin, 1985), pp. 158-9.

[4] D.W. Organ, Organizational Citizenship Behavior (Lexington, MA: D.C. Heath and Company, 1988), p. 4.

a flight attendant who invites a small child to "help" serve drinks in order to provide a brief respite to a beleaguered parent.[5]

As the above examples suggest, OCBs can have a dramatic impact upon the customers satisfaction with both the outcomes of a service (such as timely delivery) and the process of the service (such as an enjoyable journey). However, it is likely that most managers will only rarely discover that they have occurred. Because these behaviours unquestionably contribute to organizational effectiveness, the question of how managers might encourage OCBs is of more than a passing interest.

Managing for OCB:

Organizational Culture:

The "excellence literature" of the last decade often identifies strong organizational cultures as a factor differentiating superior firms from others.[6] Organizational culture may be defined as the system of values and beliefs describing "the way we do things around here".[7] It is very likely that organizational culture is an important variable in the promotion of OCB, as we shall see.

When Frederic Malek assumed the presidency of Northwest Airlines in 1987, an early priority was to change the company's rigid culture in order to give employees "more flexibility to use initiative and imagination to solve problems and serve passengers".[8] Perhaps one of the limitations Malek saw in this system was that in a quasi-military culture, front-line employees would be likely to delegate responsibility upwards rather than risk a superior's displeasure.[9] While not without its benefits, an inherent drawback of such a culture in a transportation setting is that because customers participate in the service delivery process, their perceptions of the quality of the service

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[5] Some "invisible" citizenship behaviours may be encouraged by managerial practices which reward its consequences. For example, if a bus driver is praised by a supervisor for showing up for work on time despite severe weather conditions, it is more likely that the OCB that facilitated that result (leaving home early) will recur.

[6] T. Peters and R. Waterman, In Search of Excellence (New York: Warner Books, 1982), pp. 75-6.

[7] It should be recognized that there is a wide variety of definitions for organizational culture, although the present one is sufficient here.

[8] C. Jouzatis, "Malek maps new course for Northwest," Chicago Tribune, 29 Oct. 1989, Section 7, p. 3.

[9] J. Carlzon, Moments of Truth (Cambridge, MA: Ballinger Publishing Company, 1987), p. 83.

will often be influenced by the speed with which their expectations are met. As Carlzon notes, if front-line employees have to go up the organizational chain of command for a decision on an individual problem, their ability to respond to the customer's need with speed and courtesy is compromised, and an opportunity to earn loyalty has been lost.[10]

A more powerful example of where organization culture has been used in order to encourage OCB is Scandinavian Airlines (SAS), where a "cultural revolution" during the early 1980s was instrumental in restoring profitability to the firm. Two broadly-articulated values in that culture that are relevant here include: that "people at the front line need service and support to do their job more effectively" and that "individuals need to be supported with information in order to take responsibility."[11] Both of these values square nicely with the findings of Smith and her colleagues, who found a significant relationship between "leader supportiveness" and organizational citizenship behaviours.[12]

One way in which the values that make up the organizational culture can be shared with front-line employees is through the dissemination of stories.[13] An example I am aware of involves a group of Boy Scouts about to travel to a Jamboree overseas. Unfortunately, the movie on board was not one the boys were likely to enjoy. On her own initiative, an airline customer sales and service agent charged off to the hangar, retrieved a more suitable film, and convinced a mechanic to install it. Soon afterwards, a story describing the incident appeared in the company newsletter. It is not difficult to see that the newsletter might encourage others to act with similar initiative in the future.[14]

Stories may also be an important way of letting employees know that not all "going-the-extra-mile" behaviours are truly conducive to organizational effectiveness.[15]

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[10] Carlzon, Moments of Truth, pp. 3,6.

[11] A. Edström, "Leadership and Strategic Change," Human Resource Management, 25 (1986), p. 587.

[12] C.A. Smith, D.W. Organ, and J.P. Near, "Organizational Citizenship Behavior: Its Nature and Antecedents," Journal of Applied Psychology, 68 (1983), pp. 653-63.

[13] J. Martin, M. Feldman, M.J. Hatch, and S.B. Sitkin, "The uniqueness paradox in organizational stories," Administrative Science Quarterly, 28 (1983), pp. 438-53.

[14] That the behaviour of this employee was rewarded does not detract from its "citizenship" nature, since there is no way she could have known that the newsletter story would later be published.

[15] There is some evidence that stories were used by SAS management to this end. See R. Normann, Service Management: Strategy and Leadership in Service Businesses (New York: Wiley, 1984), p. 80.

In SAS President Jan Carlzon's book, Moments of Truth (which we may presume was read by countless employees), the author tells of flight attendants who began "smuggling" business-class food trays and beverages into the economy class cabin, where no meal service was to be offered. This clearly falls short of OCB, because the company's efforts at differentiating the two classes of service were clearly being sabotaged.[16] Moreover, it raised the probability of a customer complaining if, during some future flight, "contraband goods" were not offered.

"Leading by example" is another way of sharing the culture of the organization with front-line employees. For, as Carlzon notes, in so doing, the leader will be helping create the very image that the organization presents to its customers:

> At SAS we pass out magazines and newspapers on the aircraft. We do not always have enough for everyone and sometimes, the staff tries to be kind by offering me my pick first. 'Out of the question,' I tell them. 'I cannot take any myself until I know that all the passengers have gotten what they want!'
>
> I have heard more than once that the cabin crew interprets these tiny, symbolic gestures in this way: 'Even top management is helping give the passengers good service. That shows respect for our jobs.' By demonstrating that we ourselves come last after the customers, we are telling our employees - and the customers - what the ranking order really is.[17]

This section concludes with the observation that organizational cultures which emphasize the theme of "fairness" in relationships between the organization and its various constituent groups (e.g. customers, employees, suppliers, and the local community) appear more likely to encourage OCB:

> A chronic sense of unfairness moves one to redefine the implicit social contract one has with the organization - assuming that outright abrogation of the contract (i.e. leaving) is impracticable. The most salient means of redefining the contract is to withhold those contributions of an OCB character.[18]

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[16] J. Carlzon, Riv pyramiderna (London, England: Cox and Wyman), pp. 68-9.

[17] Carlzon, Moments of Truth, p. 95.

[18] Organ, p. 78.

Training:

As one practitioner notes, "If you train your people well enough, you can just get out of the way and let them do the job."[19] The "contraband goods" incident cited earlier implies that careful training is essential if the discretion of the employees is to be used to the company's benefit. It is inappropriate to "turn employees loose" until they are thoroughly familiar with the goals of the organization and how their behaviour can help (or frustrate) the achievement of these goals.

A particular concern that training programs must address is the inherent trade-offs associated with several OCBs one might think of. For example, an employee who "bends the rules" in order to accommodate the customer's wishes must appreciate the risk of the customer becoming dissatisfied when a future encounter fails to produce similar results. The ticket clerk who devotes extensive time and resources to assisting a customer with special needs must realize that this may reduce the satisfaction of other customers who are kept waiting. By building a familiarity with both the benefits and risks of OCBs, it is likely that the quality of front-line employee decision making will improve over time.

Selection:

In general, the selection process should recognize the need for front-line employees who are able to cope with high levels of customer contact:

> Dealing with customers calls for a level of maturity and self-esteem that allows one to put personal feelings and problems aside to focus on customers and their wants and problems. Service workers need social skills and an understanding of the normal rules of social behaviour.[20]

It is unlikely that a service worker who is unable to withstand the stress of repeated customer contact will exhibit citizenship behaviours. Workers who possess the traits and abilities conducive to effective execution of normal day-to-day job responsibilities are clearly more likely to know when risk-taking in the form of going beyond what is formally required by job descriptions is appropriate.

The study by Smith and her colleagues noted earlier found individual variables (e.g. urban/rural origin, education and neuroticism) to be significant predictors of citizenship behaviour. While employee selection systems must reflect a variety of needs (such as equal employment opportunity requirements), they may nonetheless help promote OCB if they are appropriately designed. For example, Organ notes that "some

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[19] R. Zemke and D. Schaaf, The Service Edge: 101 companies that profit from customer care (New York: Penguin Books, 1990), p. 61.

[20] Zemke, The Service Edge, pp. 64-5.

corporate recruiters looks for evidence, both in interviews and background information, of how a candidate would likely react to situations requiring cooperation, fair play, and reciprocity in exchange."[21]

A basic limitation of such practices, however, is their emphasis upon past rather than current performance levels. Hence, the utility of practices such as student internships, temporary (or leased) employees, and the use of a probationary period should not be overlooked. These may facilitate better selection decisions because they provide information on what the would-be permanent employee actually does while on the job.[22]

The service system:

The service system may be formally defined as the physical and procedural apparatus used by employees and customers. It thus includes not only equipment and facilities, but also "standard operating procedures". The service system may encourage or frustrate citizenship behaviours because of its potential to help or hinder the achievement of the goals employees set for themselves, and hence, the mood state of both employees and customer.[23]

For example, airline ticket agents must often find hotel space and make onward bookings for connecting passengers stranded due to mechanical problems. One of the frustrations I experienced as I performed this chore personally was that no matter how fast I tried to work, it often took ten to fifteen minutes just to complete the paperwork in the presence of a tired and bedraggled customer. Often, the customer would become impatient, which tended to compromise the degree of "courtesy" associated with the encounter. At one of our competitors, on the other hand, I noted that the paperwork and procedural details had been designed in such a way that a customer stranded at United's O'Hare terminal could close the door of his/her hotel room within fifteen minutes of the arrival time of the inbound flight.[24] The role of the service system may be seen as

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[21] Organ, p. 82.

[22] J.E. Disend, How to Provide Excellent Service in Any Organization (Radnor, PA: Chilton Book Company, 1991), pp. 151,2.

[23] As Organ notes, perhaps the most feasible strategy for managers to encourage OCB lies in "preventing as much as possible those episodes that destroy any otherwise naturally occurring good mood" (Organ, p. 97).

[24] There is some evidence that SAS management appreciated the potential of paperwork to detract from service quality (Carlzon, Moments of Truth, p. 25). Indeed, as another author points out, "we have yet to learn how to cope with our growing hoard of facts or with the ever growing power of computers. We need to stop admiring information. In itself, it is clutter, and it should be tolerated only if it has a purpose." (G. Rose, "Reflections on the changing times," British Medical Journal, 301 (1990),

instrumental in promoting OCB (in the form of courtesy) during the encounter between the United employee and the customer.[25]

Conclusion:

Every encounter between a front-line employee and a customer represents an opportunity to confirm the customer's choice. Obviously, the most important dimension of the employee's conduct has to do with ensuring that the outcome of the service is satisfactory. The biggest smile in the business is unlikely to placate a customer whose shipment is damaged or lost. However, in the competitive environment that is so characteristic of transportation today, we cannot afford to overlook the second dimension, which has to do with process.

Citizenship behaviours may be important antecedents of customer satisfaction with both outcome and process. These may be encouraged by managers who foster an organizational culture in which they are encouraged, and who empower employees to work to their potential by sensible selection, training and service system practices.[26]

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p. 683).

[25] An excellent discussion on service system design may be found in G.D. Upah and J.W. Fulton, "Situation Creation in Service Marketing," in The Service Encounter, ed.J.A. Czepiel, M.R. Solomon and C.F. Surprenant (Lexington, MA: D.C. Heath and Company, 1985), pp. 255-263.

[26] Organ's book (see footnote 4) provides a more comprehensive discussion of how managers may encourage OCB.

VIDEOCONFERENCING AND WORK TRAVEL

Kenneth Button*

Introduction

The use of telecommunications has grown considerably over recent years. There are obvious links between the use of telecommunications & travel behaviour although these are often difficult to specify in detail & to quantify[1]. There is no doubt that improved telecommunications, through developments of electronic data interchange, has acted, for example, to improve freight transport efficiency. More difficult is the problem of isolating the impacts of trends such as telecommuting & videoconferencing on work travel[2] & teleshopping & distance learning on non-work travel.

Nevertheless, the long term importance of some forms of telecommunications as possible substitutes for transport is a topic of immediate relevance. There is mounting concern over the environmental damage done by transport & many governments are admitting that fiscal expediency will prevent traditional means of funding infrastructure developments from being used to meet projected unrestrained traffic growth. On the other hand, technology & regulatory reforms in many countries seem likely to both improve the quality of telecommunications & bring its real costs down significantly.

This paper looks at the prospect of videoconferencing becoming a major substitute for work travel. Unlike some forms of telecommunication, this does seem a field where there is scope for substitution away from person movements (Button, 1991). Initially some background information is provide as to the nature & development of videoconferencing. We then move on to establish a microeconomic framework within which one can attempt to forecast the up-take of videoconferencing facilities over the next decade. Results from a survey of UK users & non-users of videoconferencing are then used to gain a better feel of relevant parameters.

Videoconferencing

Videoconferencing is not a new concept although the technology to make it a tractable methods of communication is relatively new. While the demonstration of the picture phone at the 1964 New York World Fair is often seen as the starting point for videoconferencing, demonstration systems date back to the 1930s. Videoconferencing in the UK has a relatively long history but its use has been slow to take-off. In 1971, the Confravision service was opened by the Post Office but it was little used. In terms of the trans-Atlantic, two companies started offering UK/US services in 1983 and one a UK/Canada link. European links became established as more satellite capacity became available after 1984. Very little work, however, has been done on the total amount of videoconferencing being conducted. There are problems of measurement & of accessing records of private companies. Work on the 5 public studios & 25 business owned video-conference studies in Switzerland (Maggi & Walo, 1991), for instance, while providing a general impression of use in 1989 & 1990 encountered problems of incompatible records & difficulty of gaining access to information. What was found was that there was little use of the public systems although there was some indication that four private, in-house facilities were used more but even the most heavily used of these (Hoffmann-La-Roche) was used for less than 90 hours a month from January to July 1991 & the others we seldom used for more than 10 hours & frequently for much less.

World-wide, though, the use of videoconferencing would seem to be increasing. A survey of 100 US organisations regularly using videoconferencing fund that videocon-ferencing had doubled since an earlier 1985 survey[3]. At a global level it has been esti-

mated that image communication is growing at about 25% to 39% per annum. Some 60% to 70% of it is done in the United States, with about 25% in Europe & much of the remainder in Japan (Douglas, 1989). In absolute terms, however, use of the facility is limited. In 1988 the best estimates suggested that fewer than 6,000 units had been installed in the US. Equally, within Europe the up-take has been gradual. In part, high line costs & different standards offered by the national PTTs, coupled with user concern over the quality of service engendered by the crude technology associated with early systems, have hindered the development of the international system.

The uses to which videoconferencing is put by the business community tends to vary between companies. The types of activity where it may serve as an alternative to business travel include (see Boghani *et al*, 1991): company business trips, undertaken to visit different firm offices or sites; non-company trips required to meet a client or someone in another company; conference trips & training trips. The current, slowly increasing use of videoconferencing is often seen as coming about because it is seen as a way of reducing the costs of work based travel. Johansen & Bullen (1984) & Salomon (1986) point to the increased awareness by companies of travel costs, including time as well as money costs, & are able to compare these directly with the costs of investing in videoconferencing facilities. In practice, however, the situation is more complex & the impact of videoconferencing is seen by several studies to depend on several factors.

- Some of the studies suggest that teleconferencing will be used to conduct many types of meeting not previously carried out face-to-face using transport modes . In other words at least part of the demand will be newly generated interactions (Johansen, 1984).
- Where there is some potential for transfer, evidence from UK studies (e.g. Pye, 1976; Goddard & Morris, 1976) is that personal contact is still necessary. For instance, while some 34% of meetings recorded could have been performed by audio only conferencing & a further 10% through the use of video systems some 50% of communications still required face to face contact.
- Bennison (1988) highlights, the potential complexity of underlying relationships. His study of a field trial in the UK found that in companies where videoconferencing had become established it had become a complement to face-to-face contact meetings[4]. This conforms with Mokhtarian's (1988) study in Southern California. The indications are that videoconferencing may generate additional trips even if it reduces the average trip length.
- There is the modal effect to consider. The majority of work cited considers the impact on local transport use, & particularly the automobile. The impact on aviation may, though, be somewhat more important in the future - long air trips with accompanying car hire & accommodation costs offer the scope for substitution.

Some Economic Theory

Videoconferencing is a product & thus susceptible to the laws of economics. The amount of economic analysis looking at videoconferencing is, however, sparse & tends to be rather fragmented.

There is an established notion in management science that products go through a life-cycle. The classic form of the model assumes a sigmoid growth curve in sales of the product concerned followed by a decline (see the solid line in Figure 1). The product is initially launched but sales are low because of factors such as consumer unfamiliarity, lack of service facilities, high costs of non-mass production, technical unreliability, inadequate complementary infrastructure, etc. If it survives this phase then growth in sales occurs as consumer tastes are converted ('bandwagon' effects may also be initiated in some cases), costs of production fall, sales outlets & service facilities expand in number, standardisation of technical specifications take place, etc. A mature market is reached when long run marginal costs of production are minimised, product availability is ubiquitous & near saturation of all potential users is achieved. Finally, as new products come onto the market, & the market for the target product reaches replacement levels, so its sales decline.

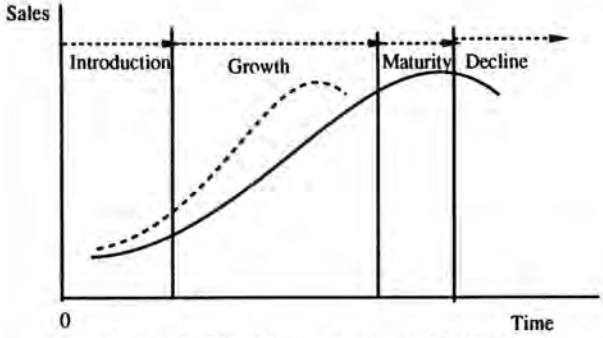


Figure 1. The Classic Product Life Cycle

While the classic framework has a degree of simple & intuitive logic to it, its application to actual products as a quantitative forecasting device is not easy (Rink & Swan, 1979). Studies have shown that the shape of life cycles vary considerably between products. While there is some evidence that more technological products tend to have a fairly long introduction phase, followed by a very rapid take-up & movement to maturity, the pattern is by no means universal. In particular, the move from the introduction phase to the growth phase is extremely difficult to predict. This is possibly one reason for what, in retrospect, appeared as rather optimistic projections of videoconferencing use in the early 1980s. Essentially, those involved thought that the growth path would be similar to that shown by the broken line in Figure 1 rather than the solid line. The important point relates to the pre-conditions which must be *in situ* prior to any 'take-off'. In the case of videoconferencing, these can be considered in terms of:-

- *Threshold demand pressures*. Any product gains a market both by attracting new users (business creation) & by taking users from other products (business diversion). In the case of videoconferencing, the diversion effect is likely to be primarily from business trip making & from audio conferencing. There has, in the recent past been a very rapid increase in business travel, & in particular that undertaken by cars. The pressure to switch to videoconferencing has been softened in many countries both by the taxation structure regarding company cars & by major road building projects which have limited the build up of congestion on trunk roads. The generalised costs of business travel have, therefore, been kept down although this is now changing[5].
- *User acceptance*. While many products offer what appear to the manufacturer to be considerable attributes in a technical sense, user friendliness is a key consideration for widespread adoption & use. In the case of videoconferencing, this may be viewed in terms of the individual users' reactions to the product & the degree to which the product fits in with the wider activities of the firm. Early equipment involved studios which proved alien & intimidating to many users. It also involved complex arrangements for booking time which reduced its flexibility for managing work patterns. These limitations are now rapidly being overcome as equipment becomes more mobile & it is much easier to arrange video meetings.
- *Synergy factors*. Videoconferencing is only one element of a range of technical possibilities in the telecommunications field. Its widespread adoption & speed of take-up will, to some extent, be influenced by the up-take of other telecommunication systems (e.g. telecommuting, tele-shopping, distance learning, etc). This synergy effect stems both from the degree to which the actual cost of videoconferencing is likely to fall as economies of scope can be realised by suppliers of telecommunications facilities as they supply a variety of different but linked products & from the reduction in user resistance to

videoconferencing as people become more familiar through usage with advanced telecommunication systems in general.

- *Technical reliability*. Product take-off requires confidence on the users part that the service sought will be forthcoming in a reasonably reliable fashion. The early UK system Confravision, for example, suffered from having to use standby television relay circuits. These problems have now largely been overcome and, in any case, the growth in traffic congestion, with its associated impact on reliability of person movements, has changed the point of comparison.
- *Product cost*. Cost is obviously a primary consideration to business users of telecommunications. Videoconferencing, in part because of the previous need for dedicated studio space, but also because of the high costs of transmission, has tended to seen as a high cost activity. Specialised studios have been available for hire which have reduced the need for high capital outlays but these have their own problems of access. Costs are now predicted to fall considerably both in terms of equipment costs but also regarding transmission costs.
- *Product standards*. Very seldom does any product gain rapid market assimilation without either some implicit or explicit sets of standards being arrived at. Without such standards equipment cannot interface efficiently, economies of scale in production cannot be achieved, training poses a problem & service & maintenance costs are high. As has been demonstrated with many products the standardisation does not have to reflect the best ultimate technology - one might wait forever for this - & may have serious limitations in the longer term as demand patterns change & technology advances.
- *Infrastructure availability*. Videoconferencing depends upon the availability of adequate & appropriate links between the users stations. In the past pre-booking systems were required although ideally a public switched service is required to facilitate easy use. At present this does not exist on a European wide, let alone global basis although the situation is changing.

Stemming from these points is the need to consider the, so-called, 'telecommunications gap' which is likely to be influenced by these trade-offs[6]. Over time there has been an upward trend in the amount of business travel which has been undertaken but there are limits to how much face-to-face contact is physically possible & there are also boundaries to the amount which is economically desirable. This limit is being reached. A sort of saturation level could be said to exist. An unconstrained path for overall interactions could, however, through the use of telecommunications continue upwards. The issue then becomes one of looking at the types of work interactions which could be substituted & seeing the pre-conditions for such substitution exist.

Maggi (1989), while concerned with developing an analytical framework to examine barriers to communication, also develops a cost model of communicating which offers a theoretical basis for deciding which types of trips are more amenable to substitution & hence fill the telecommunications gap. The main difference in communicating information by face-to-face contact & various forms of telecommunications is in terms of time costs. Face-to-face communications provide the maximum available transmission capacity (e.g. involving immediate interactions, visual gestures, use of visual aids, etc.) whereas with telecommunications the time costs of sending complex messages rises rapidly & may become prohibitive. This has clear implications when explicitly considering videoconferencing.

Distance is used as a proxy for travel time in Maggi's analytical framework There are assumed to be no (or at least negligible) fixed costs associated with face-to-face contacts. Equally, it assumed that because of the ability to lease or hire equipment & lines that there are no effective fixed capital costs on videoconferencing. In the case of the latter, however, there is assumed to be a need for investment in human capital (e.g. learning how to use videoconferencing facilities efficiently)[7]. This assumption has been given empirical support in the work of Moore & Jovanis (1988). They found a hierarchy of learning costs associated with different means of telecommunications with the telephone

involving minimal fixed costs but electronic mail & voice mail requiring a period of familiarisation. Videoconferencing, especially when as in the past studio facilities were required, would appear to be at the higher end of the fixed cost spectrum.

The implications derived from Maggi's analysis are that more regular interactions involving fairly standardised activities are most amenable to being transferred to electronic media. Specifically regarding business travel, *a priori* this would seem relate to such activities as; regular divisional meetings, up-dating sessions, information dissemination, certain types of training, etc. While business travel itself is generally a relatively small component of total travel this does not mean that in overall cost-benefit terms, increased use of videoconferencing would not yield very significant & positive traffic benefits. Certainly in terms of telecommunications acting as a substitute for travel, one would expect business related activities (e.g. commuting or shopping) to be directly influenced by cost reductions or technology change than many other forms of activity quite simply because the costs enter directly into accountancy calculations.

Previous Empirical Work

The amount of empirical work concerned with the sensitivity of travel behaviour to changing supply conditions in the videoconferencing market is small. One problems is that it is very difficult to generalise about the actual costs of videoconferencing activities & the costs of alternatives[8]. These types of problem have led to looking at the relative cost of videoconferencing *vis-a-vis* personal contacts in very specific circumstances. Fisher & Feeney (1985), for instance, use illustrations of relative costs for face-to-face & videoconference meeting between London & Glasgow & London & New York under several different scenarios.

What many of these types of study often omit is the cost of the time involved for participants. Videoconferencing essentially frees time formerly used in travel to undertake gainful employment. One can obtain some idea of the benefits of this by multiplying the time saved by the value of this to employers, i.e. by following the methodology used in transport investment appraisal (UK Department of Transport, 1989). Taking data relating to grade 7 civil servant attending conferences involving participants in London & Brussels, & including all personnel costs, show that, for example, in 1991 a two hour meeting involving one person from Brussels & one from London would cost £557.61 if held in Brussels but £1715.66 if videoconferencing was employed. However, a one hour meeting in Brussels involving two people from London & one from Belgium costs £1045.32 but if videoconferenced the cost falls to £881.13. Similar calculations for conferences involving London-Paris, London-Amsterdam London-Madrid, London-Rome, London-Copenhagen & London-Berlin provide the same general conclusions. What emerges is that despite including subsistence & salary costs, in many cases personal travel is cheaper than videoconferencing. Videoconferencing does begin to have an advantage for shorter meeting involving more participants. The evidence on the number of participants involved, however, is less certain from these calculations since logically, basic economics suggests that it would be the larger group of participants which would act as host rather than the smaller & thus the calculations probably overstate the costs of large group face-to-face meetings.

Private sector companies with in-house videoconferencing systems also operate accountancy procedures to determine when it is cost-effective to replace personal travel by a video conference. IBM in the USA have an on-line system to inform managers throughout the world of the comparative costs. In the UK, GPT, which has an internal videoconferencing system linking its main sites, equally provides details of comparable costs. The costing of the video facility is based on full cost recovery & illustrative examples of the relative cost data provided within the company for different types of trip are seen in Table 1[9].

An advantaged claimed by those responsible for the in-house videoconferencing systems, & not reflected in any of the cost estimates in the table, is that they can reduce re-

source wastage when it is discovered that individuals central to decision-making are, for one reason or another, not in attendance. GPT offer some cost calculations in the case of a manager travelling from Coventry to Liverpool (by rail) & two engineers travelling from Beeston to Liverpool (by car) but, due to the absence of a third engineer, the meeting only lasted one hour. The face-to-face meeting in this case was costed at £1135.70 while an hour's video conference between Coventry, Liverpool & Beeston would only have cost £300.

Table 1. Comparative Costs of Conferences in Person & Via Video at GPT.

Liverpool-Poole

Manager travelling from Kiverpool to Poole for 2 hour meeting

Face-to-face		**Video conferencing**	
Travel (British Rail)	£ 112	2 hours	£ 400
Time	£ 322		
Lost productivity	£ 364		
Total	£ 798	Total	£ 400

Assuming

1. 1st Class British Rail return fare
2. Time is costed at a salary of £30,000 p.a. plus 50% to reflect staff costs
3. Cost of lost productivity based on average sales per employee of £26 per hour

Beeston-Kirkcaldy

Three engineers travelling from Beeston to Kircaldy for a 4 hour meeting

Face-to-face		**Video conferencing**	
Travel (3 sharing a company car)	£ 49	4 hours	£ 800
Time	£ 351		
Lost productivity	£ 780		
Total	£ 1,180	Total	£ 800

Assuming

1. A 2 litre company car is used at the typical mileage rate of 0.23p per mile
2. Time is costed at a salary of £15,000 p.a. plus 50% to reflect staff costs
3. Cost of lost productivity based on average sales per employee of £26 per hour

What these calculations shows, & which are supported by recent work completed in Switzerland (Maggi & Walo, 1991), is that a number of factors determine the exact cut-off point where videoconferencing because a real alternative in simple financial cost terms to personal travel. The key determinants include such things as length of meetings, numbers involved, problems of guaranteed attendance, distance between relevant locations, mode of transport available, productivity of the labour involved, form of videoconferencing employed, the availability of equipment at specified times, etc. Working out actual alternative costs of travel as opposed to videoconferencing in a broad sense is extremely complicated with this type of multidimensional cost structure.

At the more macro level, one can look at the cross elasticities of demand between transport & telecommunications by applying various econometric models of consumption to national times series data. Work of this kind is scant because of data limitations & problems of model specification. Salvanathan (1991) has attempted such an approach for the UK using the so-called Rotterdam modelling framework & employing times series data for the period 1960 to 1986. The work, however, is aggregate & simply separates expenditures on private transport, public transport & communications. There is no

distinction by type of travel or means of communication. Further, the analysis is done in terms of expenditures rather than use which provides only a crude guide to physical substitution. Equally, there were major changes during the study period in the nature of the activities considered - communications in particular can hardly be considered a homogeneous product over this period of technical development. The results of this work are summarised in Table 2. They show that the demand for communications over the period was highly inelastic (-0.12). There is some indication of substitution of communications for private & public transport as the price of the former rises, however, there is only a low cross-elasticity between both communications costs & private transport (0.08) & communications costs & public transport (0.03)[10].

Table 2. Macro Estimates of Elasticities for the UK

Mode (i)	hi1	hi2	hi3
Private Transport (1)	-0.53	0.07	0.08
Public Transport (2)	0.19	-0.41	0.03
Communications (3)	0.57	0.09	-0.12

Of course, it would be inappropriate to directly apply these elasticities to videoconferencing, especially when looking at price falls of over 80% which many in the industry are suggesting as possible in the near future. However, in absolute terms, if this elasticity were applied to, say, a fall of 80% in the costs of communications then private transport use would obviously fall by 10%. Looked at another way, in Great Britain the number of trips made as part of work travel would have fallen in 1985/6 by 0.044 per person per week[11] which aggregates to some 114.4 million work trips per annum - given the nature of the substitution effect & the greater incentive to switch to communications mode when longer distance interactions are involved, the actual impact on mileage travelled would inevitably have been larger.

Developments in Supply & Demand

Although videoconferencing has been technically possible for many years, a number of recent developments indicate that significant technical advances are likely to make it a more attractive proposition to potential users. Standardisation is likely to both bring down the hardware costs of videoconferencing as well as opening up many more opportunities for inter-organisational video meetings. There is always a trade-off when setting standards between an early introduction of a standard, to assist in bringing a focus to development & design, lower production costs & simplify communications, & a later introduction of a 'better' standard, once more of the technical developments have taken place. The developments at present, while there is clearly potential for improved technology, is to seek standards which will assist in the up-take of videoconferencing on a larger scale. The International Telegraph & Telephone Consultative Committee has recently introduced a new standard & manufacturers are already moving to implementing P*64 hard & software in their video codecs. There is also discussion of a new standard for multiway video which seems likely to be accepted in the near future. Such standardisation offers both potential for improved quality of picture at any bandwidth as technical developments can be pursued within known parameters & also a wider range of product qualities as equipment at different bandwidths are tailored to meet specific requirements.

In the past complexity kept the price of videoconferencing units high but economies of large scale production are rapidly bringing these down. There are two main elements of equipment cost which need to be considered with respect to videoconferencing. First, there are studio costs. Mobility is a relative thing & some current 'mobile units' are in fact far from easy to transport about buildings but they may be used in virtually any type of

room. In particular, this means that dedicated studios are no longer required for most forms of conferencing. The new generation of codex are now much smaller than previously & some of the new configurations of equipment take up little more floor space than a desk. The reduced need for studio facilities is also likely to lead to lower labour costs in operating a videoconferencing system within an organisation.

Second there are equipment costs *per se*. These are forecast to fall very dramatically over the next few years. There are suggestions from those involved in the industry that while portable units in the USA now cost in the £30-80,000 range (while full dedicated studios can cost $200,000 although this, in real terms, is about 80% lower than in 1981) this may fall to under £5,000 by the mid-1990s (Brown, 1990)[12]. This is foreseen mainly because of economies of scale in production which will accompany higher sales as international agreements on standards for interactive video compression are reached & product uniformity increases.

Line costs are the main elements of costs associated with videoconferencing - at present codex costs amount to only about 25% of the lifetime costs of a video conference network (Calwell, 1990). They are, however, falling dramatically. At the international level, renting time on satellites in the US has dropped from about $8,000 per hour in 1981 to about $300 today. The investment now taking place in fibre optics & the increased capacity of satellite systems is likely to bring these costs down further. Within Europe, costs tend to be much higher than in the USA & in most countries there is central controlled by the national PTT. Increased competition & the liberalisation process which has gradually changed pricing structures in other sectors of the European economy are likely to be influential in changing this situation over the next decade.

One option where a company does not have its own videoconferencing units is to hire & here costs have already begun to fall considerably in competitive markets such as the USA. Conference Express charged in early 1991 between $750 & $900 for a one hour meeting between two US cities, $1900 per hour between New York & Paris, $2500 per hour between New York & London & $3300 per hour between New York & the Far East. On average these charges represent a 60% reduction for domestic videoconferences & a 75% reduction for international videoconferences since the mid-1980s.

Transport Impacts

To gain some insights into the relevant cross-over points highlighted by Maggi, a survey of some 32 UK companies was conducted to examine the motivations behind their use or non-use of videoconferencing & the factors likely to lead to its greater substitution for personal work trips. Some comments are necessary on the survey. The objective was to try & gather information from both current users of videoconferencing facilities & from those who do not use such facilities. The latter being seen as being of particular relevance if forecasts of future use are to be obtained. The problem when surveying non-users is to find someone within the organisation capable of responding to the questions being asked. Hence, only 9 non-users were in a position to offering assistance in the survey exercise. The survey was based upon a selection of large companies & organisations where some prior knowledge of use was available (e.g. from equipment suppliers, the literature, etc.). In that sense it was not random & may not be entirely representative. The objective was to try & gain an impression from users of the importance of factors such as cost rather than a strictly statistically unbiased set of data.

A structured questionnaire was used to gather information about the current use made of videoconferencing & the facilities available & to gain some idea of the limitations & problems which exist. Additionally, hypothetical questions regarding various possible changes in the cost of use & in the quality of the technology were posed. The survey was mainly conducted by telephone, but some firms were visited to obtain more details & to generally discuss views on future developments. While part of the survey falls into what is now known as a 'stated preference study' there was no effort to be over sophisticated in the method of questioning.

With regard to use, the 23 organisations in the survey using the facility provided the responses in Table 3. Of particular relevance from the perspective for long term changes in the forms of work interactions are the high scores for it representing a substitute for work travel within the UK & for communication with other companies (which may well indicate reduced trip making on the part of these companies). It is a limited substitute for international travel. Both users & non-users of videoconferencing were asked about factors which would in the future lead to greater use (or in the case of non-users, the take-up) of the facility. Table 4 provides a breakdown of the responses.

Table 3. Uses Made of Videoconferencing

	Used	Used alot
In house training/education	1	2
External education	4	5
In place of international travel	1	3
In place of travel within UK	2	14
Internal communication	5	9
Comunication with other companies	8	9
Setting up video conferences for others	7	1
Other purposes*	4	4

* Use in design and development and for demonstrations were both mentioned twice

Those already using videoconferencing are clearly most sensitive to the costs of use. One would anticipate, therefore, that any significant decrease in these costs would lead to a substantial increase in the use made of it by these organisations. Of course, this additional use may involve both new interactions & changes in the away existing interactions are conducted (i.e. a transfer from physical movements). Since the table also indicates a considerable sensitivity to the costs of alternatives (i.e. the costs of making physical contacts) one may judge that the diversion effects away from personal movements would be of quantitative significance. This can also be tied back to the importance of substitution found in Table 3. Additionally, we find, that the development pattern of the organisations concerned & the image quality provided are also going to be significant factors influencing the increased use of videoconferencing in this group.

Table 4 Factors Likely to Influence the Future Use of Videoconferencing

Currently Not Using Video Conferencing

	Not important	Important	Very important
Better quality images	4	4	1
Easier hiring of equipment	3	2	4
Transport costs	6	0	3
Costs of video conferencing	3	2	4
Increased travel within company	4	3	2

Current Users of Video Conferencing

	Not important	Important	Very important
Better quality images	8	8	7
Easier hiring of equipment	16	5	2
Transport costs	7	4	12
Costs of video conferencing	5	2	16
Increased travel within company	8	6	9

With respect to non-users, the cost factor is clearly important but equally so is access, in terms of easier hiring (not a problem perceived by exiting users), & the quality of the facilities. There exists a lack of confidence within this group as to the technical & service quality being offered at present. More detailed questions were asked of current users of videoconferencing as to the sensitivity of their organisations to possible future changes in costs[13] - see Table 5. In order to get as close as possible to the pure cost effects, those answering were told to assume that the quality of the facilities offered would be such as to meet their requirements, that standardisation would be achieved, that units would be mobile & that there would be a fairly well established network of users for inter-organisational conferencing. For simplicity, no effort was made to indicate exactly what form the cost saving would take (e.g. in terms of line costs). What emerges is that, while small changes in telecommunication costs are unlikely to result in a major up-take of videoconferencing, as the size of possible cost savings increase, though, so the additional possible take-up expands very markedly.

Tentative questions regarding the up-take of videoconferencing were also posed to the current non-users in the sample. Here the response was less dramatic with even quite significant reductions of 70% in the costs of use suggesting that many organisations, although possibly making use of the technology would only do so to a fairly limited degree. Verbal comments, however, indicate that this implied low elasticity may stem as much from concern over the ability of new systems to overcome earlier technical deficiencies of equipment as from a genuine lack of responsiveness to costs reductions. Further, information on whether this use will be a net increase in interactions or whether some of the additional use would come from reduced travel is not directly obtainable.

Table 5. Sensitivity of Video Conference Users to Cost Reductions

% Fall in Costs	0	10-20%	30-50%	50-70%	>70%
10%	10	8	2	-	-
40-50%	2	-	12	3	3
90%	1	1	2	3	13

In summary, the survey results do provide the basis for making some assumptions regarding the likely uptake of videoconferencing. First, a small cost reduction will have very little effect but a large one (of 50% or more) is likely to important. Second, technical considerations are not unimportant in the decision whether to use videoconferencing or not. Third, transport costs are important in the decision to videoconference.

CONCLUSIONS

This study has sought to examine the transport impacts of a fall in the costs of videoconferencing. What we find is that there is considerable potential for telecommunications costs to fall in the near future & with them the costs of videoconferencing. The quality & user-friendliness of equipment is also likely to improve. Evidence from users & non-users in the UK suggest that a combination of such changes combined with increasing costs & frustration with the transport network could lead to a greater use of videoconferencing. The actual overall impact is almost impossible to quantify, however, without significantly larger surveys & more intensive question of potential users.

Endnotes

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1 Sviden (1983), for example, argues that more use of telecommunications may result in a substitution from transport, an enhancement in the use of transport or a synergy effect with more of both transport and telecommunications. See also Cheese and Segal (1992).
2 An oft cited figure is that of the European Conference of Ministers of Transport (1983) that technically 13% to 23% of work trips could be substituted by telecommunications, such calculations, however, ignore the reluctance of employees & employers to make the transfer with existing costs structures & technologies.
3 The survey was conducted by D. J Bush Associates & reported in Lehrman (1991).
4 I.e., 'In the firms where videoconferencing was used, some substitution of business travel was found, but it also substituted to a limited degree for telephone & written communications, as well as forming its own kind of communications event. These findings support a view that telecommunication medium cannot be regarded as another form of transport mode, & that relationships between the two cannot be expressed in the form of a simple trade-off model' (Bennison, 1988).
5 For example, a survey of 75 managers of UK companies conducted by the Kristal Corporation in 1991 found that 91% felt that business travel now disrupts work routine & increases stress as well as interfering with family life. The problems of travel caused 21% to lose their temper; 20% to perform badly; 16% to have disturbed sleep & 13% to take solace in alcohol.
6 'The 'telecommunications gap' reflects....the increase in the use of telecommunication services caused by physical constraints of persons who have a potentially exponential growth curve for human interaction. (Nijkamp & Salomon, 1989).
7 Here we take the simple analysis where it is assumed that both parties to the communication have identical costs. Maggi develops & generalises to embrace asymmetries in costs. A survey of the literature on barriers to communication is contained in Button and Rossera (1990).
8 The types of problems involved have been known for some time, e.g. 'The difficulty with pricing teleconferencing is that it is almost impossible to generalise. there are main elements, each subject to a wide range of cost. With video links, the price depends crucially on what circuits happen to be available at the sites chosen. When using a satellite video link, it is often the 'short-haul' links (those from user to uplink & downlink to user) which are the most expensive. Even within a given city, the cost will vary according to the exact site chosen. The number of locations involved, the time of day, the type of equipment & the type of presentation are all additional variables' (Fisher & Feeney, 1985).
9 While the calculations set down here may be seen as relevant for the company concerned, they differ from the civil service data in that lost production is included. Strict economic criteria would not include lost production since it effectively involves the introduction of double counting. The salary paid to an employee at the margin represents his/her productive worth & hence the salary component is also the lost output component. Ignoring this element produces results very much in line with those for civil servants.
10 Similar aggregate work in the Netherlands (Netherlands Organisation for Applied Scientific Research, 1989) also yields low elasticities and suggests that adoption of telecommunications over the next 35 years will reduce traffic by 8% although it could flatten peak demand considerably.
11 Calculations based upon information on data from the National Travel Survey 1985/86.
12 In the UK, BT will be ready to market individual desktop videos at £5000 per unit by 1993.
13 Very broad bands of costs & take-up rates are employed on the premise that most organisations base their decision making on marginal changes & have problems handling inter marginal effects except in very general terms.

References

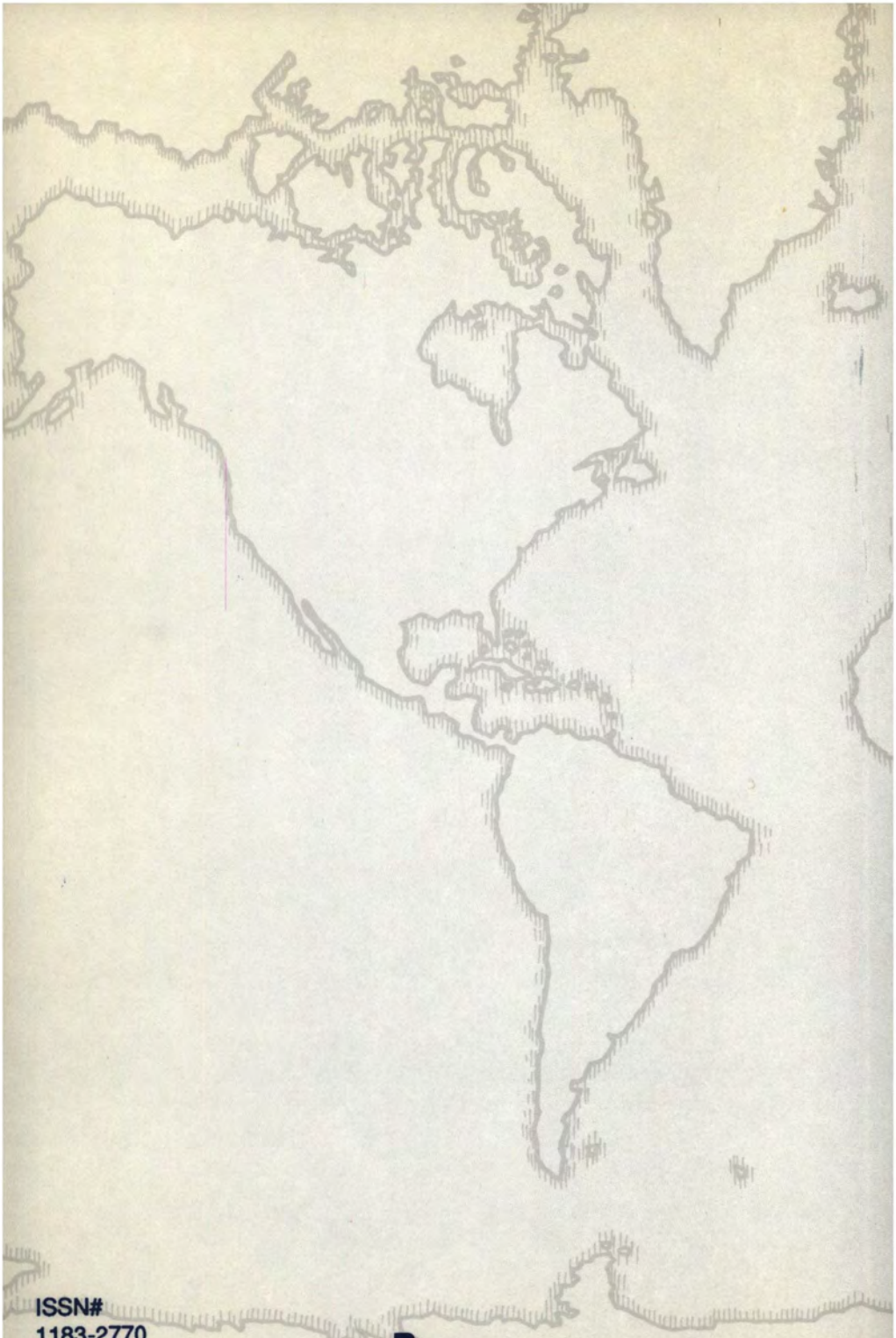
Bennison, D.J. (1988), Transport/telecommunication Interactions. Empirical Evidence from a Video-conferencing Field Trial in the United Kingdom, *Transportation Research*, 22A, 291-300.

Boghani, A.B., Kimble, E.W. & Spencer, E.E. (1991), *Can Telecommunications Help Solve America's Transportation Problems?*, Cambridge Mass: Arthur D. Little.

Brown, C. (1990), Videoconferencing Costs Expected to Hit an All-time Low, *Data Communications International*, 19, 62-64.

Button, K.J. (1991), Transport & Communications, in Rickard, J.H. & Larkinson, J. (eds) *Long Term Issues in Transport*, Aldershot: Avebury.

Button, K.J. & Rossera, F. (1990), Barriers to Communication: A Literature Survey, *Annals of Regional Science*, 24, 337-57.
Caldwell, R.H. (1990), N * N Switched Videoconferencing, *Satellite Communications*, 14, 24-26.
Cheese, J and Segal, N. (1992), *Transport and Communications: The CEST Project*, London: Centre for Exploitation of Science and Technology.
Douglas, S.M. (1989), Sharper Focus is Trained Today on Image Communications, *Communications News*, February, 25-26
European Conference of Ministers of Transport (1983), *Transport & Telecommunications* Paris: ECMT.
Fisher, T. & Feeney, M. (1985), *Teleconferencing* Oxford: Elsevier International Bulletins.
Goddard, J.B. & Morris, D. (1976), The Communications Factor in Office Decentralization, *Progress in Planning*, 6, 1-80.
Johansen, R. (1984), *Teleconferencing & Beyond: Communications in the Office of the Future*, New York: McGraw-Hill.
Johansen, R. & Bullen, C. (1984), Thinking Ahead: What to Expect from Teleconfernc-ing, *Harvard Business Review*, March-April, 164-74.
Lehrman, C.K. (1991), Videoconferencing Comes Down to Earth, *Public Relations Journal*,45, 23-7.
Maggi, R. (1989), Towards an Economic Theory of Barriers to Communication, *Papers of the Regional Science Association*, 66, 131-41.
Maggi, R. & Walo, A. (1991), Videoconferences - Fact & Fiction, mimeo, Universiy of Zurich.
Mokhtarian, P.L. (1988), An Empirical Evaluation of the Travel Impacts of Teleconfer-encing, *Transportation Research*, 22A, 283-9.
Moore, A, & Jovanis, P.P. (1988), Modelling Media Choices in Business Organizations: Implications for Analysing Telecommunications - Transportation Interactions, *Transportation Research*, 22A, 257-273.
Netherlands Organisation for Applied Scientific Research (1989), *De Invloed van Telecommunicatie op Vervoer; Gevolgen voor Energie en Millieu*, Appledoorn: TNO.
Nijkamp, P. & Salomon, I. (1989), Future Spatial Impacts of Telecommunication, *Transportation Planning & Technology*, 13, 275-97
Pye, R. (1976), Effects of Telecommunications on the Location of Office Employment, *Omega*, 4, 289-300.
Rink, D.R. & Swan, J.E. (1979), Product Life Cycle Research: A Literature Review, *Journal of Business Research*, 7, 219-42.
Salomon, I. (1986), Telecommunications & Travel Relationships: Substitution or Modi-fied Mobility, *Transportation Research*, 20A, 223-38.
Salvanathan, E.A. (1991), The Demand for Transport & Communications: Applications with Rotterdam & Almost Ideal Demand Systems, paper present to the Nineteenth Conference of Economists (Australia), University of New South Wales.
Sviden, O. (1983), Automobile Usage in the Future Information Society. Research Re-port No. 25. The Future of the Automobile Program. Institute of Technology, De-partment of Management and Economics, Linkoping University, Sweden.
UK Department of Transport (1989), *COBA 9 Manual*, London: Department of Trans-port.



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