CANADIAN TRANSPORTATION RESEARCH FORUM

LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

PROCEEDINGS OF
18th ANNUAL MEETING
CANADIAN TRANSPORTATION RESEARCH FORUM

June 1983

Regina, Saskatchewan



P R O C E E D I N G S

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A WORD FROM THE PRESIDENT



Our conference this year concentrates on transportation needs to 2000, with excellent papers addressing issues of physical capacity, operations, regulation and finance, for all modes of transportation. The gamut runs from massive increases in-bulk transportation capacity to applications of high technology and risk analysis.

In keeping with the objectives of CTRF, the sessions are structured to allow and encourage comments from the floor as well as the speakers. The free interchange of ideas at conferences such as this provides a vital means of stimulating and helping structure today's research so that tomorrow's transportation will continue to meet Canada's growing needs.

With best wishes for an instructive and enjoyable conference.

Neal A. Irwin
President
Canadian Transportation Research Forum.

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OVERVIEW

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ROAD TRANSPORTATION REQUIREMENTS TO THE YEAR 2000

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Deputy Minister

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Assistant Director of Planning

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ABSTRACT

This paper presents an overview of the present and future role of the road mode in Canada with emphasis on the provincial highway system. It briefly describes the trends in road transportation demand and supply; looks at future demand and in general terms identifies the infrastructure and provincial financial requirements to the year 2000.

The private car will keep its dominant role in passenger travel which is expected to grow at 2% per year. The infrastructure will require capacity expansion on primary highways, upgrading of surfacing standards on secondary highways and timely rehabilitation and maintenance. These improvements will require estimated provincial expenditure of $6.3 billion per year (in 1982 dollars) compared to the current expenditure of $5.2 billion per year. To make best use of available funds, highway managers will have to use measures such as attempting to reduce demand, 'staging' capacity and strength improvements, making more efficient use of existing infrastructure and improving public awareness of infrastructure costs.

PURPOSE AND SCOPE OF THE PAPER

The road is the most pervasive of all transport modes in Canada. More than 80% of passenger travel occurs on roads and streets. Most of what we eat or wear moves by truck. Automobile-related industries directly or indirectly account for one job in six in Ontario and one job in seven throughout Canada. The average family spends 11% of its budget on the family car (and only 2% on other means of transportation).

Road vehicles consume nearly 80% of the energy consumed by all transportation, cause nearly 90% of all transportation deaths and account for 60% of urban air pollution.

Roads thus have critical importance in our nation's economy and lifestyle. If we are to avoid the experience of the state of disrepair of the U.S. highway system due to lack of timely investment and the resulting damage to the economy, it is important that the state of Canada's road system be seriously monitored and appropriate measures taken.

The purpose of this paper is to present an overview of the role of the road mode in Canada with emphasis on the provincial highway system. The paper briefly describes the trends in road transportation demand and supply; it looks at future demand and in general terms identifies the infrastructure and financial requirements. Some alternatives to infrastructure expansion are also briefly outlined.

Forecasting the future of roads in Canada is particularly difficult because of lack or inadequacy of data. Since almost all roads are a provincial or municipal

responsibility in Canada, no national data bank of road statistics exists. Major deficiencies, inconsistencies and lack of uniformity exist in our knowledge of road transport demand and supply. The overview presented in this paper is not based on any fresh analyses of the available limited data but relies on previous studies and analyses conducted by Transport Canada supplemented, where possible, by Statistics Canada data and information obtained from various provincial departments of transportation.

PAST TRENDS IN DEMAND AND SUPPLY OF ROAD TRANSPORTATION

Trends in Demand

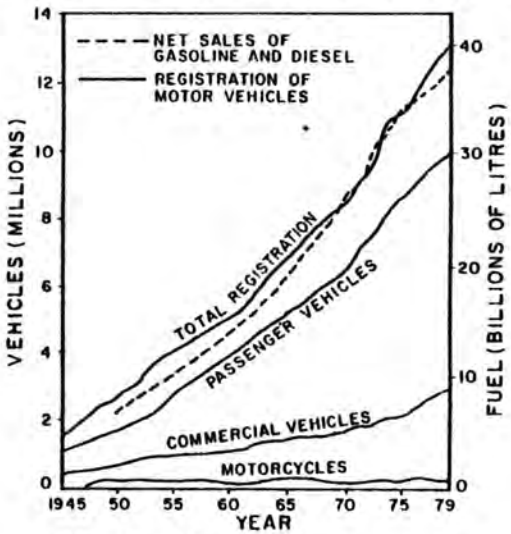
Passenger Travel Trends. Canadians are the most mobile nation in the world next to the Americans. Our propensity to own and use cars, and the characteristics of this use, have created demand for an extensive system of urban and rural roads totalling almost 1 000 000 km. Over the past three decades, personal disposable incomes have risen faster and the cost of owning and operating vehicles slower than general inflation--this being generally true even for the overall period since the 1973 oil price crisis(3).

Therefore the trends in car ownership, travel and fuel consumption shown in Figure 1 and Table 1 come as no surprise. The car is by far the dominant means of passenger transportation, accounting for 82% of the passenger-kilometres. For intercity and rural trips, the car's share is over 90% and in large urban areas about 75%.

Car travel increased at an average annual rate of 4.5% during the 1970s in the country as a whole (see Table 1). Since transportation demand can have uniquely local

FIGURE I

MOTOR VEHICLE REGISTRATION AND MOTIVE FUEL CONSUMPTION 1945-1979



SOURCE: Ref. 3

TABLE 1: ESTIMATED PASSENGER-KILOMETRES IN CANADA BY MODE FOR 1969 and 1979

	1969 Billions	%	1979 Billions	%	1969-79 Annual Average Increase (Decrease)	%
Automobile	160	87	250	82	4.6	
Bus and Urban Transit	5.5	3	6.3	2	1.0	
Rail	3.5	2	3.2	1	(1.0)	
Air	14.0	8	45.5	15	12.5	
Total	183	100	305	100	5.2	

Source: Based on Ref. 2.

characteristics, the growth rates for various provinces, and parts of provinces, varied widely from the national average. Reflecting the economic recession, most provinces experienced a temporary decline in travel of between 1 to 4% in 1981 or 1982.

The distribution of traffic volumes, which is an indication of demand for roads, over the entire 1 000 000 km road and street system is not available. Table 2 shows the estimated 1970 and 1980 traffic volume distribution on 61 500 km of the 'Canadian Highway System' (6.4% of the total length of roads and streets in Canada) as defined in the next section.

The total length of the system has not increased significantly, therefore the movement to the higher volume classification means that the increase in travel is being accommodated on the existing network. Greater capacity may be needed to accommodate increasing traffic volumes, particularly in and around major areas.

TABLE 2: THE "CANADIAN HIGHWAY SYSTEM": ESTIMATED LENGTH BY TRAFFIC VOLUME - 1970 and 1980

AADT (Vehicles per Day)	1970 %	1980 km	1980 %
less than 500	30.9	14,770	24.0
500 - 2,000	41.8	20,320	33.0
2,001 - 5,000	21.8	16,900	27.5
5001 - 15,000	4.7	6,910	11.2
15,001 - 40,000	0.7	2,430	4.0
40,000 +	0.2	190	0.3
Total	100.0	61,520	100.0

Source: Ref. 3

Traffic volume distribution on highways and roads not included in Table 2 will be different in each province, but we can assume that these roads have relatively low traffic volumes. However, the public expects a maximum of convenience, comfort and safety even on low volume roads.

Freight Movement Trends. After experiencing significant growth in market share between 1960 and 1970, the for-hire truck mode experienced an overall decrease in the number of tonne-kilometres and a significant loss of market share to the rail and pipeline modes (see Table 3).

This is a reflection mainly of the increase in both the quantities and lengths of haul of bulk commodities (such as iron ore, coal, forest products, potash and grain) that move by rail. However, the average revenue per tonne-kilometre for trucking is four to five times that for rail (due to shorter hauls, smaller shipments and preponderence of general cargo). Thus, for-hire trucks accounted for 47% of the total operating revenues of Canadian freight carriers (excluding pipelines) compared to 38% for rail(2).

Figure 2 shows that a vast majority (88%) of the tonnage is carried internally in each of the five economic regions of the country. The figure also indicates the dominant role (56% of tonnage) of Ontario and Quebec in trucking activity.

Trucks normally constitute less than 20% of total highway traffic. Also, truck traffic is much less peaked than car traffic. Therefore, trucks are not normally a major consumer of highway capacity.

On the other hand, the number of axle-weights of

TABLE 3: FREIGHT TONNE-KILOMETRES IN CANADA BY MODE FOR 1970 and 1979

	1970		1979		1970-79 Annual Average Increase (Decrease)	
	Billions	%	Billions	%		%
For-Hire Truck	52.3	11.5	42.4	6.9	(2.4)	
Rail	160.6	35.3	233.8	38.1	4.3	
Water	115.1	25.3	157.0	25.6	3.5	
Pipeline	126.9	27.9	179.5	29.2	3.9	
Air	N/A	N/A	0.9	0.1	N/A	
Total	454.9	100.0	613.6	100.0	3.4	

Source: Ref. 3.

trucks determine the pavement thickness required. Overweight trucks are a major cause of pavement deterioration.

Trends in the Supply of Road Infrastructure

System Size. In terms of jurisdiction of the road mode, the provincial governments provide infrastructure and regulate the road motor vehicle transport. Municipal governments play a similar role although the infrastructure supply is much more pronounced. The federal government regulates vehicle energy efficiency, safety and exhaust emission standards and can be considered to be responsible for infrastructure supply in national parks, Indian Reserves and the Yukon and Northwest Territories.

To fulfill the rising demand for road infrastructure, the length of roads and streets in Canada increased from 600 000 km in 1945 to 960 000 km in 1980 (See Figure 3). More importantly, over the same time period the length of

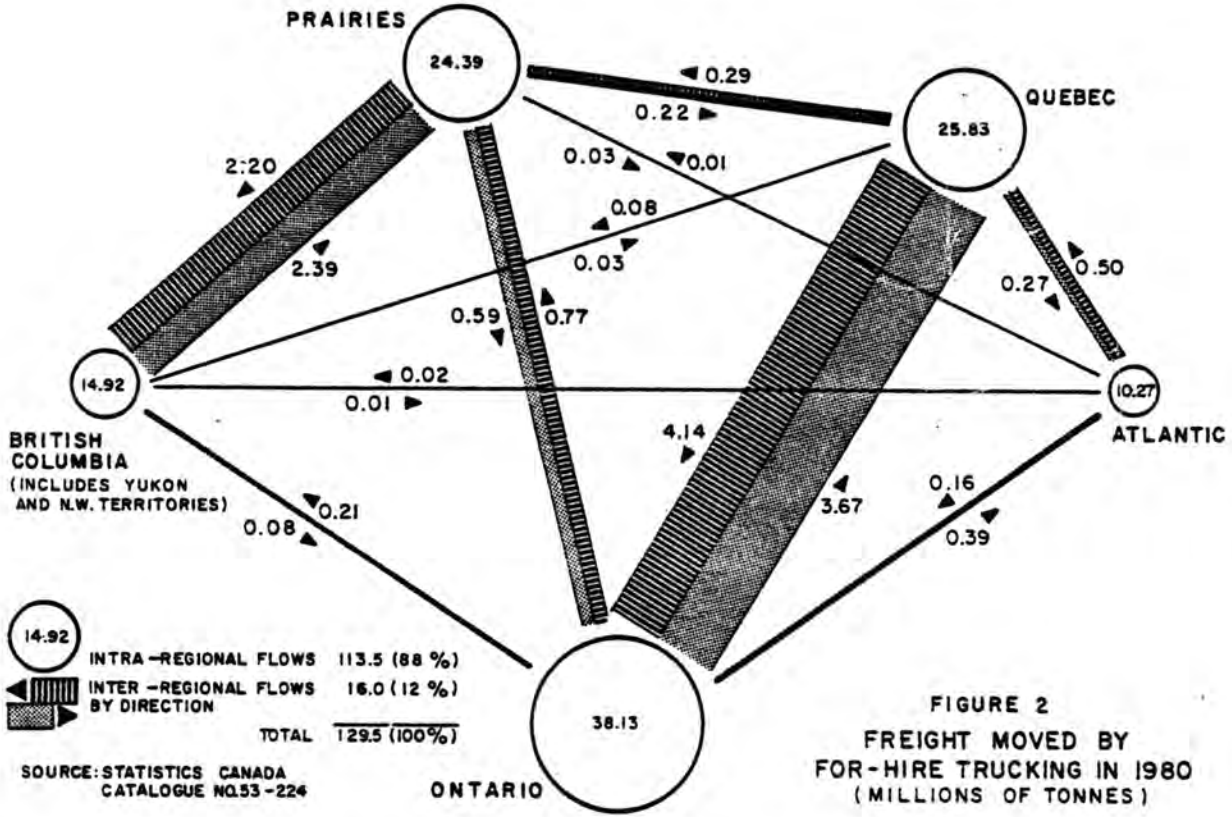
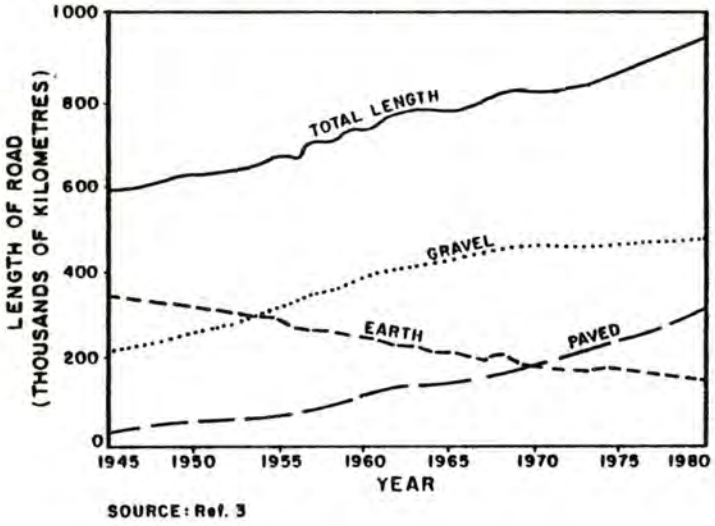


FIGURE 2
FREIGHT MOVED BY FOR-HIRE TRUCKING IN 1980
(MILLIONS OF TONNES)

FIGURE 3
LENGTH OF PUBLIC ROADS AND STREETS 1945-1980



SOURCE: Ref. 3

paved roads increased ten-fold from 30 000 km to 300 000; two-thirds of this increase occurred since 1960. These figures suggest that the Canadian road system is relatively mature in terms of length and, except for roads to resources, the current and likely future demand is generally not for system extension but for wider, safer, stronger and more comfortable paved roads.

Table 4 shows the jurisdictional road lengths (provincial, urban or rural municipal and federal) in each province and territory. Overall, 33% of roads are provincial, 11% urban municipal, 54% rural municipal and 2% fderal. (Of the 300 000 km of paved roads, an estimated 180 000 km (60%) are provincial and the remainder municipal). However, the jurisdictional split and financial responsibili-

TABLE 4: ESTIMATED PUBLIC ROAD LENGTHS AND ADMINISTRATIVE JURISDICTIONS IN 1981

Jurisdiction / Province	Provincial Government[1]		Urban Municipalities		Rural Municipalities		Federal Government		Total	
	km	%	km	%	km	%	km	%	km	%
British Columbia	45,800	68.9	8,800	13.2	9,200	13.8	2,700	4.1	66,500	100
Alberta	27,500	16.3	14,500	8.6	123,000	72.8	3,900	2.3	168,900	100
Saskatchewan	23,000	11.1	8,000	3.9	174,000	84.0	2,200	1.0	207,200	100
Manitoba	21,400	23.3	5,700	6.2	64,000	69.5	900	1.0	92,000	100
Ontario	32,900	18.9	34,700	19.9	105,000	60.2	1,700	1.0	174,300	100
Quebec	104,700	61.5	20,000[2]	11.8	45,000[2]	26.4	500	0.3	170,200	100
New Brunswick	25,200	84.3	4,400	14.7	-	-	300	1.0	29,900	100
Nova Scotia	26,100	91.6	2,100	7.4	-	-	300	1.0	28,500	100
Prince Edward Island	5,000	87.7	600	10.5	-	-	100	1.8	5,700	100
Newfoundland	10,900	75.2	3,300	22.8	-	-	300	2.0	14,500	100
Yukon	-	-	-	-	-	-	4,300	100	4,300	100
Northwest Territories	-	-	-	-	-	-	2,900	100	2,900	100
Total	322,500	33.4	102,100	10.6	520,200	53.9	20,100	2.1	964,900	100

1) Roads administered by provincial departments or agencies
2) Rough estimate from Ref. 3

Source: Ref. 3, 7

ties vary from province to province. For example, the Atlantic Provinces are responsible for all roads in their boundaries except those in certain urban areas. On the other extreme, in Ontario and the Prairie Provinces the provincial governments are responsible for only a tenth to a fourth of the roads. All provinces provide some degree of assistance for municipal roads. (For details see Ref. 3)

In addition to having different institutional and financial responsibilities, the provinces use differing road classifications. Therefore it is difficult to designate a 'national' highway system. A recent Transport Canada Study (3) defined 61 500 km (6.4% of the public roadways in Canada), as the "Canadian Highway System" linking major population centres, resource areas, defence establishments and recreational 'nodes'. The study defined 25 500 km as primary highways, (shown in Figure 5), 23 500 km as secondary and 12 500 km as access highways. These definitions would not necessarily agree with those of individual provinces. Estimated lengths by standard are: 5 700 km four-lane paved, 46 100 km two-lane paved, 8 900 km gravel and 800 km seasonal. Traffic volumes in 1970 and 1980 are shown in Table. 2

Infrastructure Expenditure Trends. Transportation costs are incurred by the agencies that provide, maintain and administer the infrastructure and by the owners of the vehicles using it. Table 5 shows the infrastructure and 'vehicle' costs for air, marine, road and rail modes in Canada in 1979. Also shown are the revenues earned by all government levels from air, marine and road related fuel

taxes (if levied), registration fees, etc.

Some interesting conclusions can be drawn from Table 5:

(a) The road mode accounts for 77% of the total cost of transportation in Canada.

(b) Out of the total road mode costs of $44.7 billion, nearly 87% are incurred in vehicle costs and only 13% in infrastructure costs. Thus, improvements in capacity, geometrics, rideability and strength that may proportionately reduce the vehicle costs would obviously be beneficial from a total societal viewpoint.

(c) Road related revenues covered 54% of infrastructure costs which was a greater proportion than for air (46%) or marine (28%). The remainder was financed from provincial or municipal government general taxation.

In 1979 the total road infrastructure costs were borne: 63% by provinces, 31% by municipalities and 6% by the federal government. The provinces are thus by far the major providers of road infrastructure.

As shown in Figure 4, while provincial expenditure on transportation increased steadily in absolute terms, the transportation proportion of total provincial expenditures decreased from an average of almost 30% in 1955 to 7% in 1979 (there were large variances from province to province). This is mainly a reflection of other expenditures taking priority over transportation and partly of a maturing highway system. In 1955 transportation was the single largest

TABLE 5: TRANSPORTATION INFRASTRUCTURE COSTS AND REVENUES AND VEHICLE COSTS FOR VARIOUS MODES IN CANADA IN 1979 (Using Book value) (Millions of Dollars)

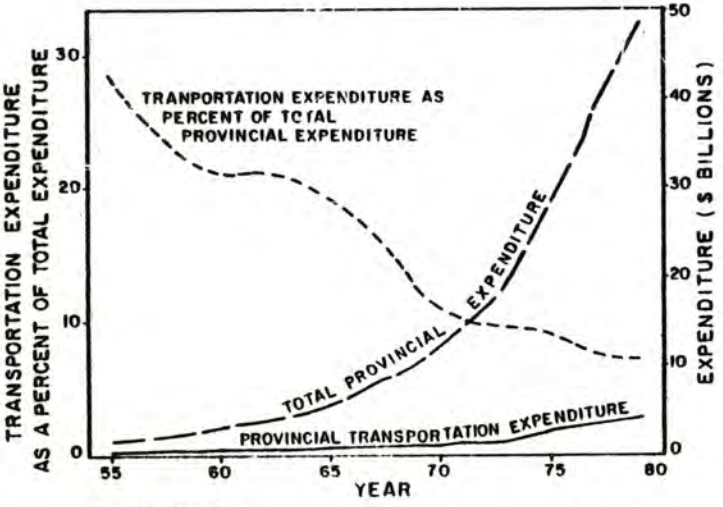
Mode	Infra-structure Costs	Vehicle Costs	Total Modal Costs	Modal Costs as a Percent of Total Transport Costs (%)	Gross* Govern-ment Revenue	Gross Revenues/ Infra-structure Cost Ratio (%)
Air	819	3,241	4,060	7	378	46
Marine	901	3,476	4,377	8	251	28
Road	6,034	38,667	44,701	77	3,237	54
Rail	1,308	3,913	4,769	8	N/A	N/A
Total	9,062	48,577	57,907	100	N/A	N/A

* Gross revenue denotes revenue earned by any level of government from a given mode even though the expenditure may be incurred by another level of government.

Source: Based on Ref. 17

FIGURE 4

PROVINCIAL GOVERNMENT TRANSPORTATION EXPENDITURES



SOURCE: Ref. 3

item in provincial budgets. By 1961 the cost of education had overtaken transportation; health accomplished that in 1965 and social welfare programs in 1971 (3).

During the 1970s, highway construction costs in Canada increased much faster than capital expenditures. Most provincial highway agencies have experienced a significant reduction in actual capital work and have had to allocate an increasing proportion of the total budget to maintenance, a trend likely to continue. Even with that, maintenance costs have shown a slight decrease in real terms (1).

FUTURE DEMAND AND SUPPLY

Demand Forecast

Transport Canada's recent macro-economic forecasts, as reported by Mayes and Welch (7), indicate that the overall outlook for the Canadian economy to the year 2000 is fairly good. After a gradual recovery in 1983 and 1984, the growth will be strong from 1985 to 1990 and moderate from 1990 to 2000. The personal disposable income per capita is forecast to increase 2.5% per year between 1985 and 1990 and 2.1% per year between 1990 and 2000. The price of oil will show a slight decline in real terms to 1990 after which it will start increasing.

These factors and expected improvement in vehicular fuel economy will mean the rate of increase in vehicle operating costs would not be much higher than general inflation rate to 1990 and perhaps even to 2000.

The population of car drivers and first-time car owners is expanding. This, coupled with the high growth rate of household formation (mostly in urban areas) and

small family size will result in the growth of car ownership of about 2% per year to 1990 (6).

Thus, to the year 2000, intercity rural and urban passenger travel will still be dominated by the automobile.

Based on somewhat different macro-economic assumptions, Transport Canada in early 1982 had forecast an annual average growth of 2.1% in car-person trips and 2.3% in bus-person trips between 1980 and 1991 in Canada as a whole, with wide variation among regions (15). Passenger travel in the Prairies was forecast to grow 4.1% per year to 1991 compared to 2.2% per year in Quebec.

For-hire truck traffic was forecast to increase at an average annual rate of 2.4% for Canada, 1.7% for Ontario and Quebec and 3.7% for the rest of the country.

In view of the 1981 and 1982 decline in travel, these forecasts appear high. However, most of the provincial transportation officials believe this decline to be temporary and that travel will resume growth as the economy recovers. The forecast rate of increase of just over 2% per year seems plausible compared to 4.5% during the 1970s.

Between 1990 and 2000 freight traffic will grow perhaps less rapidly. However, passenger traffic should remain quite strong in view of the continued moderate growth in real disposable income and the demographic characteristics mentioned above.

Future Infrastructure Requirements

The major future requirements for provincial road infrastructure can be categorized as: a) expansion of capacity on primary highways by widening, twinning,

realignment, b) pavement rehabilitation to restore strength and riding comfort, c) upgrading of surfacing standard on secondary highways, d) system extension by construction of new links to serve new developments, and e) provision of maintenance to provide acceptable rideability.

Most provinces prepare five year capital improvement programs. Ontario is perhaps the only province that prepares a proposed 20 year plan. Highway planning and needs studies to the year 2000 are not available on a consistent basis for the entire country. Transport Canada has collaborated with the Prairie and Atlantic provinces in recent years to study primary highway system needs (5, 16). Detailed future highway plans are kept confidential in most provinces. Because of that and of this paper being a general overview, the following is a sketchy outline of the future infrastructure requirements compiled from published reports and discussions with some provincial officials.

Capacity Expansion on Primary Highways

Figure 5 gives a general view of the primary highway links considered deficient or that will become deficient in capacity by the year 2000. The figure has been compiled from disparate sources as discussed below; original sources should be consulted for details.

Western Provinces. Table 6, based on the Pacific Rim Study, shows that of the 12 024 km defined as primary highways in the four Western Provinces, 67% operated at level of service A or B, 19% at C. Only 14%, 1 623 km in British Columbia and the National Parks were deficient in capacity with a level of service D or lower.

TABLE 6: LEVEL OF SERVICE BY CATEGORY AND WESTERN PROVINCES, 1976

Level of Service	B.C.		Nat. Parks		Alta.		Sask.		Man.		Total	
	km	%	km	%	km	%	km	%	km	%	km	%
A	-	-	6	-	980	34	1,384	61	872	77	3,243	27
B	1,955	37	89	24	1,759	61	819	37	249	22	4,852	40
C	1,971	37	109	30	159	5	50	2	16	1	2,306	19
D	772	14	142	39							929	8
E	563	10	10	3							573	5
F	108	2	13	4							121	1
	5,369	100	369	100	2,898	100	2,253	100	1,137	100	12,024	100

Source: Ref. 16

Although Table 6 shows that the primary highways in Alberta, Saskatchewan and Manitoba were not considered to be capacity deficient, discussions with transportation officials in these provinces indicate that, due to strong public pressures, it is probable that the TransCanada Highway will be a four-lane divided highway across Manitoba, Saskatchewan and Alberta by the year 2000. British Columbia also propose to twin or provide passing zones on the portion between Golden and Merritt.

The Alberta government is also committed to twinning the Yellowhead Highway. The Saskatoon to Lloydminster portion of the Yellowhead in Saskatchewan will probably see some twinning before the year 2000.

Ontario. The expansions needed and planned in Ontario are too numerous to list here (8). In general, the planned improvements are widening of the freeways and highways in the southwestern region, extension of freeways to Parry Sound and toward North Bay and numerous widenings or twinning projects near urban areas.

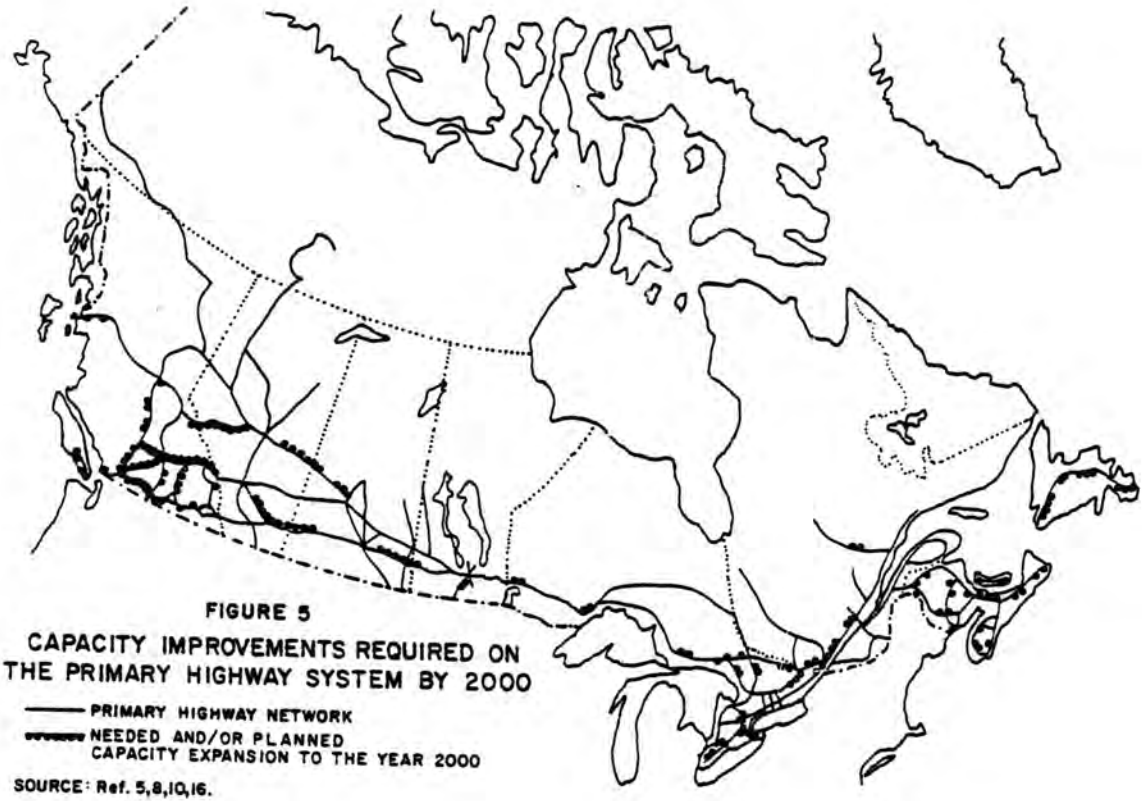


FIGURE 5

CAPACITY IMPROVEMENTS REQUIRED ON THE PRIMARY HIGHWAY SYSTEM BY 2000

——— PRIMARY HIGHWAY NETWORK

▪▪▪▪▪▪ NEEDED AND/OR PLANNED CAPACITY EXPANSION TO THE YEAR 2000

SOURCE: Ref. 5,8,10,16.

Maritime Provinces. The recently completed Maritime Provinces Primary Highway System Needs Study: 1981-2000 (5) identified capacity, strength and rideability deficiencies in 2000 based on a moderate traffic growth. Table 7 indicates that by the year 2000, out of the total primary system length of 3 467 km, 1 076 km (31%) will be deficient in level of service, 992 km (29%) in pavement strength and 1 478 km (43%) in rideability. It will require over $1.4 billion (1982 dollars) by 2000 to correct the deficiencies.

Quebec, Newfoundland. No updated information could be obtained for Quebec and Newfoundland. The deficiencies indicated in Figure 5 for these provinces are based on Ref. 10.

Future Expenditures for Capacity Expansion. Without costing individual projects, it is almost impossible to estimate the total future financial requirements for road infrastructure to the year 2000. In 1975 Transport Canada had forecast an expenditure of $9 billion over 15 years ($0.6 billion per year) required for expanding the capacity of deficient links on the primary highway system (10). This translates into approximately $1 billion per year in 1982 dollars. A comparison of Figure 5 with the deficient links identified in the 1975 Transport Canada study indicates that this level of expenditure will probably have to be sustained to the year 2000 to upgrade capacity deficient links.

Pavement Rehabilitation

Pavement rehabilitation is required to restore strength or rideability. An assessment of the strength and ride-

TABLE 7: MARITIME PROVINCES PRIMARY HIGHWAY SYSTEM DEFICIENCIES IN THE YEAR 2000

Province	Length km	No. of Kilometres of Deficiencies: Level of Service L of S<LevelC	Pavement* Strength (Def.>0.045)	** Rideability (R.C.I≤5.5)	Cost of Correcting Deficiencies ($ Million - 1982): Level of Service	Pavement Strength	Rideability	Total Cost
New Brunswick	1,774	449	695	380	449	122	38	69
Nova Scotia	1,229	550	65	943	563	7	73	643
Prince Edward Island	464	77	232	155	76	63	16	155
Total Maritime Provinces Highway System	3,467	1,076	992	1,478	1,088	192	127	1,407

* Pavement strength is depicted here as the no. of kilometres of highway deficient in pavement strength excluding certain sections of highway with level of service deficiencies.

** Rideability is depicted here as the no. of kilometres of highway deficient in riding comfort excluding certain sections of highway with level of service and strength deficiencies.

Source: Ref. 5.

ability deficiencies on all primary highways is not available. Discussions with various highway officials indicate that due to lack of funds, a backlog of required pavement rehabilitation is building up in all provinces.

If we assume an average life of 15 years for pavements, then one-fifteenth of the 180 000 km of paved provincial roads in Canada, i.e. 12 000 km, should be rehabilitated each year. At an average cost of $80,000/km in 1982 dollars, this would amount to nearly $1 billion per year indefinitely.

Upgraded Standards on Secondary Highways

All highway departments are familiar with public demands to get them "out of the dust". This pressure to pave gravel roads and to generally upgrade the standards on secondary (collector and local) highways is likely to continue.

The Canadian Highway System Study (as reported in Ref. 11) estimated that 63% of provincial highway expenditures between 1972 and 1982 would occur on the primary highway network and the remaining 37% on the secondary system. This ratio would vary among the provinces. In Saskatchewan, for example, nearly 75% of the capital budget for rural highways was spent on secondary highways in the five year period 1976-81.

Estimates on future provincial expenditures on secondary highways are not available. If we assume that 60:40 ratio of primary and secondary highway expenditure will continue to the year 2000, and apply it to the projected $1 billion in primary highway capacity expansion, the

estimated expenditure on secondary highways would be 40:60x$1 billion equalling $670 million per year. This expenditure level is quite plausible when we compare it to the history of activity on secondary highways. As shown in Figure 3, the length of paved roads increased at approximately 10 000 km per year between 1960 and 1980. If we assume that the future average rate of reconstruction of gravel secondary highways to paved standard would be only 3 000 km per year at an estimated 1982 cost of $200,000/km for grading and paving, then the cost to highway departments would be $600 million per year. Other improvements to the secondary system would be in addition to this sum. The above two calculations suggest that an annual expenditure of $0.7 billion on secondary highway upgrading to 2000 would not be out of line.

New Links

Most of the new highway links to be built by the year 2000 will be in northern areas to service mineral or industrial development. Examples include extensions to and off the Dempster and Mackenzie Highways in the Northwest Territories and Yukon and resource development roads in northern areas of British Columbia, Alberta and Saskatchewan. Also, construction of the cut-off between Hope and Merritt in B.C. will extend the divided highway from Vancouver to Merritt. An interior island highway on Vancouver Island is also being considered.

Beyond the year 2000, one can perhaps expect completion of the Quebec-Labrador-Newfoundland Highway, new freeways in Montreal and Toronto area such as Highway 407 to

Peterborough.

Summary of Future Financial Requirements

Table 8 presents a summary of the estimated future annual requirements for provincial expenditure on transportation to the year 2000. The estimated 1981-82 expenditure is also shown.

On the assumption that the transfer payments and non-highway expenditures would not increase, and that operation and maintenance expenditure will on average be somewhat higher than present levels, Table 8 shows that gross provincial expenditure of $6.3 billion per year (1982 dollars) will be required to the year 2000, compared to a 1981 actual expenditure of $5.2 billion indicating a shortfall of at least $1 billion per year for highway expenditure, excluding the cost of extension to the highway system. In other words, provincial highway funding needs to be increased by at least 20% in real terms over present expenditure level.

Based on past expenditure trends, the municipal governments will require an additional $3 billion per year, and the federal government about $0.5 billion per year for the road mode.

These figures are a guesstimate but do indicate that very large investments will have to be made in our road system over the next 20 years. In view of the economic conditions and the demand for funds for social programs, provincial highway budgets are not likely to be increased to meet the forecast road needs.

No attempt was made to forecast the financial require-

ments for vehicles. It can be presumed that, in view of rising real incomes, people will be able to afford to buy and operate cars, and that trucking companies will have enough capital to replace their rolling stock every 10 years or so.

TABLE 8: SUMMARY OF GUESSTIMATED ANNUAL PROVINCIAL FINANCIAL REQUIREMENT FOR TRANSPORTATION INFRASTRUCTURE TO THE YEAR 2000

Type of Work	Estimated 1981-82 Expenditure (billions of 1981 dollars)	Guesstimated Annual Requirements to 2000 (billions of 1982 dollars)
Provincial Highways Capital		
System Extension	not available	N/A
Capacity Expansion on Primary Highways		1
Upgrading of Secondary Highways		0.7
Rehabilitation		1
Sub-total Capital	1.94	2.7
Operations and Maintenance	1.60	1.8
Total Provincial Highways	3.54	4.5
Transfer Payments (to municipalities)		
Roads	0.66	0.7
Transit	0.69	0.7
Air, Water and Rail Modes	0.35	0.4
Total Transportation Expenditure	5.24*	6.3

* Includes $0.14 billion of fedearl contributions

Source: Ref. 13 for 1981-82 expenditures.

ALTERNATIVES TO INFRASTRUCTURE CAPACITY EXPANSION

General

It is by now obvious that money will not be available to fulfill all demands for road infrastructure. Methods to increase road revenues such as higher gasoline taxes (e.g. the recent five cents per gallon increase in U.S. federal tax) and higher registration fees are not likely to be popular. In fact, Alberta and Saskatchewan removed their gasoline taxes in 1978 and 1982, respectively. Also, too high a gasoline tax may create equity problems requiring rebate mechanisms for low income groups. In any event, these measures are political decisions and generally out of control of highway managers.

However, highway managers can present a better case for more funds for highway improvements by making the public and the political decision-makers more aware of the economic importance of good highways. In this vein, a recent U.S. Department of Transportation study (19) concluded that deteriorating highway performance would "reduce the economic welfare of the nation in terms of higher prices and lower levels of production, employment, disposable income, consumption and productivity", and would divert resources away from desirable sectors of the economy.

To make best use of the available funds, the highway manager will have to use a combination of: a) 'staging' the provision of capacity and strength; b) reducing demand, particularly in the peak period; c) making more efficient use of existing infrastructure; and d) making the public more aware of the costs of road infrastructure with a view

to moderating their demands.

Staging

Studies in Alberta have shown that provision of strategically located passing zones on two-lane highways will help delay twinning for a considerable time. This approach is not new. Climbing lanes and passing zones are frequently used in mountainous terrain. Their value on relatively high volume highways in flat terrain will perhaps depend upon public perception of their safety.

Staging of pavement thickness offers another means of effective use of available funding. By initially building a thin pavement (say N-5) and then overlaying it as and when warranted will avoid cases where an N-15 or N-20 pavement would be overdesigned for much of its life. Thinner pavements likely will be more expensive to maintain. However, economic analyses based on Saskatchewan's experience with staging of pavement thickness show it to be cheaper than non-staging on a life cycle cost basis. Indeed, on thousands of kilometres of Saskatchewan highways with low volumes (less than 600 AADT) very thin (20 to 50 mm asphalt mix mat on subgrade) have provided an acceptable quality of service, albeit requiring extensive maintenance.

Reduction of lane or shoulder width on low volume roads is another cost saving method worth considering.

Reducing Transportation Demand

In the short term, few practical measures are available for reducing the demand for highway travel. A significant shift to bus or rail cannot be expected for reasons discussed earlier. Even the shift of a small proportion of

car travellers to rail or bus would require enormous increase in the capacity of these latter modes--something that cannot be achieved quickly.

A shorter work week and staggering of working hours has already been shown to spread out the peaks on highways near cities. Higher weekend fees at parks and campsites may help encourage weekday use of such facilities and thus reduce the weekend peaking. Piggybacking will remove some trucks from intercity highways but not from urban roads. Prohibition of recreational vehicles from certain highways during certain times would help even out the peaks but may not be acceptable to the public.

Some of the longer term measures for reducing highway travel demand that may be necessary by 2000 are:

- Some fixed costs of car use may be converted to variable costs, e.g. insurance could be charged on a per kilometre basis.
- The pattern of summer and school holidays could be changed to even out the summer peaking of highway traffic.
- Renting/leasing and shared car ownership (automobile cooperatives in Sweden) could reduce car ownership and use (6).
- Road pricing (tolls) or higher fuel taxes would either be relatively ineffective or unacceptable to the public.
- Substantially reduced speed limits would not be acceptable to the public either.
- Although the sprawl of our urban areas and the

development of bedroom communities are facts of life in Canada, an attempt to keep urban areas compact would reduce the congestion on nearby highways.

Telecommunications as a substitute for highway travel is not likely to be a major factor by the year 2000.

Making Better Use of Existing Infrastructure

General. "Transportation System Management" types of improvement (such as one-way streets, contra-flow lanes, traffic signal coordination, car pooling and parking management) have been successfully applied in urban areas to increase the utilization of existing street space. Few of these measures can be applied to rural highways.

Any shift to high-occupancy vehicles such as buses, or increasing the occupancy of cars, or using trucks that can carry more freight per vehicle will make better use of the road capacity. The unlikelihood of a shift of car users to buses was discussed earlier.

Truck Weights and Dimensions. Improvements are being made in truck design to reduce tare weight resulting in improved economy, payload gains and productivity. Examples include use of lighter materials and use of the double draw bar dolly converter for combination vehicles thus removing one point of articulation in the A-train configuration.

Improved operating efficiency can be obtained through computerization, consolidation of terminals and routes, automated terminals, intermodal terminals and containerization.

In the future, increased productivity within a framework of given regulations and a greater shipper flexibility

should favour a gradual increase in the use of multiple trailers. Public opinion, pavement and bridge requirements and safety considerations will be the factors retarding the growth to longer vehicles.

Vehicle weight regulations are being studied by a national committee of Roads and Transportation Association of Canada and the Canadian Council of Motor Transport Administrators in hope of developing uniform regulations. In Western Canada considerable uniformity has been achieved and the provinces are trying to improve this even further. However, each provincial infrastructure has built-in constraints in bridges which cannot be overcome quickly.

In order to make better use of existing infrastructure through changes in technology and regulations, development of close liaison and cooperation between the motor vehicle and trailer manufacturing industry, trucking companies and the regulating agencies in research, development and setting of regulations is of utmost importance.

Most provinces have attempted to address vehicle weight and dimension regulations with a view to maximizing efficiency in cooperation with the transportation industry. An example is Saskatchewan's winter weight policy. Initially secondary highway weights were increased to allow primary highway weights during the winter period. This change provided an economic benefit of nearly $3 million per year to the trucking industry with no appreciable increase in pavement damage. In the second stage, the weights on the primary highways were increased by 10% on all axles except the steering axles and for all vehicles except for

comination vehicle trains which are at the overall maximum gross vehicle weight. On a standard semi-trailer unit this results in an increase of 3 200 kg in payload without any increase in damage on the highway pavements. For a secondary highway this means a total increased payload of 6 200 kg. The second stage is expected to yield even greater economic benefits to trucking.

Another example of industry cooperation is Saskatchewan's bulk commodity policy. Under this policy, any manufacturer shipping 30 000 t or more per year can enter into an agreement with the government whereby he is allowed special vehicle dimensions and weights, provided he pays incremental road damage costs this haul causes to the highway system. Some stringent safety requirements for vehicles and operators must also be met. Where the haul is deemed competitive with rail, the incremental cost is deemed to be the total cost of the haul. The government may absorb part of the cost if there is a large direct economic benefit to the province. If the haul is not deemed competitive with rail, then the cost is only the incremental cost incurred over the damage which could result if the movement took place at regulation loadings.

Improved System Management. Highway managers can effect economies and make better use of the infrastructure by implementing measures such as more cost-effective methods of road construction and maintenance, substitution of asphalt pavements by granular pavements on low volume roads, reduction in the number of overweight trucks by stricter enforcement and implementation of better management infor-

mation systems, e.g. pavement management system.

A well-designed pavement management system can help decide the optimum rehabilitation and maintenance strategies to save money and at the same time provide a better service on paved highways.

Public Awareness. The Canadian public expects and has been willing to pay for a high level of service on our roads. This ability to pay is diminishing without a corresponding lessening of expectations. For example, governments in the Prairie Provinces have been under strong public pressure to twin highways at 3,000 AADT. Perceived safety hazards of two-lane highways have often been cited as reasons.

In view of shrinking budgets, highway managers will have to devise ways to inform the public of the costs of highway improvements and present the public and the political decision-makers with a range of alternative solutions, showing the cost-effectiveness and pros and cons of each in a simple manner. For example, twinning a highway is perhaps the least cost-effective means of reducing traffic deaths and mandatory safety belt usage the most cost-effective.

SUMMARY AND CONCLUSIONS

This paper has presented an overview of the present and future role of the road mode in Canada with emphasis on the provincial highway system.

The major points or conclusions in the paper are:

1. The private car carries more than 80% of passenger travel in Canada. For-hire trucks are the dominant mode for short-haul general freight. These roles of

the car and truck will be maintained beyond the year 2000.

2. Car travel which grew at an average annual rate of 4.5% during the 1970s is expected to grow at just over 2% per year to 2000.

3. For-hire truck tonnage is forecast to increase by 2.4% per year to 1990 and somewhat less rapidly after that.

4. Provinces bear 63% of the road infrastructure costs, municipalities 31% and the federal government 6%. Provinces will continue to be the major providers of road infrastructure in the future.

5. Infrastructure requirements on provincial highways and roads to 2000 are forecast to entail: capacity expansion on primary highways costing $1 billion per year (1982 dollars); pavement rehabilitation-- $1 billion; upgrading of standards on secondary highways-- $0.7 billion; and operation and maintenance-- $1.8 billion. Cost of any extension to the highway system will be in addition. Allowing for expenditure on other modes and for transfer payments to municipalities, $6.3 billion per year will be required for gross provincial expenditure on transportation. Compared to the 1981 expenditure of $5.2 billion, this represents a short-fall of at least $1 billion or 20%.

6. To make best use of available funds, highway managers will have to use measures such as: a) 'staging' of highway capacity and strength; b) reducing demand particularly in the peak periods; c) making better use

of existing facilities by improvements in infrastructure and vehicle technology, uniform truck weights and dimensions and implementation of pavement management systems; and d) making the public more aware of the costs of highways with a view to lessening their expectations.

7. Major deficiencies, inconsistencies and lack of uniformity exist in our knowledge of road transport demand and supply in Canada. A major cooperative effort is required to first establish a national 'bank' of existing statistics and then to bring about uniformity in classification, vehicle standards and accounting systems of provinces.

REFERENCES

1. Barton, R. Highway Expenditures and Trends in Canada During the 1970's, RTAC Forum, Vol. 3, No. 2:77-81, 1981.

2. Canadian Transport Commission. Transport Review: Trends and Selected Issues, 1981. Ottawa, 1981.

3. DelCan Ltd. A Profile of the Canadian Highway System-1981, Ottawa, Transport Canada, 1982.

4. Energy and Mines Canada. Transport Energy Data Book, Report No. TE-82-5, Ottawa, 1982.

5. Federal-Provincial Maritime Provinces Transportation Planning Committee. Maritime Provinces Primary Highway System Needs Study (1981-2000), Ottawa, Transport Canada, 1983.

6. Khan, A. M. Future Role of the Automobile in Canada, Report No. TP3759, Transport Canada, Ottawa, 1982.

7. Mayes, R. R. and Welch, J. R. Transportation Energy Requirements to the Year 2000, Proceedings, Canadian Transportation Research Forum Conference, Regina, Saskatchewan, June 1983.

8. Ministry of Transportation and Communications. 'Provincial Highways Long-Range Plan 1983-1987', and 'Future Perspectives, Provincial Highways 1981-2001',

Toronto, 1983 and 1981.

9. Roads and Transportation Association of Canada. Highway Statistics Project Committee Final Report, Ottawa, 1982.

10. Transport Canada. An Interim Report on Freight Transportation in Canada, Ottawa, 1975.

11. Transport Canada. An Interim Report on Intercity Passenger Movement in Canada, Ottawa, 1975.

12. Transport Canada. Canadian Freight Transportation System Performance and Issues, Report No. TP3010E, Ottawa, 1981.

13. Transport Canada. Federal and Provincial Government Transportation Expenditures by Province 1974-75 to 1981-82, Report No. TP2726, Ottawa, 1982.

14. Transport Canada. The Future of the Automobile in Canada, Report No. TP1148, Ottawa, 1979.

15. Transport Canada. Transport Canada Freight and Passenger Forecasts, 1982, Ottawa, 1982.

16. Transport Canada. Pacific Rim Highway Access Study, Phase I, Report No. TP1639, Ottawa, 1978.

17. Transport Canada. Transport Costs and Revenues in Canada 1969-1979, Report No. TP3737E, Ottawa, 1982.

18. Science Council of Canada. Transportation in a Resource-Conscious Future: Intercity Passenger Travel in Canada, Ottawa, Ministry of Supply and Services, 1982.

19. Butler, S.E. et al. Highways and the Economy, Report No. SS-42-U9-1, Cambridge, Mass., U.S. Department of Transport, January 1983.

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SOME THOUGHTS ON AIR TRANSPORT TO YEAR 2000

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AS A SPOKESMAN FOR AN INDUSTRY THAT IS CURRENTLY IN THE INTENSIVE-CARE WARD I FIND THAT FORECASTING ITS FUTURE IS A HIGHLY SPECULATIVE TASK. IT'S RATHER LIKE ASKING A MOUNTAIN CLIMBER ABOUT HIS NEXT EXPEDITION AS HE CLINGS PRECARIOUSLY TO THE SHEER FACE OF HIS PRESENT PEAK. HIS MUTTERED REPLY WOULD PROBABLY BE SOMETHING ABOUT SURVIVING THE PRESENT BEFORE HE CAN ASSUME HE HAS A FUTURE.

LAST YEAR CANADIAN AIR CARRIERS LOST ABOUT $100 MILLION - THE LARGEST LOSS IN THE INDUSTRY'S HISTORY - AND THIS YEAR'S BOTTOM LINE IS ALSO EXPECTED TO BE ENTERED IN DEEP RED INK. SOME $70 MILLION OF THE 1982 LOSS WAS ACCOUNTED FOR BY OUR TWO LARGEST AIRLINES, AIR CANADA AND CP AIR, WITH THE REMAINING $30 MILLION LOSS ATTRIBUTABLE TO SOME OF THE REGIONAL CARRIERS, LOCAL SERVICE CARRIERS AND THE HELICOPTER TRANSPORT COMPANIES. INCIDENTALLY, IN THE CANADIAN INDUSTRY'S BEST YEAR, 1980, WHEN REVENUES REACHED NEARLY $4 BILLION WE ONLY MANAGED TO EXTRACT A PITIFUL NET INCOME OF 2.8%. THE HISTORIC RETURN ON INVESTMENT IS VERY POOR AND EVEN IN THE GOOD OLD DAYS OF SURGING GROWTH IT IS BEST CHARACTERIZED AS PROFITLESS GROWTH.

BEFORE I ATTEMPT TO LOOK AHEAD SOME SEVENTEEN YEARS TO THE CENTURY'S CLOSE I SHOULD ALSO SAY SOMETHING ABOUT THE CURRENT GLOBAL SCENE IN AIR TRANSPORT. THE CANADIAN

EXPERIENCE HAS NOT BEEN UNIQUE: THE INTERNATIONAL AIR TRANSPORT ASSOCIATION SAYS 1983 WILL MARK THE FIFTH STRAIGHT YEAR OF NET LOSS FOR ITS MEMBERS. IATA FORECASTS A 1983 LOSS ON SCHEDULED INTERNATIONAL SERVICES OF UP TO $2 BILLION. SOME OF THE SPECIFIC REASONS ARE STAGNANT MARKETS, HIGH INTEREST PAYMENTS, INADEQUATE YIELDS AND CAPACITY OUTSTRIPPING TRAFFIC GROWTH.

IN SIMPLE TERMS THERE ARE TOO MANY EXPENSIVE AIRPLANES FLYING TOO MANY SIMILAR ROUTES;A SURPLUS OF SEATS AND A SHORTAGE OF PASSENGERS.

TODAY WE'RE CLINGING TO THE EDGE OF MOUNT RECESSION HOPING WE CAN MAKE A CROSS-OVER TO MOUNT RECOVERY AS THE ECONOMIC STORMS DIMINISH AND BETTER CLIMBING WEATHER RESULTS. THERE IS ONE CERTAINTY: CANADIAN AIR CARRIERS WILL BE IN BETTER SHAPE TO PROFIT FROM AN UPTURN BECAUSE THEY HAVE ADOPTED THE LEAN AND HUNGRY LOOK IN THEIR BATTLE TO SURVIVE THE CURRENT AND RECENT TURBULENCE. MIND YOU THE INDUSTRY FACES A CONTINUING CHALLENGE IN THE LONGER TERM BECAUSE IT MUST MAINTAIN THAT LEAN AND HUNGRY STATE, AND IT'S AN INDUSTRY WITH AN UNHEALTHY TENDENCY TO OVEROPTIMISM WHICH IN THE PAST HAS LED TO A SELF-INFLICTED ILLNESS: EXPANSIONITIS FEVER. BUT, ASSUMING A GRADUAL RETURN TO BETTER TIMES OVER THE NEXT FEW YEARS, I BELIEVE THE AIRLINES WILL RESTRAIN THEIR TRADITIONAL OPTIMISM WHEN THEY VIEW THEIR SCARS. ONE HUNDRED MILLION DOLLAR LOSSES TEND TO WONDERFULLY CONCENTRATE AN INDUSTRY'S COLLECTIVE MIND.

NOW I'LL RAISE MY SIGHTS TO THE YEAR 2000 BUT, WHAT I SEE THERE WILL NOT STAGGER YOU. THERE WILL BE A FEW THINGS MARVELLOUS OR AMAZING BECAUSE THE FUNDAMENTALS OF COMMER-

CIAL AIR TRANSPORT WILL NOT UNDERGO ANY DRAMATIC CHANGE FROM WHAT WE KNOW TODAY. OBVIOUSLY THERE WILL BE CHANGES, BUT IN THE MAIN THEY WILL BE A MATTER OF EVOLUTIONARY REFINEMENTS OF EXISTING FUNDAMENTALS. THE LIKELY REFINEMENTS AND CHANGES CAN BE ROUGHLY DEPARTMENTALIZED UNDER THE FOLLOWING HEADINGS: ENERGY, AIRCRAFT, AIR CARRIER MARKETS, LABOUR AND RETURN ON INVESTMENT.

THE MANY SIGNIFICANT TECHNOLOGICAL ADVANCES IN THE DESIGN, MANUFACTURE, AND OPERATION OF AIRFRAMES AND POWERPLANTS DURING THE 70's AND 80's HAVE RESULTED FROM THREE ESSENTIAL ELEMENTS;THE NEED FOR CARRIERS TO MATCH FLEET CAPACITY WITH DEMAND, TO DEAL WITH CONSTANTLY SPIRALLING FUEL COSTS SINCE 1973 AND THE REQUIREMENT TO CONTROL MAINTENANCE AND ENGINEERING COSTS THROUGH BETTER DESIGNED, MORE DURABLE AND MORE EASILY MAINTAINED SYSTEMS AND COMPONENTS.

WITH SURGES IN THE ECONOMY AND A RESULTING GENERAL DOWNWARD TREND IN DEMAND FOR CAPACITY, OUR INDUSTRY, INITIALLY CONFRONTED WITH EXCESS CAPACITY AND IN MANY CASES WITH HIGH PERCENTAGES OF INEFFICIENT EQUIPMENT, HAS FOCUSSED SHARPLY ON FLEET ADJUSTMENTS WHICH REPLACED OLDER EQUIPMENT WITH MORE FUEL EFFICIENT AIRCRAFT AND POWERPLANTS BEST SUITED TO CHANGING MISSION PROFILES AND THE NEED FOR GREATER OPERATIONAL FLEXIBILITY IN CHANGING MARKETS. IN PURSUIT OF INCREASED FUEL EFFICIENCIES RESULTING ENGINE DESIGNS HAVE ALSO BECOME SIGNIFICANTLY QUIETER.

PROMINENT AMONG THE MORE RECENT AIRCRAFT DESIGNS ARE THOSE OF THE LAST DECADE, WHICH HAVE DRAMATICALLY

CHANGED ORIGINAL TURBOJET TRANSPORT TYPIFIED BY THE EARLY DC-8's AND B707's TO THE NEW GENERATION OF TWO, THREE AND FOUR ENGINED WIDE BODIED AIRCRAFT WITH MAJOR IMPROVEMENTS IN AERODYNAMIC AND POWERPLANT EFFICIENCIES AND EQUIPPED WITH FLIGHT MANAGEMENT AND NAVIGATION SYSTEMS WHICH REFLECT THE GIANT STRIDES ACHIEVED IN COMPUTERIZED STATE-OF-THE-ART. OF VERY RECENT DATE FOR EXAMPLE, LOCKHEED CALIFORNIA CO. RECEIVED FAA CERTIFICATION FOR THEIR NEW 4-D FLIGHT MANAGEMENT SYSTEM WHICH ADDS THE DIMENSION OF TIME TO THE EXISTING CLIMB, CRUISE AND SPEED PARAMETERS FEATURED IN THE FMS SYSTEM IN L-1011's SINCE 1977. WIDESPREAD APPLICATION OF SUCH SYSTEMS WOULD HELP SMOOTH THE TRAFFIC FLOW AT AIRPORTS, ELIMINATING THE NEED FOR COMPLEX FLIGHT PATTERNS WHICH IN ADDITION TO SIGNIFICANT FUEL SAVINGS WOULD EASE THE BURDEN ON AIR TRAFFIC CONTROL SYSTEMS AND FURTHER IMPROVE SAFETY FACTORS IN TODAYS AIRWAY SYSTEMS, PARTICULARLY IN DENSE TERMINAL AREAS.

UNFORTUNATELY, THE ADVANCES IN ONBOARD TECHNOLOGY HAVE SO FAR GENERALLY OUTRUN THE ABILITY OF AIR TRAFFIC CONTROL SYSTEMS TO KEEP PACE. ONE EXAMPLE OF THIS IS EVIDENCED BY THE IDENTIFIED NEED IN 1981 TO REVIEW THE PROCEDURES AND SYSTEMS EMPLOYED BY CANADIAN ATC IN THE CONTROLLING OF SOME 8700 FLIGHTS ANNUALLY OF LARGE TURBOJET TRANSPORTS THROUGH NORTHERN CANADIAN AIRSPACE TRANSITING TO/FROM THE NORTH ATLANTIC OCEANIC TRACK SYSTEM KNOWN AS NATOTS, TO CANADIAN, U.S. OR EUROPEAN DESTINATIONS.

THE NATOTS SYSTEM FEATURES NARROWER SEPARATION STANDARDS AND EXPEDITED ATC PROCEDURES WHICH OPTIMIZE

AIRSPACE UTILIZATION. NATOTS IS BASED ON A SET OF NAVIGATIONAL STANDARDS DEVELOPED TO TAKE ADVANTAGE OF NAVIGATION EQUIPMENT COMBINATIONS SUCH AS TRIPLE MIX I.N.S. OR DOUBLE I.N.S. WITH SINGLE OMEGA WITH AUTOMATIC POSITION UPDATING CAPABILITIES AND SO ON, WITH SPECIALIZED FLIGHT CREW, AND AIR TRAFFIC CONTROL TECHNIQUES, FOR A NON RADAR ENVIRONMENT. WHILE NATOTS IS A VERY EFFICIENT SYSTEM, AIRCRAFT TRANSITING TO CANADIAN DOMESTIC AIRSPACE MUST REVERT TO MORE EXAGGERATED AND OUTDATED SEPARATION STANDARDS DUE TO THE ABSENCE OF NATOTS STYLE HARDWARE AND PROCEDURES WITHIN THE CANADIAN DOMESTIC ATC SYSTEM. BECAUSE CANADA HAS NOT YET ADOPTED THE NATOTS TYPE SYSTEM, AND THE LACK OF AUTOMATION IN THE ATC SYSTEM, THERE REMAINS THE NEED FOR CANADIAN CONTROLLERS TO COMPUTE TRAFFIC MOVEMENTS BY RULER, GREASE PENCIL AND HAND HELD CALCULATORS TO DETERMINE AIRSPACE CONFLICTS.

THE RESULTS OF COURSE ARE INEFFICIENT USE OF AIRSPACE, RESTRICTIONS TO TRAFFIC DENSITIES AND MORE COSTLY ROUTINGS IN TERMS OF FUEL CONSUMPTION.

A RECENTLY COMPLETED NORTHERN AIRSPACE SYSTEM DESIGN PROJECT JOINTLY DEVELOPED BY DOT AND INDUSTRY, RECOMMENDS THE ADOPTION OF THE NEWER TECHNIQUES, AUTOMATION OF THE ATC SYSTEMS SO THAT FLIGHT PLANS ARE RECEIVED FROM AIRLINE AUTOMATED SYSTEMS SENSITIVE TO MINIMUM TIME TRACKS AND FED INTO AN ATC COMPUTER WHICH RESULTS IN CONFLICT PREDICTION IN ADDITION TO PROVIDING CONTROLLERS WITH CONSTANTLY UPDATED POSITION REPORTS.

THESE IMPROVEMENTS RESULT IN REDUCED SEPARATION STANDARDS ON ROUTINGS BASED ON MINIMUM TIME TRACKS;

FACTORS WHICH WILL SAVE MILLIONS OF DOLLARS OF FUEL COSTS ANNUALLY.

ATC PROCEDURES AND SYSTEMS HAVE BEEN UNDER CLOSE SCRUTINY IN CONCERTED EFFORTS BETWEEN GOVERNMENT AND INDUSTRY IN SEVERAL OTHER CASES, NOT THE LEAST OF WHICH ARE JOINT USE OF MILITARY FLYING AREAS, IMPROVED TERMINAL PROCEDURES, MORE DIRECT ROUTINGS BETWEEN DEPARTURE AND DESTINATION AIRPORTS, IMPROVED DESCENT PROCEDURES AND REDUCTION OF AIRBORNE DELAYS COMMONLY KNOWN AS "HOLDS".

EFFORTS ARE THEREFORE UNDERWAY, AS AN URGENT PRIORITY, TO BRING GROUND SYSTEMS IN LINE WITH ONBOARD TECHNOLOGICAL IMPROVEMENTS. WHILE SUBSTANTIAL GAINS CAN BE ATTAINED IN THE ATC SYSTEM THROUGH THE APPLICATION OF AVAILABLE TECHNOLOGY, IT WOULD BE REASONABLE TO PRESUME THAT AIR-CRAFT AND PROPULSION SYSTEMS HAVE IMPROVED TO A LEVEL THAT MAY REMAIN RELATIVELY CONSTANT FOR THE NEXT 10 - 15 YEARS BY WHICH TIME MORE ADVANCED AERO-DYNAMIC ENGINEERING AND PROPULSION RESEARCH MAY WELL INTRODUCE YET ANOTHER GENERATION OF AIRCRAFT, POWERPLANTS AND FUELS TO OUR INDUSTRY.

IN THIS RESPECT STUDIES AND TESTING ARE WELL UNDERWAY ON THE FOLLOWING IDEAS:

HYDROGEN FUEL

HIGH SPEED, LARGE TURBOPROP TRANSPORTS

BULK CARGO AIRSHIPS

ADVANCED MICROWAVE LANDING SYSTEMS AND AREA NAVIGATION PROCEDURES

THE VALUE OF TIME CONTINUES TO INCREASE IN THIS DAY AND AGE. FOOD AND SHELTER WHILE TRAVELLING IN CANADA COSTS

ABOUT $30 - $50 PER DAY BY CAR. WHEN TRAVELLING BY TRAIN A ROOMETTE COSTS ABOUT $50 MONTREAL-HALIFAX AND MEALS COST AT LEAST $25 A DAY. THE RESULT IS THAT ON JOURNEYS REQUIRING ACCOMMODATION FOR EVEN ONE NIGHT, THE TOTAL COST OF CAR OR RAIL EXCEEDS THE STANDARD ECONOMY AIR FARE, AND SUBSTANTIALLY EXCEEDS A DISCOUNTED ECONOMY FARE. ANY JOURNEY WHERE THE COST INCLUDES PROFESSIONAL TIME LOST, SUCH AS A LAWYER WHO NORMALLY BILLS $150 PER HOUR, IS VERY LIKELY TO BE BY AIR. AIR TRAVEL PASSED RAIL TRAVEL IN CANADA IN 1953. LONG HAUL CAR TRAVEL IS NOW EXPENSIVE IN FUEL AS WELL AS IN EN ROUTE FOOD AND SHELTER. AIR IS COMPLETELY DOMINANT OVER 1500 MILES, AND IS LIKELY TO GAIN MARKET SHARE DOWN TO 1000 MILES AND LESS.

THE DISCRETIONARY PART OF THE MARKET IS GROWING. THE TRAVEL MARKET FOR SURFACE MODES WAS ALWAYS HEAVILY WEIGHTED BY DISCRETIONARY SPENDING. AS THE AIR MODE PENETRATION INCREASES, AIR CARRIERS FACE MORE OF THE TOTAL MARKET, AND THUS A HIGHER PROPORTION OF DISCRETIONARY SPENDING. PRICE ELASTICITY THEREFORE INCREASES FROM AROUND MINUS 0.5 FOR BUSINESS TRAVEL TOWARD THE MINUS 1.0 TO 1.5 RANGE FOR DISCRETIONARY SPENDERS. IN SHORT, THE MARKET BECOMES MORE FICKLE, BUT IT GETS BIGGER, ON ITS LONG TERM TREND. WHAT YOU LOSE IN YIELD YOU CAN THEORETICALLY RECAPTURE IN VOLUME - THEORETICALLY.

(THE 1979-82 PERIOD WAS BADLY AFFECTED BY THE RECESSION.) THE LONG TERM DISCRETIONARY MARKET IS LIMITED BY THE GROWTH IN CONSUMER DISPOSABLE INCOME IN REAL TERMS, UNLESS IT CAN SQUEEZE OUT OTHER HIGH TAG ITEMS LIKE AUTOMOBILES AND CONSUMER DURABLES. IN THE IMMEDIATE

FUTURE THERE IS MORE PENT-UP DEMAND FOR AUTOMOBILES AND CONSUMER DURABLES THAN FOR AIR TRAVEL. THE BUSINESS TRAVEL AND CARGO MARKETS ARE STRONGLY LINKED TO THE LEVEL OF BUSINESS ACTIVITY.

THERE ARE ONLY TWO FUNDAMENTAL TYPES OF AIR FARE. THE FARE YOU PAY TO GO AND RETURN WHEN YOU WANT AND THE FARE YOU PAY IF YOU WILL GO AND RETURN WHEN THE AIRLINE WANTS YOU TO. THE SECOND TYPE OF FARE HAS A LARGE VARIETY OF SUB-TYPES, BUT TWO STAND OUT: THE FIRST IS WHOLE PLANE-LOAD LOTS SUCH AS ADVANCE BOOKING CHARTERS AND THE EARLY FORM OF SKYBUS AND THE SECOND IS CAPACITY CONTROLLED SEAT ALLOCATIONS ON SCHEDULED SERVICES SUCH AS CHARTER CLASS FARES AND SEAT SALES.

THE DECADE OF THE 1960's SAW THE DISCOVERY BY THE AIRLINE INDUSTRY OF THE DISCRETIONARY SPENDER. VARIOUS CHARTER REGIMES INITIALLY DUG THEM OUT. REMEMBER THE AFFINITY BOWLING LEAGUE GROUPS? REMEMBER THE NEW PHRASE "TOUR PRODUCERS"? THE 1960's ALSO BROUGHT TECHNIQUES FOR PREDICTING SURPLUS SEATS ON SCHEDULED SERVICES. THIS ENTAILED A LONG DEVELOPMENT TIME AND THERE WERE MANY EARLY MISTAKES. A DETAILED HISTORY WAS NEEDED FOR DEVELOPING CONFIDENCE IN THE PREDICTIONS. PREDICTION COMES IN THIS FORM: "THERE IS A 90% PROBABILITY THAT FLIGHT 100 ON THURSDAYS IN JUNE WILL HAVE 20 OPEN SEATS OUT OF 100". THIS IS VERY SUCCESSFUL FOR SCHEDULED CARRIERS SINCE IT ALLOWS INCREMENTAL REVENUE TO BE EARNED ON FLIGHTS OF THE CARRIERS CHOICE AND IN AMOUNTS DETERMINED BY THE CARRIER. THE AMOUNT OF POTENTIAL YIELD EROSION IS THEREFORE ALSO PRE-DETERMINED AND CONTROLLED BY BOOKING RESTRICTIONS OF

"FENCES". CARRIERS FACE A MUCH LOWER RISK BY THIS METHOD THAN BY BETTING A WHOLE PLANE-LOAD LOT, AS IN CHARTERS AND EARLY SKYBUS. THE 1970's SAW THESE TECHNIQUES GREATLY EXPANDED AND REFINED.

HOWEVER, THE EARLY 1980's RECESSION HAS HIT AND RECOVERY IS SLOW AND AS A RESULT THE SURPLUS SEAT SALE TECHNIQUE NOW IS IN THE FORM OF: "THERE IS A 90% PROBABILITY THAT FLIGHT 100 ON THURSDAYS IN JUNE WILL HAVE 60 OPEN SEATS OUT OF 100". IF 60 SEATS ARE SOLD AT HALF-PRICE THE FORMER YIELD STRUCTURE IS DESTROYED AND THE MARKET PRICE BECOMES HALF OF WHAT IT WAS. IF THEY ARE NOT SOLD, THE CARRIER BECOMES VERY SHORT OF CASH.

IN THE SUMMER OF 1982 CANADIANS GOT THEIR TASTE OF "CUT-YOUR-OWN-THROAT" FARES. FORTUNATELY, THE CTC STEPPED IN AND INSISTED ON FENCES DESIGNED TO LIMIT THESE DEEP DISCOUNT FARES TO THE TRULY DISCRETIONARY TRAVELLER AND TO INHIBIT A WHOLESALE DIVERSION FROM HIGHER TO LOWER FARES.

AIRLINE EMPLOYEES GENERALLY ARE PAID MUCH HIGHER WAGES FOR LABOUR TASKS PERFORMED THAN COMPARABLE EMPLOYEES IN OTHER INDUSTRIES. AIRLINE EFFORTS TO INCREASE PRODUCTIVITY ARE SOMETIMES THWARTED BY THIS.

THERE IS NO DOUBT THAT AIRLINES REQUIRE HIGHLY SKILLED WORKERS BUT ONE WONDERS WHETHER THE DIFFERENCES IN SKILLS FULLY ACCOUNT FOR THE APPARENT WAGE DIFFERENTIAL THAT HAS GRADUALLY CREPT IN AS A RESULT OF GRANTING THE VERY GENEROUS WAGE AND WORK RULES SETTLEMENTS OF THE PAST DECADE. IF AIR CARRIER WAGES HAD JUST REMAINED COMPETITIVE WITH THE MANUFACTURING SECTOR OF THE ECONOMY, PAY PER UNIT

OF OUTPUT FOR THE MAJOR CARRIERS WOULD CURRENTLY BE ABOUT 30% LOWER. FROM STATISTICS AVAILABLE FOR THE YEAR 1981 THE AVERAGE WAGE IN THE CANADIAN AIR TRANSPORT INDUSTRY WAS $26,102. OVER THE PAST TEN YEARS AVERAGE WAGE GROWTH HAS BEEN 9.5%. IN 1971 THE AVERAGE ANNUAL WAGE WAS $10,489. EVERY EFFORT MUST BE MADE IN THE YEARS AHEAD, IF NOT TO ROLL BACK WAGES AND WORK RULES, AT LEAST TO ELIMINATE FUTURE EXTRAVAGANT DEMANDS AT THE BARGAINING TABLE. THERE IS ONLY SO MUCH BLOOD IN THIS FLYING STONE.

THE EXTENT TO WHICH CANADIAN AIRLINES CAN MEET CAPACITY REQUIREMENTS BETWEEN NOW AND THE YEAR 2000 BOILS DOWN TO A QUESTION OF FINANCIAL INTEGRITY.

EARLY IN 1982 MRS. LIISA O'HARA, FORMERLY WITH CP AIR, HEADED UP AN INDUSTRY TASK FORCE IN ATAC ON AIRLINE FINANCIAL PERFORMANCE AND THE IMPORTANCE OF RETURN ON INVESTMENT TO FINANCIAL VIABILITY. THE VERY EXCELLENT WORK DONE BY MRS. O'HARA AND THE TASK FORCE RESULTED IN A REPORT WHICH HAS BEEN ADOPTED IN TOTAL BY THE ASSOCIATION.

THE MAIN OBJECTIVES OF THE REPORT WERE TO COMPILE THE CAPITAL EXPENDITURE PLANS BY THE PARTICIPATING CARRIERS FOR THE 1981-1985 PERIOD, TO ESTIMATE THE COST OF THE CAPITAL NEEDED TO MEET THESE PLANS AND TO ESTABLISH CRITERIA FOR ROI REQUIRED BY CARRIERS TO ATTRACT NEW CAPITAL. IN ADDITION, FROM AN APPLICATION POINT OF VIEW, THE REPORT COMMENTS ON METHODS WHICH WOULD ALLOW THE ATC TO INCORPORATE ROI CONSIDERATIONS INTO TARIFF CHANGE REQUESTS AND TARIFF REGULATION PROCEDURES.

THE COST OF FLEET REPLACEMENT AND ADDITIONS AMOUNTS

TO $4.5 BILLIONS OVER THE 1981-1985 PERIOD. THIS LARGE SUM MUST BE RAISED FROM AN UNDERCAPITALIZED COMPOSITE BALANCE SHEET WHICH SHOWS ONLY $.75 BILLIONS OF EQUITY AND IS ALREADY BURDENED WITH $1.6 BILLIONS OF DEBT OR WITH A 68/32 DEBT/EQUITY RATIO. THIS AIRLINE PROBLEM OF RAISING CAPITAL OF THIS MAGNITUDE IS COMPOUNDED BY THE FACT THAT MOST OF THE MORE ATTRACTIVE FORMS OF FINANCING OF THE 1970's ARE NO LONGER AVAILABLE TO CANADIAN AIR CARRIERS IN THE 1980's.

THE LONG TERM FUTURE OF THE CANADIAN AVIATION INDUSTRY DEPENDS ON ITS ABILITY TO MODERNIZE ITS AGING FLEETS. MODERNIZATION, IN TURN, DEPENDS ON THE AIRLINES' ABILITY TO INTERNALLY GENERATE EARNINGS THAT ARE SUFFICIENT TO PARTIALLY PAY FOR THE NEW EQUIPMENT AS WELL AS TO INDUCE LENDERS AND NEW EQUITY INVESTORS TO PROVIDE THE BALANCE OF THE REQUIRED CAPITAL.

PROSPECTS FOR GENERATION OF SUFFICIENT INTERNAL FUNDS ARE NOT PROMISING IF THE PAST TRENDS ARE TO CONTINUE. THE RECORD OF PAST FINANCIAL PERFORMANCE IS POOR.

RETURN ON INVESTMENT AVERAGED ONLY 9% OVER THE 1971-1980 PERIOD. THIS ROI WAS ACHIEVED WITH AN AVERAGE OPERATING MARGIN OF 5.6%.

WITHOUT ANY ALLOWANCE FOR INTEREST, IT WOULD TAKE 25 YEARS FOR THE INDUSTRY COMPOSITE OPERATING PROFIT OF 178.1 MILLIONS EARNED IN 1980 TO PAY FOR THE PLANNED INVESTMENT.

THE AIRLINE INDUSTRY, THE REGULATORY BODIES AND THE PUBLIC CANNOT AVOID THE NECESSITY OF IMPROVED EARNINGS.

THE CANADIAN TRANSPORT COMMISSION (CTC) SHOULD RECOGNIZE A ZONE OF REASONABLENESS FOR THE ROI REQUIRED BY

CANADIAN AIR CARRIERS TO COMPETE WITH OTHER INDUSTRIES FOR FUNDS. BASED ON THE RESULTS OF THIS STUDY, THE ZONE SHOULD RANGE FROM 14.5% TO 19% WHERE:

- THE LOWER LIMIT OF 14.5% REPRESENTS THE MINIMUM ROI REQUIRED BY A CARRIER WHICH ALREADY ENJOYS THE INDUSTRY'S TARGET DEBT TO EQUITY RATIO OF 55/45 TO FINANCE NEW CAPITAL EXPENDITURES WHILE MEETING THE FIXED CHARGES ON EXISTING CAPITAL AND MAINTAINING THE DESIRABLE CAPITAL STRUCTURE.
- THE APPROXIMATE MIDPOINT OF 16% REPRESENTS THE ROI REQUIRED BY THE INDUSTRY TO FINANCE NEW CAPITAL EXPENDITURES AND TO ACHIEVE THE TARGET DEBT TO EQUITY RATIO OF 55/45 IN FIVE YEARS.
- THE UPPER LIMIT OF 19% REPRESENTS THE CURRENT MARKET COST OF CAPITAL FOR CANADIAN AIR CARRIERS AND IS VITAL FOR CARRIERS WHO DO NOT HAVE ACCESS TO DEBT FINANCING AT RATES BELOW PRIME.

BY EARNING 14.5% FOR FIVE YEARS, THE INDUSTRY AS A WHOLE WOULD ENJOY A 62/38 DEBT/EQUITY RATIO BY THE END OF 1985.

EARNINGS AT 19% ROI LEVEL WOULD RESULT IN A DEBT/EQUITY RATIO OF APPROXIMATELY 50/50 AS OF DECEMBER 31, 1985. EARNINGS WITHIN THE ABOVE ZONE WILL ENABLE CANADIAN AIR CARRIERS TO GENERATE SUFFICIENT CASH TO PAY OFF PRESENT AND FUTURE DEBT AS WELL AS TO PRODUCE A RETURN ON EQUITY WHICH WILL ATTRACT NEW EQUITY CAPITAL TO THE INDUSTRY.

UNLESS PROFITS IMPROVE AND THE BALANCE SHEETS GET STRONGER, A SERIOUS IMPAIRMENT OF SERVICE WILL THREATEN THE TRAVELLING PUBLIC.

THIS URGENT NEED FOR IMPROVED PROFITABILITY SHOULD BE TRANSMITTED AS A FIRST ORDER OF BUSINESS TO AIRLINE MANAGEMENT AND EMPLOYEES (UNIONS), REGULATORY BODIES, CONSUMER GROUPS AND THE GENERAL PUBIC.

BOTH THE AIRLINES AND THE REGULATOR MUST CONTRIBUTE TO ACHIEVEMENT OF THE TARGET. AIRLINES WILL CONTINUE TO IMPROVE COST EFFICIENCY OF OPERATIONS AND TO EXERCISE RESPONSIBLE YIELD MANAGEMENT.

THE REGULATORY BODIES, ON THEIR PART, ARE REQUESTED TO ACT ON THE FOLLOWING KEY RECOMMENDATIONS OF THE TASK FORCE CONCERNING:

1. IMPROVED PROFITABILITY

   AS LONG AS AN AIR CARRIER IS EARNING LESS THAN THE UPPER LIMIT OF THE REASONABLE ROI ZONE, THE CTC SHOULD FAVOURABLY CONSIDER TARIFF CHANGE REQUESTS, WHETHER JUSTIFIED ON THE BASIS OF COST RECOVERY OR ON THE BASIS OF IMPROVED PROFITABILITY.

2. RELAXATION OF JUSTIFICATION REQUIREMENTS FOR TARIFF FILINGS

   BASED ON AIR CARRIERS' FIRST GENERAL TARIFF FILING FOR EFFECT IN A CALENDAR YEAR THE CARRIER AND THE CTC WILL ESTABLISH A PERCENTAGE RANGE WITHIN WHICH TARIFFS WOULD BE ALLOWED TO INCREASE WITHOUT FURTHER JUSTIFICATION DURING THE SUBJECT YEAR.

3. REDUCED COST OF FINANCING

   TO ALLOW CANADIAN AIRLINES ACCESS TO THE LOWEST COST AIRCRAFT FINANCING, THE M.O.T. SHOULD ADOPT AMENDMENTS TO THE AIR CARRIER REGULATIONS WHICH WOULD ENABLE CARRIERS TO OPERATE AIRCRAFT REGISTERED OUTSIDE CANADA

DOMESTICALLY, THE CANADIAN INCOME TAX ACT SHOULD BE REVIEWED AS IT RELATES TO THE AIR TRANSPORT INDUSTRY WITH EMPHASIS ON CAPITAL COST ALLOWANCE AND TAX SHELTER ADVANTAGES TO THE LESSOR.

OBVIOUSLY THE KEY TO WHAT TYPE OF CAPACITY WILL BE DEPLOYED BY THE AVIATION INDUSTRY BY THE YEAR 2000 WILL DEPEND ON WHAT THE CARRIERS CAN AFFORD. THIS IN TURN DEPENDS ON DECISIONS MADE BY GOVERNMENTS, REGULATORY AGENCIES, PASSENGERS, SHIPPERS, SUPPLIERS AND LAST BUT NOT LEAST, THE AIRLINES THEMSELVES.

ACCORDING TO JIM WORSHAM, PRESIDENT OF DOUGLAS AIRCRAFT THE WORLD'S COMMERCIAL AIR FLEET WILL REQUIRE BETWEEN 5000 AND 7000 NEW AIRCRAFT BY 1995 AND THAT AN ANTICIPATED RETURN TO 6% ANNUAL TRAFFIC GROWTH BY THE AIRLINES WOULD MORE THAN DOUBLE THEIR CURRENT REVENUE PASSENGER MILES TO A TOTAL OF MORE THAN 1.5 TRILLION REVENUE PASSENGER MILES PER YEAR.

THAT KIND OF GROWTH COULD SOLVE A LOT OF PROBLEMS. IF WE ARE NOT CAREFUL, IT COULD ALSO BE AN INVITATION TO HIDE A LOT OF SINS. THE AIR INDUSTRY CAN NO LONGER AFFORD TO LET THIS HAPPEN. THE BENEFITS OF GROWTH, TO THE EXTENT IT OCCURS, MUST BE FOCUSED ON IMPROVING THE EARNINGS MARGIN OF CARRIERS IN ORDER TO ENSURE THEY ARE AROUND TO PURCHASE AND OPERATE THE AIRCRAFT THAT WILL BE FLYING AT THE TURN OF THE CENTURY.

HOPEFULLY A FOUNDATION IS BEING LAID TO BRING THIS FACT OF LIFE HOME TO EVERYONE USING THE AIR TRANSPORT SYSTEM AND EVERYONE WORKING AT MAKING IT GO.

TRANSPORTATION: LEARNING FROM OUR PAST TO BUILD OUR FUTURE

NOTES FOR A PAPER

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ABSTRACT

This paper discusses the characteristics of the existing Canadian rail system, how they developed, and likely changes that may occur by the end of this century. Technologically, the railways will evolve in incremental, rather than revolutionary, stages. The greatest opportunity for change rests with rail's service characteristics, which, because of the pending surge in railway replacement and expansion, have the potential for being designed in response to user needs. Because of topical contents of the paper, it is subject to change upon presentation.

INTRODUCTION

Canada today has a transportation network to be proud of. It is competitive, it is efficient and it is reliable. Most of all, it is responsive to the needs of its customers -- constantly seeking ways to provide them with better and better service.

It has taken a long time for Canada to achieve such a system. In so doing, many of our traditional beliefs about transportation, and its role in our society have had to change.

In the 1880s, when the CPR was built, it was widely believed that transportation was so important for the good of the country -- through its use as a means of promoting settlement and economic development -- that it was almost irrelevant whether it was economically sound or not.

This philosophy took a tenacious hold on our national conscience. So strong a hold, in fact, that remnants of it are still being espoused. But this philosophy is almost extinct now, and the transportation system has become a modern, competitive network to move goods across Canada.

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Technology was the initiator of this development. Up to the Second World War railways were the principal, and in some cases the only, form of transportation available. After the war, advances in highway truck design and a substantial improvement in the road system, allowed trucking to become a viable alternative to the railways. In 1959, the St. Lawrence Seaway was opened, providing Eastern Canada with another mode of transportation.

Such technical changes were the impetus behind the first stirrings of competition between different modes of transportation. However, our philosophy and regulatory climate both took time to recognize and accept the changes occurring in the market-place.

As far as railways were concerned, it wasn't until the MacPherson Commission of 1961 that official recognition was given to the increasingly competitive nature of transportation. This Commission concluded that the broad aim of Canadian transportation policy should be to ensure "the various modes of transportation be given a fair chance to find their proper place within a competitive system..." It further recommended that transportation be "allowed to develop in response to the demands of shippers for its services." [1]

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With the National Transportation Act of 1967, this new philosophy moved towards political reality. The NTA permitted all modes of transportation to find their proper, most effective economic place in the total picture. It enabled railways, for example, to negotiate with shippers for rate levels designed to permit development of industries such as coal and petrochemicals, far from tidewater.

With these steps, the objective of Canadian transportation moved further and further away from the original philosophy. Transportation is still used as a tool of national policy, but it now is recognized that it has to be employed within the framework of natural economic forces. In short, all modes of transportation not only have to serve a purpose, they also have to be economically viable.

But what are the practical realities of the competitive transportation system that we now have, and what are their implications for our rail network during the remainder of this century?

Basically, operating in a competitive environment means that each mode of transportation has to meet the specific service and cost requirements that its users request, or risk losing traffic to a competing mode. Such requirements can be divided into three main categories -- adequacy, economy and efficiency.

By adequacy, I mean the ability to serve all desired areas of the market; the capacity of route and plant to accommodate peak movements in traffic; and the regularity of operations, which allows customers to be served year round.

Adequacy has a different meaning for different commodities. For grain, it is the availability of cars and locomotive power to move the product to meet peak market demands. For coal, it is the availability of equipment for loading at mines. For petroleum, it is the capacity of pipelines and tankers to maintain the flow of crude oil, and the list goes on.

By economy, I'm referring to the cost of transportation service. If several carrier routes are available, and all are adequate, a customer will naturally choose the least-cost carrier.

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By efficiency, I'm referring to factors such as dependability, safety and speed. It can often be said that using a lower-cost carrier will increase the transit time of commodities to be moved. In moving most of Western Canada's bulk commodities, dependability of service is of prime importance, since they are primarily export-bound. The arrival of a commodity at a port has to be co-ordinated both with port facilities and with ship arrivals, to ensure a smooth flowing system.

In Canada, the needs of transportation users vary according to the area of the country in which they operate. The East -- Ontario and Quebec -- is industrialized. The majority of Ontario and Quebec's traffic is manufactured goods, ideally suited for transport by truck and intermodal systems. These provinces also have access to the St. Lawrence Seaway and make good use of the services it provides.

In the West the situation is very different. Most Western traffic tends to be high-volume bulk commodity shipments such as grain, coal and potash for export markets. Since the Prairie provinces are landlocked, they do not have the opportunity of using domestic maritime shipping to transport their goods to tidewater.

These differences can be clearly seen from statistics provided by a recent Transport Canada study.[2].

Transport Canada analyzed the breakdown of activity of three competing modes -- rail, truck and marine -- for the year 1979. Based on this analysis, they also did a forecast of the activity of each mode for the year 1990. The figures have to be interpreted with caution, as there is some double counting.

In 1979, the three Prairie provinces accounted for 27 per cent of all rail loadings -- 65.2 million metric tons. If British Columbia is included in the total, 42 per cent of all Canadian rail loadings occurred in these four provinces. This is only slightly greater than Quebec and Ontario, which accounted for 41 per cent of all rail loadings.

If statistics for the other two modes are examined, the East dominated. Fifty-five per cent of all marine loadings -- 118.2 million tons -- occurred in Quebec and Ontario, compared with only 35 per cent for the West. Quebec and Ontario also accounted for 65 per cent of all truck loadings.

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To summarize these figures, in 1979 the majority of traffic loadings, whether it was on rail, truck or marine vessels, took place in Ontario and Quebec.

In the same study Transport Canada forecasts that, by 1990, all levels of traffic will have increased significantly -- rail loadings up 43 per cent, marine up 40 per cent and truck up 30 per cent.[3] But even more importantly, there will have been a marked shift in traffic origins.

By 1990, it is forecast that 50 per cent of all rail traffic will originate in the four Western provinces -- 31 per cent, or 105.1 million tons on the Prairies and 19 per cent, or 63.5 million tons in British Columbia. By comparison, only 34 per cent of all rail traffic will originate in Quebec and Ontario. A similar, shift is seen in marine traffic. By 1990, 44 per cent of all marine loadings will occur in British Columbia, while the percentage of loadings in Quebec and Ontario will have dropped to 45 per cent of the total. A similar, but much smaller shift is also seen in truck traffic.

What conclusions can be drawn from this data?

It is clear, even though the current recession has altered the timetable, that Western Canada's natural resources will generate traffic growth for this decade, and in all probability for the next as well.

This forecast also demonstrates the need for an adequate Western port system. By 1990, it predicts that 134.1 million tons of commodities will be loaded onto ships in British Columbia -- a 78 per cent increase over 1979.

While I spoke earlier of the adequacy of different transportation modes, what we really have to look at is the adequacy of the total system.

I think I can safely say that while Canada has plentiful natural resources, we do not have a monopoly on any of them. We have to compete with those countries -- whether they be the United States, Australia, Brazil, or the European Economic Community -- which also want a stake in the international market-place. This constitutes very tough competition, but it is one we are going to have to beat if we want to realize our economic goals.

We can no longer afford to look at any component of a commodity's production, marketing or transportation process in isolation. Production decisions impact on marketing decisions, which in turn impact on transportation decisions. The same holds true in reverse.

Railways are ideally suited to handle the West's raw, bulk commodities. In fact, railways can be compared to a pipeline on wheels. They do their best job when handling repetitive, high volume, normalized annual volume movements. Not only are they ideally suited for handling bulk commodities, but both Canadian National's and CP Rail's lines go from east to west across the heart of the Prairies, providing access to both domestic and export markets, including the United States.

The railways are now at a crucial point in expanding the rail system that will be required by 1990 and to the end of the century. With interim grain payments, and the expectation of a legislated correction of the losses resulting from hauling grain at statutory rates, the railways will have the financial capabilities to increase the pace of modifying and expanding the existing system.

In 1983, both railways are pressing forward with significantly greater spending programs than would have been possible if no Crow resolution appeared imminent.

At CP Rail, our capital expenditures for 1983 are about 75 per cent greater than would have been possible if we had not received payment for our grain-handling losses. A total of $315 million will be spent on capital programs this year.

A brief over-view of some of our projects include:

-- a 40 million dollar, four-year expansion project at Golden, B.C., where a new yard and car repair facility will be built to service unit coal trains operating between southeastern British Columbia and Roberts Bank.

-- a 15 million dollar combined diesel-locomotive servicing and freight car repair facility will be built over a three-year period at Moose Jaw, Sask.

-- a four-year, 40 million dollar project will install centralized traffic control track signalling to expand capacity and improve operations on the 420-mile railway corridor between Winnipeg and Thunder Bay, Ont.

-- more than 20 million dollars of double-tracking and grade improvement work will be undertaken in the Rogers Pass-Revelstoke area of the Selkirk Mountains in British Columbia, to provide additional capacity to carry the growing volumes of grain, coal, potash, sulphur and other commodities to tidewater.

On the Canadian National line, projects include:

-- the spending of 87 million dollars to complete sections of double track on the south line, as well as terminal improvements at Winnipeg, Jasper, Boston Bar and North Vancouver, and signal system improvements between Kamloops and Boston Bar.

-- upgrading of the B.C. north line at a cost of 105 million dollars for rail, ties, ballast, drainage, bridges, sidings and signalling works, as well as for terminal improvements at Prince George, Smithers, Watson Island, Terrace, Endako and Ridley Island at Prince Rupert.

-- expanding intermodal terminals and the introduction of general productivity programs at a cost of 24 million dollars.

As you can see, we are starting to put in place the rail system of the future.

As for the railways' needs to the end of the century, any changes that will occur will be determined by the same factors that are with us today -- the need to have sufficient capacity to safely handle traffic demands, the need to improve productivity and equipment utilization and the need to be cost-efficient.

We are a mature industry, with proven technologies and methodologies, and I don't foresee any great technological or operational leaps ahead during the next 17 years. But I do have my own perspective on some of the evolutionary changes that might occur.

I doubt very much that we will see any electrification of high density traffic lines. Under current conditions electrification is not economically viable, and our best estimates for the future show only marginal improvement in the economics. It is perhaps more probable that some exotic fuels may come into use -- propane or other liquid fuels, perhaps from coal -- but this too will be largely dependent on diesel fuel availability and costs.

Certainly, there will be greater utilization of computers in railway operations. Centralized computer systems will allow us better surveillance of train performance across the system so we can optimize their content and movements. There will be an improvement in dynamic train control, to provide improved fuel efficiency and safer train handling, through the installation of microprocessors onboard trains. Video display terminals may be placed in locomotive cabs, to transmit vital information to the engineer.

But despite these changes, the rail system in the year 2,000 will still have a 4 ft. 8½ inch (1.44 metre) gauge and will not be vastly different from the system we now have. Certainly, the rationale we use to evaluate our investment decisions for expansion projects will be the same.

Each project we undertake, each dollar we spend, requires careful planning. Before we proceed with any project we have to seek answers to the following questions: What facilities need to be expanded? What equipment has to be purchased? How should feeder services be designed? Where are new terminals and customer services required? In short, we look at various projections of traffic growth and shifts and try to determine the optimal ways of improving the rail system to meet these changing needs.

These questions have to be answered so that we can achieve a well designed system which meets all the criteria of adequacy, economy and efficiency.

A key element of these decisions, which perhaps tends to be overlooked at the time, is that each project we undertake has a limiting impact on future projects. The installation of hot box detectors, the increasing utilization of centralized traffic control with established siding spacings and the environmental impact of railway construction both in urban and rural areas, all tend to limit the options available in the future -- or at least make it very expensive to change the configuration of the expanded system once it has been put in place.

These factors make it essential that we have a clear idea of the future demands our users are going to place on the system, before we get too far along in each phase of capacity expansion.

We now are preparing for the greatest single thrust of rail replacement and expansion since the 1880s, but with a significant difference -- <u>we are now tailoring the system to meet the needs of our users</u>. We are building to get their goods and commodities to market. The opportunity we have is not just to put a rail network in place, the railways can do that, the opportunity is for <u>all</u> participants in the system to work together to build the best system possible.

Although they may not be aware of the fact, our users have a great potential for influencing transportation service design. Any company facing a major capital expenditure wants to build the most productive facility that can be built. So do the railways. By viewing the system as a whole, mutual productivity gains in each area can be identified, to achieve the greatest overall efficiency.

For this opportunity to be grasped, all participants have to learn to co-operate, to consult together, and to work together in an atmosphere of trust. This will require flexibility in needs and demands, so that the best overall system can be created. It will also require the discipline of not looking at each part of the system separately, but of looking at the system as an integrated whole.

In certain cases, this flexibility has been achieved -- but only for specific industries. I am referring to the co-operation that permitted the coal and potash producers to develop world-scale industries far from tidewater. Through the use of innovative railway techniques, such as mid-train power -- coupled with an integrated approach to design of handling facilities -- Canadians have been able to develop these industries while overcoming the inherent disadvantage of inland location compared with many major competitors.

Of course, the operations involved in handling coal, potash or sulphur are very different from those necessary for hauling grain. Unit trains of these commodities are loaded at a single source, with one grade of the commodity. Grain trains are put together with cars loaded at many elevators with different grades, or even types, of grain. As a result, many railway operating techniques or innovations developed to haul potash or coal efficiently are not applicable to grain.

But grain can be handled more efficiently by the railways. For the past ninety years, not only has grain been effectively isolated from the competitive environment that has emerged for transporting all other traffic, it has imposed a capital shortage on the railways. The result is that the grain transportation system has not really been upgraded to take advantage of modern shipping methods.

Under proposed changes to the statutory grain rate, the railways' revenue base will be improved. But we are now very concerned about the potential for increa sing the productivity of the total system. There must be incentives for all participants in the system to seek efficiencies. We cannot afford to let traditional practices and beliefs blind us to the possibilities of the future

In the United States, where all participants share in the cost of grain handling and transportation, many innovations have been introduced into their system.

Some Americans have been experimenting with the use of a standardized grain container placed on a rubber-tired vehicle. The container is filled with grain and sealed at the farm, and transported to a rail yard, where is it transferred to a rail flat car. At an ocean port, the container is transloaded onto a ship and delivered to its overseas customer, without ever having been opened from the time it was filled. It's possible we could see a low, combination ocean-rail rate develop for this type of traffic.

Admittedly, this technique may not be relevant for Canadian conditions, except for hauling specialty crops, but there are improvements that we can make. At CP Rail we have been experimenting with a new operating procedure to reduce the travelling time of westbound solid grain trains from the Prairies to British Columbia by up to 21 hours. Time-saving has been achieved by placing robot cars on the train at its main line origin. Normally, the robot car is inserted into the train at Calgary, where it is needed to get the heavy train over steep mountain grades.

This and other innovations that might be suitable to our Canadian grain-handling environment could be considered or tested with a view to improving the productivity of our system.

With my rail background, I can only speak with knowledge on possible ways the rail portion of the system can be improved. I am not suggesting that these are changes that have to be, or even should be, incorporated into our grain handling system. But rather that grain handling and transportation on a properly compensated basis, no less than any other operation, is subject to and should be ready to respond to change -- to examine and introduce new methods and equipment which will improve its efficiency.

Certainly the system is already responding to change. The Wheat Pools are installing computerized inventory systems to review instantaneously the volume, type and grade of grain in storage. If the participants in the total grain handling system could co-ordinate these and other responses to change -- to create a synergism of change -- then the benefits will be that much greater.

In looking at ways to improve the total system, the railways can help by defining the restrictions or limitations of new approaches from a rail perspective. We could also help by suggesting possible ways a new approach might be improved. It must not be forgotten that we, like any company operating in a competitive environment, have to meet the needs of our customers.

As we head into the twenty-first century, the rail system will be different. Technologically, the changes may not seem great, but they will be there. When I started my railroad career about 37 years ago, we were almost a total steam railway and our basic fleet unit was the 40-ton boxcar. That's almost completely changed now. In addition, most of the plant has been replaced a couple of times.

To stand still is to lose competitive position -- not just with the competitor you can see, but in world markets as well. I don't think we can afford that, even if we wanted to.

But, the most important need facing railways today is for our users to decide and let us know their future needs, and for them to join with us in seeking an efficient transportation system. Their choices are crucial for the future development of the system, and it is only with their input and support that we can grow, change and achieve the transportation network that Canada needs and deserves.

REFERENCES

1. Royal Commission on Transportation. 3 vols. Ottawa: The Queen's Printer, 1961

2. Transport Canada. Transport Canada Freight and Passenger Forecasts. Ottawa: Transport Canada Economic Analysis Directorate, December 1982

3. Ibid.

A TRANSPORTATION REGULATORY AGENDA FOR THE YEAR 2000

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A TRANSPORTATION REGULATORY AGENDA FOR THE YEAR 2000

INTRODUCTION

The economic regulation of transportation has had a long and eventful history in Canada. The most obvious feature of Canadian transportation regulation is that we have always been ready to regulate. For example, in 1851, when there were less than 100 miles of railway track in Canada, the Rail Clauses Consolidation Act provided for the approval of rates by the Governor in Council and stipulated there was to be no discrimination in rates. In 1919, about a decade after the inaugural flight by the Wright brothers, the Air Board Act signalled the beginning of air transport regulation in Canada.[1]

Not only have legislators been quick to react to developments in the transportation sector, they have also been more than ready to anticipate developments. For example, we have the not-so-well known statute known as the Teleferry Act. Any of us who contemplate the operation of a teleferry which would connect a province with any other province, or which would connect Canada with the United States should be mindful that the federal government already has a regulatory system in place for us.

While Canada has been ready to regulate, it has equally been ready to reform regulations. Perhaps the best example of this is the deregulation of the rail industry with amendments to the Railway Act and the National Transportation Act in 1967. More recently, we are seeing major reviews of the trucking industry, primarily in the province of Ontario.

I think that it is fair to suggest that the reason Canadians have been ready to reform economic regulation is due largely to economic realities, and not in response to a regulatory philosophy. It is no accident that the current impetus for regulatory reform began with the First Ministers Conference in February of 1978 which focussed on the need for new economic strategies. Economic conditions since that February 1978 meeting, particularly the recession of 1981-1982, have led shippers and carriers and governments alike to seriously re-examine the kind of economic institutions which can best serve the transport sector and the economy as a whole. That process is still ongoing in many sectors.

The purpose of this paper is to attempt to define the current direction of transportation regulation in Canada, with particular reference to the impact on surface freight transportation. The

paper will also attempt to identify those issues which will require the attention of carriers and shippers and governments over the next ten to fifteen years.

MAJOR CURRENT ISSUES

Three issues which both define the present state of transportation regulation in Canada and serve as points of departure for the future direction of transportation regulation.

The first issue is pricing. This includes the future of tariff bureaus for both rail and truck carriers, the question of common rates (particularly for the rail industry), and the consequent exemption or lack thereof from the Combines Investigation Act for both rail and truck carriers. The second issue, and this relates in part to the pricing issue, is the question of Canada/U.S. regulatory interaction. Over the past winter, we have seen evidence of difficulties in the air sector and the trucking sector, and there are also major implications for the rail sector. The third issue is the impact of regulatory change. The essence of this question is whether existing institutions (both public and private) can cope with rapid deregulatory change, and whether new institutions and institutional arrangements are possible to meet the

challenges of various kinds of regulatory developments.

PRICING

Pricing is a key element in the transportation sector. It represents what shippers pay and try to keep to a minimum. It represents what carriers receive and try to keep to a maximum. It also represents what governments regulate and this regulatory activity is of great importance to both shippers and carriers alike.

The pricing structure in the transportation industry is certainly among the most complex in the economy. Even the mention of the words "tariff bureau" creates an instant image of volumes of paper, complex rules and regulations, etc. The role of a tariff bureau (in this case the Canadian Freight Association, representing Canadian railways) has been described by the Canadian Transport Commission as follows:[2]

> As a practical matter, the Canadian Freight Association acts as the agent, in fact, if not always in law, for all the carriers who file tariffs of tolls with the Committee. It is not difficult to understand why this practice has grown up, when it is realized that there is a tremendous annual volume of new tariffs and amendments to old tariffs ranging from those that involve only one railway company to those affecting shipments between points in Canada and the United States, involving scores of railway companies, both domestic and foreign. In one sense, the Canadian Freight Association is a clearing house for the tariff material that is being submitted for filing almost daily to the Committee. In another, it is the agent for the carriers in relation to matters

> pertaining to concurrences in and filing of freight tariffs as required of railway companies by the Railway Act and by regulations established by the Commission.

The prices published by tariff bureaus are in many ways like prices in a department store catalogue. The types of goods and services available and their prices are identified. However, the difficulty which arises is that each carrier does not have its own "catalogue"; there is one catalogue for all carriers. Therein lies the essence of the tariff bureau issue which is whether the existing operation of tariff bureaus eliminates price competition in the transportation sector.

If we analyze this argument extensively, we are bound to examine rate bureaus as cartels. A recent article on this subject makes the connection quite clearly:[3]

> The term "cartel" refers to a group of producers who collaborate for the purpose of stressing or limiting competition. The goal of the cartel is to eliminate all competitors so that the group of firms can act as a single monopoly firm. Generally, collusion will generate larger total profits for the group, and thus is preferable to competition. Railroad rate bureaus, acting within the cartel framework, limit the price competition among their members so that all carriers will remain competitive, rather than compete with each other. (Original emphasis)

This same article examines in some detail the various arguments which have been put forward by both carriers and shippers in support of tariff bureaus.

The first argument examined concerns the advantages to shippers in rate uniformity and stability. The discussion concludes that while advantages exist, greater economic efficiencies exist with a system which allows shippers and carriers individually and efficiently to respond to changing economic conditions.

The second argument examined concerns the notion that the rate bureaus can establish rates which provide rail service to shippers with a wide range of routing options. Again it was considered that this argument has some merit, but that the need for multiple routes stemmed from various other kinds of service inadequacies, such as circuitous routing. The discussion concludes that more important service features such as transit time and reliability are being affected adversely by the practise of maintaining an excessive number of alternate routes.

The final argument examined was that collective rate making was of benefit to "captive shippers". The essence of this argument is that without collective rate making captive shippers would be charged more than shippers with competitive options and that these higher costs would in turn result in route abandonment thereby eliminating service to the captive shipper. The discussion concludes that the costs to the majority of shippers in protecting the captive shipper through

collective rate making are much larger than the potential costs to the captive shipper if tariff bureaus were eliminated. In general, this study concluded that while there were certainly costs to shippers in eliminating tariff bureaus, the benefits resulting to shippers as a result of eliminating tariff bureaus were substantially greater. The study did not offer any quantitative estimates of either the benefits or the costs.

Possibly the strongest argument in favour of tariff bureaus is they minimize transaction cost. At present, for example, any shipper who is moving goods by rail can have access to the rates of any other shipper to any destination. Without tariff bureaus it is argued, this information would be extremely difficult and costly to obtain. Whether this argument is still valid with the present state of computer technology is uncertain, but it would certainly be less costly in today's economy than it would in the days prior to the widespread use of computer technology.

A specific consequence of the operation of rail tariff bureaus is that railways are allowed to agree upon and charge common rates. This is specifically allowed (but not required) under Section 279 of the Railway Act. As part of the review of the regulation pursuant to the First Ministers Conference in February

1978, a study by the Canadian Transport Commissions Research Division entitled "Competition and Regulation in the Railway Freight Industry"[4] reviewed this matter and concluded that Section 279 should be retained at the present time.

Various concerns were subsequently raised about this status quo position. The strongest position was expressed from the Department of Consumer and Corporate Affairs which made an argument similar to the above study on the operation of tariff bureaus in the United States, namely that present regulations remove the possibility of price competition from railway freight traffic. The Canadian Manufacturers Association found itself in "sympathy" with the position of the Consumer and Corporate Affairs and requested to Transport Canada that a more comprehensive study of Section 279 be undertaken. As a result, a study was undertaken by Trevor D. Heaver for Transport Canada entitled "Competition and Collective Pricing Between Railways in Canada".[5] The study, now in draft form, concludes that collective rate making "is well suited to Canadian economic and political conditions."

It is evident that there is no clear consensus in the transportation community on whether Section 279 should be retained or repealed. Both railways have indicated that they are inclined to retain Section 279

as is, and are able to demonstrate a number of advantages to shippers with the current arrangements compared to what might arise with the elimination of the Section. Shippers appear to be of two minds: on the one hand, shippers are anxious to see more price competition on the part of the railways; but on the other hand, since there is no guarantee of price competition, they are reluctant to move away from a regulatory system which, first of all they understand, and second, which at least ensures a certain level of service competition.

Another very important implication of Section 279 of the Railway Act is that it effectively exempts rail carriers from the provisions of the Combines Investigations Act. Therefore, if Section 279 were repealed, and if railways were not specifically permitted to charge common rates, it is conceivable that certain actions on the part of the railways might be subject to review under the Combines Investigation Act itself. This would provide for a very different kind of regulation of railway rates than we have ever experienced in Canada. It would in fact give rise to a situation very close to that which now exists in the United States, where the Sherman Act (the U.S. equivalent of the Combines Investigation Act) is the major effective regulatory force for railway pricing. It is widely recognized that the U.S. anti-trust laws

are substantially more pro-competitive than the existing Combines Investigation Act in Canada. However, it is apparent that some changes may be made to the Combines Investigation Act, and it is difficult to make any sound judgements on the eventual impact of the removal of Section 279 of the Railway Act without knowing what the anti-combines law in Canada might eventually be.

To summarize this discussion on pricing, tariff bureaus, and common rates, it is evident that there is a great deal of concern about the workings of the existing tariff bureaus, and the general collective rate making process in Canada. That concern is certainly more organic than systematic in origin, i.e. it is based more on "feelings" than analysis. It also suffers from a lack of any clear and quantitative impacts of either the existing system or of any proposed systems. Since the transportation component of many of Canada's products is crucial to both the domestic and international competitiveness of Canadian goods, it would seem imperative that this whole question of collective rate making be pursued as the first item on a regulatory agenda.

Furthermore, since the United States has removed virtually all of the price regulation which has applied to the rail, motor carrier, and air sectors over the

past few years, it would be instructive to monitor the developments in that country. The following section looks at the relationship between the Canadian and the U.S. regulatory system particularly with a view toward ensuring compatibility on the transportation of goods from Canada to the U.S. and vice versa.

CANADA/U.S. REGULATORY SYSTEMS

It is well known that over the past few years, the United States government has deregulated the air, motor carrier, and rail sectors dramatically. This same move has been paralleled in most of the individual states as well. From the Canadian perspective, these various deregulatory moves have resulted in an increased divergence between the Canadian and the U.S. regulatory systems. While this divergence need not necessarily be a major problem, it is clear from several recent events, that it may well arise as a serious impediment to Canada/U.S. trade.

In the fall of 1982, the President of the United States issued a moratorium on the issuance of certificates or permits for Canadian motor carriers to operate across the international border. The deregulation of U.S. trucking industry has resulted in a "vending machine" approach towards entry into the trucking industry, and Canadian carriers were taking

advantage of this. However, at the same time, the Canadian provinces were operating with a much more restrictive entry system and U.S. carriers did not have the same ease of entry into the Canadian industry that the Canadian industry had to the U.S. In addition, U.S. truckers wishing to purchase Canadian operations were subject to the Foreign Investment Review Act.

Both Federal and Provincial Ministers responsible for Transport issued a joint statement which expressed concern over the U.S. action which it termed "unwarranted and unacceptable". Following bilateral discussions, both Canada and the United States have agreed to some basic principles that should apply in the regulation of transborder trucking. A task force comprised of officials of both countries continues to meet on this matter.[6]

Last winter, a dispute arose concerning transborder airfares. This dispute was based on the markedly different rules for entry and for price regulation in the airline industry in the two countries. The immediate problem of a suspension of a transborder airfare was resolved and talks are continuing on various other transborder air issues.

The passage of the U.S. Staggers Rail Act in October 1980 created some very unusual difficulties for

Canadian railways. The difficulty arose in connection with joint international through rates. The U.S. Staggers Act stated that only "practicable participants" in a joint rate could get together and discuss that rate. This created an unusual situation for the Canadian railways:[7]

> The dilemma perceived by the Canadian railways was as follows: if executives from the CN and the CP were to meet collectively in conformity with Canadian legislation, set rates for traffic destined for the U.S., both the CN and the CP together with the officers as individuals, together with the shippers involved, would be vulnerable to a multi-million dollar anti-trust suit in the U.S. -- notwithstanding that they acted strictly in accordance with Canadian law.

Both CN and CP have made numerous appearances before the ICC in an attempt to gain some kind of immunity from U.S. anti-trust laws. Specifically, the railways are seeking to have themselves considered as "one integrated enterprise". In this way, the Canadian railroads could continue to meet together as they are permitted now to do so under Canadian law, and to continue to partake in joint rates with practicable American carriers. The Interstate Commerce Commission in the United States has not yet made a decision on this application.

This case has appeared to give the Interstate Commerce Commission a good deal of concern. First, it is considered that the ICC may be reluctant to grant to

foreign railroads what it does not grant to railroads within the U.S. Second, it is not clear whether the ICC has the jurisdiction to grant this kind of immunity. Third, it is not certain that the ICC would be inclined to grant immunity of this nature.

In the event that Canadian railways do not succeed in obtaining immunity, in one form or another, from U.S. anti-trust laws, it is likely that in the case of international traffic, there would be a common rate between a border point and Canadian origins or destinations, and a joint rate from the border point to the U.S. destinations. Alternatively, one could imagine a joint rate involving one or other of the Canadian railroads and whatever number of U.S. carriers. While either of these events would not likely be the end of the world for Canadian shippers (or for Canadian railroads), it is clear that such an event would result from the imposition of conduct on Canadian railroads by U.S. regulatory authorities. The question has frequently been raised of a need for a more integrated approach to transborder rail traffic. The following paragraphs discuss the origins of such a proposal, and some potential options for the future.

The closest that Canada and the U.S. have come to a joint regulatory regime was in the 1910 to 1914 period. At the time, the concern arose that there was not sufficient control over international rates by the

ICC and the then Board of Railway Commissioners for Canada. At the request of their respective governments, the Chairmen of the ICC and the Board considered the question of joint control of international traffic. They joined in finding that:[8]

> The existing laws of the United States and Canada are inadequate for the effective control of international carriers, as respects through rates and the establishment of through rates and other matters which are proper subjects of joint regulations, and such regulations would be mutually advantageous to the interests of both countries.

The recommendations from the two Chairmen were embodied in a treaty which was submitted by the U.S. State Department to the Government of Canada in 1911. No further action has subsequently taken place.

The essence of the treaty was that it would regulate international carriers in a manner similar to that exercised over interstate carriers in the United States. Appeals from the joint board would be available to each carrier in its own jurisdiction. It is clear that even in 1910 the regulations of the ICC were much different from those of the Canadian regulatory body. The difficulty in devising a joint regulatory system which would satisfy both regulatory systems remains to the present. Until 1980, the situation which we faced was one where the U.S. regulatory system was much more stringent than that in Canada; at present, the situation is reversed.

The volume of trade as well as passengers between Canada and the United States is of sufficient importance to ensure that both trade and passenger flows occur in as uninterrupted a manner as possible. Whether uninterrupted flows can be best maintained through a specific regulatory system for transborder traffic, or whether ongoing discussions on problems which arise can best resolve the problem is not clear. However, it would seem imperative that the Governments of both the United States and Canada take whatever action is necessary to ensure that trade is maintained and fostered.

THE IMPACT OF REGULATORY CHANGE

In May, 1979, at a seminar on the subject "How to Handle Deregulation -- The Canadian Experience" then Vice President and Senior Executive Officer of CN Rail, R. R. Latimer, was invited to discuss how the railways saw the deregulation of the Canadian rail system in 1967. At that seminar, Mr. Latimer made the following remark:[9]

> It was not until 1974 that CP and CN began to take advantage of the rate freedom given them.

I would contrast that comment with the following quotation from a trucking industry consultant made in

late 1982 about two years after the Staggers Rail Act:[10]

> The joke in Washington today is when you (would) go through the halls of the (Interstate Commerce) Commission in the old days you would stick your head into the door and ask your old friend what's happening. Today when you go through the halls of the Commission, your old friend sticks his head out and asks you what's happening.

While I would not want to suggest that U.S. carriers have necessarily been able to react better and faster to deregulation, I think it is fair to say that both rail and motor carriers are more capable now of reacting faster to deregulation than carriers were in the late 1960's. An example of the speed at which change can take place is the situation concerning contract rates under the present U.S. rail regulatory system.

Contract rates were allowed in the Staggers Rail Act of October 1980. Under Section 208, railroads and shippers are allowed to develop contracts covering rates and conditions of service. The ICC has 30 days to either approve a proposed contract or schedule it for review. Once approved, the agreement becomes exempt from ICC regulation (and, incidentally, subject to anti-trust law). In the first 18 months after the passage of the Staggers Rail Act, one thousand contracts were consumated. The next one thousand took only three months; and it is estimated that by the end

of 1982, there were over three thousand contracts in force.

The contract rate is probably the most popular and creative aspect of the rail deregulation developments in the U.S. It allows rail carriers to tailor their transportation services to the specific demands of shippers. It also allows shippers to segment their transportation demand into small and large parcels, and to negotiate with a carrier or carriers to service this demand. Both shippers and carriers have shown a great deal of imagination in using this new rate tool.

While U.S. shippers and carriers have been fast to react to certain parts of U.S. rail deregulation, their is no guarantee that this kind of reaction will result in every case. Regulatory change, unless it is very carefully spelled out, and unless its goals and objectives are very carefully defined, can lead to a great deal of confusion. The remark quoted above from Mr. Latimer that it took Canadian railroads seven years before they began to take advantage of rate freedom speaks volumes not only of rail carriers, but of shippers as well. I think it is safe to say that regulatory change, whether it be in terms of the continuation of tariff bureaus, the introduction of price competition in the railway sector, or exemption from anti-combines law, should not proceed as an end in

itself. The eventual benefits of these various regulatory changes have to be very carefully thought out and identified together with the cost of such changes. Only then can shippers and carriers be expected to take a position one way or the other, and only then can the governments involved begin to assess the public benefits and costs of such moves.

THE RESOLUTION OF CURRENT TRANSPORTATION ISSUES

The title of this paper refers to a regulatory agenda. I have chosen the word "agenda" rather than a word like solutions, simply because the eventual solutions are not clear at this time. It is my view that if we direct our attention towards the items I have discussed above, we will be in a much better position to focus on both the problems and the solutions in the transportation regulatory system over the next decade or so.

The state of transportation regulation in both Canada and the United States today is at best confusing. The best way to describe the impact of existing impending deregulation in both the rail and motor carrier sector in both countries, is that it is much like the game of Chinese Baseball. Chinese Baseball is played the same way as American baseball, with one exception, ie. when the ball is in the air,

and until it touches the ground the fielding team can move the bases anywhere they want on the playing field. Thus, both a runner on base and a hitter know what they want to do, but it is never very clear exactly how they should reach their goals.

What I have attempted to do is to stimulate the discussion of transportation regulation and to suggest various areas which need both our attention and our quantification. Furthermore, while I have used a good number of American examples as benefits of deregulation, I would not want to suggest that we emulate the U.S. experience to the letter. Certainly, the main beneficiaries of the current state of U.S. rail deregulation are the the railways themselves. The railway companies are becoming valuable assets as stock market activity and merger activity certainly indicate. However, it is also clear that U.S. deregulation is designed to be of major benefit to consumers and not necessarily shippers.

What is required in the next decade or so is a resolution of many of the outstanding regulatory issues which arose during the 1970's and the early 1980's. The resolution of these issues can be accommodated with a new kind of regulatory planning, planning which is based on maximum flexibility. This kind of flexibility would allow shippers and carriers and governments to

respond quickly to developments as they occur rather than to lock us into a rigid system which does not adapt very quickly to changing situations. We will require a transportation regulatory system which promotes productivity and competition and one which will ensure that Canadian goods can effectively compete in both domestic and international markets.

FOOTNOTES

1 Z. Haritos and A. Elliott. Canadian Transportation Regulation: Trends and Issues, a paper prepared for presentation at the 61st annual meeting of the Transportation Research Board, Washington, DC January 1982.

2 R. W. Lake and P. M. Bunting (Editors). Competition and Regulation in the Railway Freight Industry, Ottawa: Canadian Transport Commission, Research Branch Report No. 1982/09E, Page 127.

3 B. J. Allen and M. R. Scheltheis. Trade-Offs Involved in Maintaining Railroad Rate Bureaus: An Evaluation of Shipper Support, ICC Practitioners' Journal, Volume 47, No. 5, 1980.

4 Op. cit.; Lake and Bunting.

5 T. D. Heaver, Competition and Collective Pricing Between Railways in Canada, A Study of the Issues with and Alternatives to Railway Pricing Under Section 279 of the Railway Act and Section 32(2) of the Transport Act prepared for Transport Canada, January 1983, TP4302, Draft.

6 External Affairs, Transborder Trucking, Press Release issued November 30, 1982, No. 172.

7 R. J. Lande, U.S. Deregulation -- Anti-Trust Implications for Canadian Railways and Shippers, The Logistics and Transportation Review, Vol. 18, No. 2, June 1982.

8 W. J. Wilgus, The Railway Inter-Relationships of the United States and Canada, 1937.

9 R. R. Latimer, The Challenge of Great Freedom, Railway Age, May 28, 1979.

10 Dr. Irwin Silberman, as quoted in Handling and Shipping Management, December 1982.

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TRANSPORT REGULATIONS

RATE ARBITRATION AND REPARATIONS IN CANADIAN TRANSPORT LEGISLATION

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In the summer of 1980, Transport Canada circulated a discussion paper on legislative proposals regarding freight rates.(1) During 1980 and 1981, representatives from Transport Canada and the Canadian Transport Commission wrote to and visited the provinces, the major railways and shippers' associations in order to understand their respective positions on the desirability of incorporating rate arbitration and/or reparations into Canadian transportation law. Toward the end of 1981, Transport Canada published two papers which concluded that no legislative amendments on the above subjects should be implemented.(2)

Footnotes

1. Transport Canada, Discussion Paper on Legislative Proposals Regarding Railway Freight Rates, March 24 1980. In addition to dealing with the subject of the arbitration process for settling rate disputes, this paper also analyzed maximum rate regulation and international rate regulation.

2. Transport Canada, Initiatives Regarding Railway Freight Rates, Dec. 14, 1981, and Transport Canada Reparations and Railway Freight Rate Disputes, Dec. 22, 1981. In lieu of legislative change, these papers recommend a speedier section 23 appeal procedure, a greater mediation role by the CTC, and a further review after three years.

The support which has been given to the concepts of rate arbitration and reparations stems from a dissatisfaction on the part of certain rail shippers with the present rate appeal mechanism under section 23 of the National Transportation Act.[3] The Section 23 appeal constitutes the major exception to the pricing freedom which was allowed to Canadian railways in 1967.[4] Section 23 gives the Canadian Transport Commission the authority to order the roll-back of any freight rate which has been proven to be prejudicial to the "public interest". Since 1967 there have been no more than five major rail section 23 appeals which have involved industry-wide protests against excessive rail rate levels or rate discrimination.[5]

Various shippers' associations have publicly complained about the lengthy delays and great expense

Footnotes

3. National Transportation Act, 1966-67, c.69, Chapter N-17.

4. Other regulatory restrictions on the freedom of railways to price their freight rates according to market demand include sections 276 and 278 of the Railway Act R.S., c.234. Chapter R-2.

5. In the Summary of Section 23 Applications, Traffic & Tariffs Branch, Canadian Transport Commission, March 1982, 26 section 23 appeals are listed from April 1970 to Nov. 1981. However, many of these applications required no decision as they were settled out of court. Others involved individual shipper complaints on such subjects as private siding fees and demurrage charges.

necessary to bring about a section 23 appeal.[6] They proposed rate arbitration as a less formal, quicker and inexpensive means by which small shippers could achieve redress from excessive freight rates. Although there have been many descriptions of the proposed "rate arbitration tribunal", we shall use the outline given by the Council of Forest Industries as an example.[7]

According to COFI, rate arbitration should only be initiated if the parties have already attempted to negotiate the freight rate(s). A full-time administrator appointed by the CTC would decide whether the criterion of full negotiation had been met.[8] Either the railway, an individual shipper, or a shippers' association would be able to request arbitration. Within ten days of the request for arbitration, the administrator must select an arbitrator who is acceptable to both parties. If

Footnotes

6. Position Paper - Rail Rate Arbitration, Council of Forest Industries of British Columbia, July 31, 1980, page 9. A Users Point of View, Kevin B. Doyle, President, Sultran Ltd., Western Canadian Transportation Congress, Edmonton, Sept., 1982, page 5. A Transportation Policy Framework, Joseph Macaluso, President, The Coal Association of Canada, Western Canadian Transportation Congress, Edmonton, Sept., 1982, page 10.

7. Position Paper - Rail Rate Arbitration, Council of Forest Industries of British Columbia, July 31, 1980, page 9.

8. Ibid, page 4.

the disputants cannot agree after two attempts, to name an acceptable candidate, then the administrator's third nomination would be binding.[9]

Each party is allowed but not required, to use legal counsel, and the arbitrator shall in all cases have legal assistance made available to him by the CTC. Government representatives should not become involved in the arbitration process unless invited by one of the disputing parties.[10]

COFI states that it is imperative for a limit of 30 days to be imposed during which the arbitration must be concluded, unless both parties agree to an extension. This 30-day period will begin from the date when the arbitrator accepts the case and will not be extended unless both parties agree.[11]

COFI does not recommend that there be any appeal from the arbitrator's decision. Furthermore, the arbitrator must decide in favour of either the railway's statement of what the rate should be, or the shipper's position, there being no allowance for a compromise solution.[12]

Footnotes

9. Ibid, page 6.
10. Ibid, page 7.
11. Ibid, page 7.
12. Ibid, page 8.

Lastly, COFI does not believe that the above-described arbitration mechanism should replace the Section 23 appeal, but suggests instead that a shipper have a choice between the two recourses.[13]

The Canadian Manufacturers Association submitted views on rate arbitration which were similar in many respects to the format described by COFI. For example, the CMA believed that the arbitrator should be obliged to choose either the carrier's rate or the shipper's rate. This "either/or" position would, it was claimed force serious negotiations beforehand.[14] However, there were important differences as well. The CMA did not believe that the administrator should appoint an arbitrator on whom the parties didn't agree. Furthermore, they said that legal counsel should not be used by the parties. Also, Section 23 appeals of arbitration awards would be possible.[15]

Footnotes

13. Ibid, page 6.

14. Proposals for Arbitration of Transportation Rate Disputes, Transport Canada, Table 1, August 2, 1979. These views were apparently taken during discussions of Bill C-33 and C-20 and may no longer represent the position of the CMA. For further reference, Submission by CMA on Bill C-33, June 1977 and Submission of CMA to the House of Commons Committee of Transport and Communications on Bill C-20, Feb. 1979.

15. Ibid.

The Canadian Pulp and Paper Association position on the rate arbitration process also differed in some important aspects from the COFI proposal. The CP&PA suggested that either party have the right to apply to the Railway Transport Committee for a review of the arbitrator's decision.[16] The CP&PA also proposed that the arbitrator have the right to order the production of railway costs, on a confidential basis. They recommended that the arbitrator's award be in effect for one year, like agreed charges, but that the arbitrator not have the authority to compel the shipper to transport a specified percentage of volume by rail.[17]

Although neither CMA nor CP&PA thought that the arbitration mechanism should replace the maximum rate section in the Railway Act,[18] Transport Canada suggested the following way in which this might be achieved.[19] A shipper wishing to make use of rate arbitration would declare himself captive, but this declaration of captivity could be limited to a particular route

Footnotes

16. Preliminary Position on Arbitration Proposals, Canadian Pulp and Paper Association, National Transportation Policy Committee, Sept. 28, 1979.

17. Ibid.

18. Sec. 278 of the Railway Act provides shippers, who are captive to the rail mode with a right of redress to the Canadian Transport Commission so as to have their freight rates lowered, if the latter are above a cost-related "ceiling".

19. Supra 1, pages 12 and 13.

or destination.[20] The shipper would then be required to offer 100% of whatever traffic he had declared captive for shipment by rail for a period of at least one year. In return, the shipper would have access to binding arbitration if rate negotiations were not successful; the arbitration process would however only affect the goods which had been declared captive.

The submission of the Province of Alberta agreed with the idea of a shipper's declaring himself captive for a particular commodity and route(s), but suggested that this be done only after rate negotiations had failed.[21] Alberta also suggested that the administrator should determine whether the shipper's position was "reasonable", before accepting the case for arbitration.[22]

In weighing the desirability of a rate arbitration mechanism, the following difficulties must be addressed:

Firstly, there exists the danger that rate arbitration will replace rate negotiation, the latter practice having proven itself the very foundation upon which an efficient Canadian transportation system has developed since 1967.

Footnotes

20. Conversely, the shipper could declare his whole operation captive, which would mean that he would have to offer all of his traffic to the rail mode for 1 year, in exchange for the right to arbitration.

21. Response to Transport Canada's Discussion Paper, Alberta Economic Development, Transportation Services, Dec. 8, 1980, page 5.

22. Ibid, page 7.

The opportunity for shippers to "try their luck" at getting a lower freight rate from an arbitrated decision should not be allowed to undermine the negotiation process, which is presently working well. The National Transportation Act encourages freight rates to be set at levels determined by market forces and by modal competition. For a rate to be determined by a person, such as the arbitrator, other than the actual parties to the movement is a form of rate regulation, which the NTA wished to preserve only in exceptional circumstances.

Secondly, the arbitrator should be provided with specific guidelines as to what would constitute a valid claim. Otherwise, in deciding whether a rate is excessive or not, an arbitrator could choose any one of a number of possible criteria; an undesirable precedent might be created. A clearly-defined burden of proof would lead both parties to understand what was required of them, and this would result in fewer claims and shorter hearings.

Thirdly, it seems inequitable to allow a shipper to choose between two judges, especially when the appeal recourses are dissimilar. If rate arbitration is supposed to co-exist with section 23 applications, then a shipper may choose between an informal and short enquiry or an in depth and lengthy analysis of the complaint in question, the scope of the respective decisions being the same. On the one hand, the shipper faces an informal 30-day arbitration proceeding, the decision of which

cannot be appealed. On the other hand, he may choose the section 23 claim which would involve considerable time[23] and expense and be susceptible to various appeals up to and including the Supreme Court of Canada. Who, realistically, would have an interest in going the section 23 route?

Lastly, it is questionable as to whether a 30-day arbitration hearing would be sufficient, or even whether written submissions could satisfactorily represent all the vital considerations which the arbitrator would be called upon to analyze in order to make his or her decision. As will be seen in greater detail in that part of this paper concerning reparations, the reason why the major section 23 applications have involved several months of hearings was the complex relationship between rate

Footnotes

23. For example, the Prince Albert Pulp Co. case and the Rapeseed Case each took 3 years from the date of the application to the date of the decision. The Woodpulp Parity Case took over 5 years.

    The length of section 23 applications led the CTC to propose more stringent delays in its revised "General Rules of the Canadian Transport Commission", Nov. 23, 1981. Under these proposed amendments, the CTC would be required to determine whether or not a prima facie case had been made, within 45 days of the close of pleadings if a public hearing is held. The CTC would then be bound to set the time and place of a hearing as to the merits within 70 days of the prima facie determination. Its decision on the merits of the application would have to be issued within 60 days following the close of hearings.

    At the time of the publication of this paper, the revised "General Rules" had not yet been published in the Canada Gazette.

levels in different geographic regions and the multiplicity of rate-related issues which arose. Because of this inter-relationship between rates, we must ask whether one arbitration decision to lower one freight rate could not have a disequilibriating impact on an entire rate grouping, involving hundreds of similar commodity rates from different origins to different destinations.

The case for reparations involves the proposal that Canadian Railway legislation be amended so that shippers are compensated for overpayments where a freight rate is found to be too high.[24] One of the strongest proponents of this concept has been the Canadian Pulp and Paper Association.[25]

Footnotes

24. Reparations is primarily of concern vis-à-vis section 23 applications. It has also been suggested in the context of rate arbitration. However, since the rate arbitration mechanism, as proposed, is only 30 days in length, the overpayment or underpayment would not be that significant. Furthermore, section 23 applications do not allow a rail carrier to claim that the freight rate is too low and therefore the shipper should compensate for the difference retroactively, whereas rate arbitration would theoretically permit this.

25. Discussion Paper on Legislative Proposals, Canadian Pulp and Paper Association, submitted by Howard Hart, President, Nov. 7, 1980.

The CP&PA stated that neither the Railway Act nor the National Transportation Act contain provisions for refunds to shippers where rail rates are lowered or disallowed by the CTC. They said that the absence of provisions for refunds discourages railways from settling disputes quickly and encourages prolonged litigation.[26] They submitted that this inequity could be alleviated if the existing legislation were amended to empower the CTC to order refunds (including interest) from the date on which the section 23 applications were filed. In other words, let us presume a section 23 case lasted three years (after all subsequent Court appeals had elapsed) and the CTC decided that a given freight rate which was the object of the section 23 complaint, was excessive by $1 per ton mile. The railways would then be ordered to refund those shippers who had successfully taken the section 23 case for the difference between the corrected CTC rate, and the "excessive" rate which the shippers had been paying during the 3 years of litigation, plus interest.

In order to see whether the proposed concept of reparations would be appropriate as an amendment to the present Canadian transportation regulatory framework, three major section 23 applications will be analyzed: the

Footnotes

26. Ibid, page 5.

Quebec Newsprint Case, the Rapeseed Case and the Woodpulp Parity Case. After the issues, positions taken by the parties, and decisions of these three cases have been described in some detail, it will then be possible to draw certain conclusions as to whether such concepts as reparations and rate arbitration would have been a viable alternative had they existed previously.

The Quebec Newsprint Case[27] centered around a group of newsprint mills known as the "Grand'Mere Group", located primarily in Southern Quebec, who shared common rates on newsprint movements into the United States. The applicants complained to the CTC that the freight rates given to them by Canadian railways to the major newsprint-consuming points in the U.S. were consistently higher for similar distances than the rates which were given by U.S. rail carriers to competing U.S. mills located in Maine and the southern States. In other words, they claimed that these U.S. mills, who were their competitors, had a significant advantage over the Grand'Mere Group because of the uncompetitive Canadian freight rate structure. The applicants alleged that because of these excessive rates, the Canadian share of what had been a traditionally Canadian-supplied U.S. market was in decline. They also alleged that Western Canadian rate bases were lower than for Eastern Canada.

Footnotes

27. Anglo-Canadian Canadian Pulp and Paper Mills Ltd., et al. Date of application-May 7, 1970. Decision rendered-March 25, 1977.

The Canadian railways contended that the newsprint rates were market-related and were at a level which allowed them to be competitive in the U.S. market. They argued that the decline in the U.S. market share by the Quebec newsprint mills was primarily due to increased domestic production of newsprint in the United States, not Canadian freight rates. The railways pointed out that although the Canadian share of the U.S. newsprint market had not kept pace with the percentage growth of that market, total Canadian newsprint shipments had increased.

The railways added that to lower the rates would only have the effect of causing the U.S. railways to in turn reduce their domestic rates, which would not result in any improvement in the relative position of the Canadian mills. The railways attempted to demonstrate that newsprint does not always move to market from origins with the lowest freight rate; there are other factors such as customer preference, availability of supplies, long term contracts and newspaper ownership of mills. The railways argued that since 1934 the selling price of newspaper had increased by over 300%, while the average freight rate had gone up only between 137% and 192%.

As with most legal disputes, the arguments by both parties centered around the factual data which had been submitted into evidence. For example, the railways stated that the data which the applicants had presented

was incomplete because there had been no rate comparison of the newsprint mills in Nova Scotia, New Brunswick, Ontario and Quebec (known as the Grand'Mere Arbitrary Group). Furthermore, the railways contended that it was unfair to conclude, as the applicants had done, that all rates from the Grand'Mere Group were consistently higher than from the Official Territory since the destinations used were mostly border points.[28] The railways presented an alternative sample of destinations where it was found that rates from Canadian mills were higher than their U.S. counterparts only 48% of the time. Lastly, the railways criticized the data which had been supplied by the applicants on the grounds that the latter had used basic rates whereas incentive and water-competitive rates constituted by far the major portion of the traffic.

The decision rendered, as well as the subsequent appeal, were both in favor of the Canadian railways' position. It was held that the loss of market share experienced by the Grand'Mere Group was due to factors

Footnotes

28. For rate making purposes the U.S. rate bureaus have divided their country into segments, the Official Territory comprising the New England States and the Southern Territory, comprising much of the southern States. It should be noted, however, that many of the borderline points which were cited in rate comparisons by the Grand'Mere Group were considered Official Territory when coming from Canada but were redesignated Southern Territory when coming from the south due to an historical anomaly. A lower rate scale applies within the South, than applies from the South to Official Territory. This let to a difference in interpretation by the parties as to whether the U.S. rate comparisons were valid.

other than transportation costs. Foremost among these factors was the construction of new newsprint mills in the Southern U.S. The Canadian Transport Commission did not find that there existed an overall rate disadvantage between Canadian and Maine newsprint mills. More importantly, they did not find that the existing rate structure of Canadian rail freight rates was prejudicial to the "public interest". In conclusion, the existing newsprint rate structure was not shown to be damaging to the prospects for the continued growth of the newsprint industry in Eastern Canada.[29]

The Rapeseed Case[30] involved four Western Canadian rapeseed crushers from Manitoba, Sasktachewan and Alberta who claimed that their rail transportation costs for rapeseed oil and meal were substantially higher than those

Footnotes

29. The CTC decision as to the Quebec newsprint rate structure was rendered after a similar decision from the Interstate Commerce Commission had found that joint international through rates on newsprint from origins in Eastern Canada to points in the United States had not been shown to be unjust or unreasonable nor were they preferential nor otherwise unlawful. This ICC decision was rendered in December, 1975.

30. Saskatchewan Wheat Pool, AGRA Industries Ltd., Co-Op Vegetable Oils Ltd. and Western Canadian Seed Producers Ltd., date of application Oct. 14, 1970; date of decision June 27, 1973; application to Governor-in-Council March 1974; Federal Cabinet decision, April 1976.

applicable to their competitors in Eastern Canada.[31] They claimed that the failure on the part of of the railways to give rapeseed meal and oil the same domestic and export rates as the raw rapeseed product itself, would discourage the processing of rapeseed in Western Canada. They stated that it was cheaper to transport rapeseed to Eastern Canadian and off-shore crushing plants for processing, than it was to crush the rapeseed in the West and transport the products to the consuming markets. The applicants also emphasized their dependence on the Eastern Canadian market.

The Canadian railways responded by stating that the rate which was given to the Eastern Canadian processor of raw rapeseed was a water-competitive rate and no similar modal competition existed for rapeseed meal or oil. They argued that the applicants already enjoyed the benefit of low statutory and market competitive rates on rapeseed products and it would not be in the "public interest" to reduce them further.

Footnotes

31. When the applicants mentioned their Eastern Canadian competitors they were referring primarily to Canlin Ltd. of Montreal which was the only Eastern processor crushing rapeseed into meal and oil in significant volumes at that time. Canlin Ltd. purchased seed in Western Canada and moved it in box cars on a combination of the Crow rate to Thunder Bay and agreed charge rate eastward to Montreal.

There were several intervenors in the Rapeseed Case. The Governments of Alberta, Manitoba and Saskatchewan supported the applicants' position by stating that rapeseed processing benefits both the national and regional public interest since the applicants compete with imported oils and protein meal. They contended that because of the difference in rates between transporting rapeseed to the East and transporting rapeseed meal and oil eastward, Western crushers were being disadvantaged.

The Provinces of Ontario and Quebec intervened in support of the railways' position. The Government of the Province of Ontario stated that the application would have a detrimental effect on crushers of rapeseed and soya beans located in Toronto and Hamilton. The Government of the Province of Quebec stated that they were encouraging the growth of the rapeseed industry within the Province, and the section 23 application, if successful, would disturb the existing balance between Western Canadian rapeseed processors and Eastern Canadian processors of soya beans and other vegetable oil seeds.

Three Ontario soya bean crushers and Canlin Ltd. of Montreal also intervened in support of the railways. They argued that the section 23 appeal was aimed at bettering the applicants' competitive position vis-à-vis the Eastern crushers. They argued that the Western crushers had increased their volume from 25% to 35% during the five years prior to the application, while soya bean oil crushed in Eastern Canada had dropped from 40% to 33%.

The Western crushers amended their application during the course of the hearing so as to request that the rates for rapeseed meal and rapeseed oil moving east and west for export and east for domestic consumption should be set at the lowest compensatory rate rather than at the statutory rate.[32]

In its decision, the CTC ordered the railways to reduce the domestic rates on rapeseed meal from Thunder Bay to points in Ontario, Quebec and the Maritimes.[33] The CTC did not however change the rates for rapeseed oil to Eastern Canada. Insofar as export rates were concerned, the CTC directed the railways to submit a new export rate structure to the Railway Transport Committee.

The Western Crushers and Prairie Provinces subsequently filed an appeal with the Governor-in-Council.[34] They

Footnotes

32. This was due to a concern on the part of the applicants that the statutory rate which formed a part of the Rapeseed rate to Montreal, might not be compensatory, as well as the uncertainty as to whether the CTC had the authority to enlarge the scope of the statutory rates.

33. The decision of the CTC with regard to domestic rapeseed meal rates east of Thunder Bay set a new rate to Montreal equal to the existing rate on raw rapeseed published in Canlin Ltd.'s agreed charge. To all other destinations in Quebec, Ontario and the Maritimes, the CTC established new lower domestic rapeseed meal rates based on an arbitrary over the railways' feed grain rates.

34. Section 64 of the National Transportation Act.

argued that a substantial error had been made in not granting domestic movements of rapeseed oil a reduced rate. The Federal Cabinet decided to order minimum compensatory rate levels to be established for both rapeseed meal and oil.[35]

The Woodpulp Parity Case[36] involved 16 woodpulp mills from Western Canada complaining about the higher level of freight rates which they were paying for transportation of woodpulp from Western Canadian origins to various U.S. destinations. They claimed that the rate levels which northwestern U.S. woodpulp mills were

Footnotes

35. In virtue of Order-in-Council P.C. 1976-894, dated April 13, 1976, the CTC was instructed to establish minimum compensatory rates on rapeseed meal and rapeseed oil moving for export, as well as for the domestic movement of Rapeseed oil to Eastern Canada, and on that portion of domestic rapeseed meal rates east of Thunder Bay or Armstrong, Ontario. (Rapeseed meal moves at 1 1/2¢ over the Crow rate to Thunder Bay and Armstrong.)

    In compliance with P.C. 1976-894, the CTC prescribed minimum compensatory rates for the above-noted movements of meal and oil by CTC Order No. R-23976, dated November 26, 1976, following their evaluation of joint CP/CN cost submissions based on 1976 cost levels.

36. Sixteen Western Canadian woodpulp mills, date of application Aug. 23, 1977; date of Decision, Aug. 17, 1979. CTC Order R-29767 was set aside on June 20, 1980. The decision on the Duncan Bay differential was rendered Dec. 9, 1980 (Order R-31684). On May 5, 1981 CTC Order R-32165 ordered respondents to publish a discount tariff in order to restore parity. CTC Order R-33156 amended the discount tariff on Jan. 20, 1982.

paying to U.S. railways for transportation to the same U.S. destinations were significantly lower and made them uncompetitive as a result.[37] The applicants demonstrated that Western Canadian woodpulp mills must compete with northwestern U.S. mills for the sale of woodpulp in the U.S. They argued that the pulp and paper industry in Western Canada is a very significant economic factor in the economy because of jobs and revenues and therefore depriving the woodpulp mills of their ability to compete was prejudicial to the "public interest". Secondly, the applicants argued that their woodpulp rates had been on a par with those of the northwestern U.S. mills for over 60 years. During that period, woodpulp rates from Western Canada had always been subjected to the same Ex Parte rate increases or

Footnotes

37. With the publication of Supplement 7 to Ex Parte Tariff 318 on April 18/76, Canadian railroads obtained a 7% increase on Woodpulp to U.S. destinations from Western Canada. Originally, this increase was also to accrue to U.S. carriers serving northwestern U.S. woodpulp mills as well. However, a number of U.S. carriers opted out with the end result that only the Canadian carriers allowed the increase to stand. Subsequently, Ex Parte 330 was published which increased the rates for U.S. mills by 5%. In supplement 23 to Ex Parte 330 rates on woodpulp from northwestern U.S. mills were reduced by as much as 7% depending upon destination territory and minimum weights. The end result of these actions left Canadian mills paying rates up to 7% higher on weights of 150,000 lbs. or more, and up to 4% higher on weights of less than 150,000 lbs., depending on destination.

reductions as those applied to rates from northwestern U.S. mills. In requesting "parity", the Western Canadian mills were asking not only that the Canadian rate changes which had occured in 1976 be withdrawn, but also that there be uniform application of future rate changes to ensure that the rate relationship between the applicants and their northwestern U.S. counterparts remain the same.

The railways stated that they were opposed to parity unless competitive circumstances warranted it; the revenue requirements for Canadian railways were different than for U.S. roads. Furthermore, they argued that the applicants were actually at an advantage over their northwestern U.S. competitors when the rate of exchange and currency surcharge were taken into account.[38] Lastly, the railways maintained that the Canadian Transport Commission's jurisdiction was limited since it could not impose a joint international rate upon a foreign carrier nor require a foreign carrier to enter into such rate. The railways alleged that the applicants had failed to show a diminution in Canadian woodpulp tonnage shipped to the U.S. as a result of the 1976 rate changes. They concluded by stating that if this section 23 case were successful, it could establish a dangerous precedent

Footnotes

38. They attempted to show that with the U.S. dollar at a 12.375% premium over the Canadian dollar, out of 2500 origin/destination pairs, 52% of the rates were lower for Canadian mills.

applicable to commodities other than woodpulp.[39]

The decision of the CTC ordered the railways to restore parity. The CTC concluded that there had been a long-standing rate relationship between woodpulp mills in Western Canada and those in northwestern U.S. which had been maintained by a uniform application of rate increase or decrease. The Commission did not accept the railways arguments concerning currency exchange due in part to the fact that the railways are protected by the 60/40 currency exchange surcharge.[40]

Following this decision the railways appealed to the Federal Court of Canada, Appeal Division, but were not successful.[41]

Footnotes

39. The eastern U.S. railroads also intervened in support of the Canadian railways arguing primarily that the Canadian Transport Commission lacked jurisdiction, since foreign carriers could not be subjected to a CTC order.

40. The currency surcharge tariff is predicated on the basis that the proportion of the total haul for the carriage of international traffic between Canada and the United States is, on the average, 40% in Canada and 60% in the United States. The payment of the exchange surcharge depends upon whether the U.S. dollar is at a premium in relation to the Canadian dollar and whether freight is collect or prepaid.

41. The only point on which the appeal succeeded was the breach of natural justice that occured when the railways were denied their right to be heard on the Duncan Bay diversion. This involved the loss of 20,000 tons of woodpulp from Crown Zellerbach in Duncan Bay, B.C. since this mill negotiated a barge rate to Seattle where the woodpulp could then be shipped by rail to final destination. The original order was set aside until another hearing could be held on this point. Subsequently, Order R-31684 was issued replacing all previous Orders and once again requiring the restoration of parity.

Several attempts were made by the Canadian railways to get U.S. roads' approval to one plan or another before parity was restored.[42]

In conclusion, the above analysis of the Quebec Newsprint Case, the Rapeseed Case and the Woodpulp Parity Case raised two questions with regard to the desirability of an amendment to section 23 of the National Transportation Act so as to include the concept of reparations. Firstly, a substantial portion of the major section 23 cases which have been dealt with by the Canadian Transport Commission have involved international traffic. The Quebec Newsprint Case and Woodpulp Parities Case are prime examples.[43] In the event the CTC would accord reparations to a shipper due to an "excessive" international

Footnotes

42. The railways filed proposals in January of 1981 which called for the U.S. roads to take a 10% increase on woodpulp, with the Canadian roads taking lower increases to bring about parity. The applicant mills objected to these proposals and on February 20, 1981 at a public hearing, the RTC ruled that the proposals did not comply with the Board Order. The railways were advised to take "other tariff action" by March 6. The railways then proposed flagging out of subsequent Ex Parte Increases. The mills objected, and the RTC ruled that this method was inadequate. On May 5 the RTC issued Order R-32165 which required the publication of a discount tariff retroactive to March 9.

43. The Prince Albert Pulp Co. Ltd. Case, like the Quebec Newsprint Case involved concurrent petitions to the Interstate Commerce Commission, as well as to the Canadian Transport Commission.

rate increase, would there not be the danger that the Canadian railroads would be obliged to pay the full refund, even though they had only participated in a part of the movements?

Secondly, there is the question of whether the "public interest" criterion of the section 23 application lends itself to a reparations judgement. For example, in the Rapeseed Case one of the principle arguments was the development of the rapeseed crushing industry in the provinces of Manitoba, Saskatchewan and Alberta. Similarly, in the Woodpulp Parity Case, the applicants stressed that their industry was necessary to the well-being of Western Canada. The type of public interest issue which the Railway Transport Committee of the CTC is called upon to decide is quite different from the ordinary legal case for damages where a refund plus interest must be given from the date of the suit filing. The proposal to include reparations within section 23 of the NTA is based on the premise that the shipper can establish damages. It is doubtful whether this premise can be interwoven with the "public interest" criterion which, as we have seen above, is essential to the section 23 recourse.

TRANSPORTATION CROWN CORPORATIONS AND PUBLIC POLICY IN CANADA

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ABSTRACT

Government has traditionally intervened in Canadian transportation through such instruments as regulation, subsidies, public ownership and moral suasion. Transportation's contribution to the national economy, Canada's scattered demography and its resource-oriented economy dictate that such intervention continue. In recent years, questions have been raised about the effectiveness of government intervention in the marketplace, primarily in terms of public accountability and management and direction of Crown corporations. This paper addresses the accountability and control of federal government transportation Crown corporations. It discusses their role and policies related to diversification, financing, divestiture and privatization and the need for a performance framework.

1. INTRODUCTION

The Federal government portfolio has 178 wholly-owned Crown corporations. Twenty-two federal Crown corporations are involved in transportation[2] (Table 1). These range from the monopolistic type of corporation, such as the St. Lawrence Seaway Authority, to the more commercial competitive corporations, such as Air Canada and Canadian National.

In 1958, about 65% of the total assets ($6.5 Billion) of federally owned enterprises were in transportation.[3] By

1978, this figure had decreased to 21% of total assets ($35 Billion), mainly because of the growth of government involvement in finance, insurance and real estate. In absolute terms, however, transportation assets increased from $4.2 to $7.4 Billion over this period. Canadian National dwarfs all other Crown corporations as employer (67,000 employees in 1982) and has the largest assets of the non-financial service Crown corporations ($6.3 Billion).

TABLE 1 - TRANSPORTATION CROWN CORPORATIONS [a]

Air Canada (and subsidiaries)
Canadian National Railways (and subsidiaries)
Harbour Commissions:[b] Belleville-Fraser River-Hamilton-Lakehead-Nanaimo-North Fraser-Oshawa-Port Alberni-Toronto-Windsor-Winnipeg & St. Boniface
National Harbours Board
Northern Transportation Company Limited (and subsidiaries)
Pilotage Authorities: Atlantic-Great Lakes-Laurentian-Pacific
The St. Lawrence Seaway Authority
The Seaway International Bridge Corporation Limited
VIA Rail Canada Incorporated

[a] Source: Royal Commission on Financial Management and Accountability (Lambert Commission Report), Government of Canada, March, 1979.

[b] These Commissions are not true Crown corporations as not all members are appointed by the Governor in Council. Refer to Section 2(3)(c) of Ex-Bill C-27, Nov. 26, 1979.

At the provincial level, public ownership in transportation has grown significantly, either through establishment of Crown corporations or investment in facilities such as road and transit. The assets of provincial transportation corporations have more than doubled in 1970-1977, from $0.8 Billion to $2.0 Billion.

Table 2 summarizes public ownership in transportation, including Crown corporations, by all levels of government for the most recent years for which data are available.

TABLE 2 - THE DEGREE OF PUBLIC OWNERSHIP IN TRANSPORTATION[a]

	NET FIXED ASSETS	REVENUES	NET INCOME (LOSS)
		($ Million)	
FEDERAL			
CROWN CORPORATIONS			
Air Canada	1,424	2,306	(33)
Canadian National	5,193	4,165	(223)
Harbour Commissions (11)	204	34	7
National Harbours Board	439	181	60
NTCL	44	46	7
Pilotage Authorities (4)	2	48	(1)
SLSA & Bridges	634	69	(6)
Via Rail	279	561	1
SUBTOTAL[d]	8,219	7,410	(188)
OTHER			
Airport System	1,399	314	(505)
Coast Guard	551	28	(312)
Ports and Harbours	17	5	(4)
SUBTOTAL[d]	1,967	347	(821)
TOTAL[d]	10,186	7,757	(1,009)
PROVINCIAL & MUNICIPAL OWNERSHIP			
Pacific Western	198	242	12
B.C. Railway	607	119	8[b]
Ontario Northland	121	79	10
Urban Transit	1,476	1,064	1
Road Infrastructure	22,239[c]	3,237	(2,797)
TOTAL[d]	24,641	4,741	(2,766)
GRAND TOTAL[d]	34,827	12,498	(3,775)

[a] Most recent years available 1979, 1980, 1981 or 1982.

[b] BCR includes a $70 million grant from the Province of British Columbia.

[c] Includes federal as well as provincial roads.

[d] Totals represent data from different years: they are not representative of any one year.

2. GENESIS OF CROWN CORPORATIONS AND RATIONALE

Crown corporations were created to achieve political and economic objectives.[4] Each was established to fulfill a specific perceived government need, including regional development, promotion of national unity, control of natural monopoly, incentives for pioneering ventures, etc. Neither socialism nor a desire to radically alter the market economy has greatly influenced the creation of Crown corporations over the years. Rather, governments have intervened in the private markets, either in light of the unwillingness of the private sector to undertake ventures because of large requirements for front-end capital and high financial risks, or in response to national objectives.

The creation of the Canadian National Railways in 1919 is seen as the first major venture into public enterprise, although the National Battlefields Commission, established in 1908 to restore and preserve historic battlefields of Quebec, is the oldest existing Crown corporation.

The largest growth in the establishment of Crown corporations came during World War II. In establishing companies to assist the war effort, the government was using an organizational form attractive and familiar to businessmen from the private sector. Many wartime Crown corporations were dismantled at the end of the war. Many others continued, however, augmented by additional companies established during the reconstruction period.

The speed with which Crown corporations were created during World War II, and the diversity of purposes, did not

allow for any comprehensive definition of effective systems of control, direction and accountability.

The government, in recent years, has benefited from corporate ownership. Some of the advantages involved the use of Crown corporations to promote regional and industrial development through the implementation of procurement policies, promote Canada internationally, and implement government policies such as bilingualism.

3. POLICY CONSIDERATIONS

The federal government and Parliament have numerous mechanisms to influence the behaviour of Crown corporations.

The present regime of financial direction, control and accountability over Crown corporations is embodied in Part VIII of the Financial Administration Act (FAA) enacted in 1951. In June 1982, however, concern about this regime led to proposals for changes in the relationship between the federal government and Crown corporations being tabled in Parliament in a Government Organization Bill (Bill C-123). (In addition, the 1979 Lambert Report concluded that an accountability framework for Crown agencies had been applied inconsistently.)

Other mechanisms by which the government, or the Minister of Transport, can interact with transportation Crown corporations, and influence their behaviour include constituent acts, regulatory acts, budgetary controls, policy direction, moral suasion and Parliamentary Committees.

The question for resolution is not whether policy mechanisms exist; rather, it is what the government wishes the

commercially-oriented Crown corporations to do and then selection of the most effective instrument to do it.

The question arises whether Crown corporations should be profit-seeking institutions, whose performance is best measured by conventional commercial yardsticks, or whether they should be strictly policy instruments, whose behaviour and performance differ radically from private enterprise.

The answers are not clear. There is more difficulty in assessing the performance of Crown corporations, owing to the range of public objectives, than that of their private sector counterparts. Further, the goals of Crown corporations are dynamic and often change owing to technological advances, market circumstances, international forces and government needs and objectives.

Commercially successful Crown corporations are subject to criticism from their competitors, shippers and the public. In contrast, commercially unprofitable Crown corporations are criticized for inefficiency, inability to compete in the private market and being a burden on the taxpayer.

Trying to determine a course of action for these Crown corporations has given rise to issues concerning their relationship with the government. For example, what is the role of these Crown corporations? How should they interpret the government's objectives? What factors should be considered when Crown corporations diversify? Finally, should the government privatize them? The next part deals with these questions and addresses the role of Crown corporations, diversification, future financing, performance framework, and privatization.

3.1 Role of Crown Corporations

The role of a Crown corporation cannot be defined rigidly; corporations are dynamic institutions that grow and change over time rather than moving within fixed limits. It is necessary to recognize their evolutionary nature: the corporation has a principal role and, in carrying it out, becomes involved in other activities that either enhance or detract from it.

Any attempt to define a corporate role must recognize that both the industries in which the Crown corporations are situated, and the policies of the shareholder, who owns and controls the corporations, have also evolved. It is essential to re-examine the corporate role from time to time.

The central issue for government is guiding the natural commercial instincts (of pursuing profit goals) and practices of commercial Crown corporations once their role has been identified.

3.2 Diversification

Diversification is purchase (or creation) by a Crown corporation of an interest, partial or total, in a corporate entity which entails new activity by the corporation. This would include, in the case of CN, investment in Cast, and in the case of Air Canada, Guinness Peat Aviation Ltd. These investments led to CN's involvement in a North Atlantic container line, and to Air Canada's involvement in a firm which acts as a lessor and broker for commercial aircraft.

The questions here should not be whether Crown corporations should diversify (it is assumed that they will continue to do so); a prohibition against further diversification would place Crown corporations at a disadvantage[5] vis-à-vis their private sector competitors. Transportation, like other industries, has a natural economic life cycle; financial problems can occur during the mature phase of the cycle, especially in periods of economic difficulty. In such a situation, diversification, especially one capitalizing on the corporation's proven strengths, becomes an important support for the transportation side.

The relevant questions are what kind of diversification is appropriate for Crown corporations as ancillary to, and in support of, their main operations;and what factors should be taken into account in determining the appropriateness of particular diversification processes.

Normally, proposals for diversification originate with Crown corporations themselves. Their rationale has been, and likely will be, to retain and/or strengthen their commercial viability and long-term financial stability. Additional factors have been increased efficiency and productivity.

The following three factors appear important in determining the appropriateness of diversifications.

a) <u>Promotion of Efficiency and Productivity</u>

A proposed diversification should be contingent on the extent of increase in productivity and efficiency of the transportation system. If a proposed diversification will not significantly alter and augment the exist-

ing efficiency and productivity of the transportation system, then the need should be questioned for additional public ownership and presence in the market place. Diversification need not be encouraged that results in transfer of ownership from the private to the public sector without benefit to the transportation system .

b) Promotion of the Role of Crown Corporations

Another relevant factor of diversification proposals is the extent to which they will promote government objectives, more particularly the principal role of Crown corporations.

A variation of this factor in market terms is whether the diversification constitutes vertical or horizontal integration as it relates to the corporation's role. Vertical integration is the purchase of a corporation providing inputs to the holding company or market outputs of the existing company. Vertical integration, if closely related to the role, could be desirable.

Horizontal integration could lead to a corporation vastly different from the original. In addition, horizontal integration could result in a complex corporation spread through many sectors of the economy (e.g., transportation and energy). This indicates that proposals leading to horizontal integration need to be questioned and investigated to a greater degree than those for vertical integration, since they may detract from the principal role of the corporation.

It is more difficult to determine the difference between horizontal and vertical integration for trans-

portation, than for other industries because of its derived demand character.' Few, if any, commodities do not require some mode of transportation to move them from their point of origin to the final consumption stage.

A delineation could be made, however, between vertical and horizontal integration on the basis of the degree of market penetration of a particular product activity into which the Crown corporation wishes to diversify. For example, CN has a major impact on the railway rolling stock market in Canada, as it represents one of the few purchasers of this particular product. Thus, CN, hypothetically, could be allowed diversification into the rolling stock manufacturing industry to ensure the latter's continuity in Canada. On the other hand, CN, as a railway and trucking company, is only one of many purchasers of the by-products of the oil and gas industry; its impact on the resource industry is not as great, as industry survival is not dependent on CN's demand for that product.

c) Impact on Government Finances

This relates to the impact diversification proposals have on the immediate requirement for external financing, and consequently on the provision of government equity. Does the government have the budgetary resources to invest in Crown corporations?

The degree of diversification will also affect future cash flows of Crown corporations. What will the impact

be on their ability to pay dividends to the government on its equity investment, and also on tax liabilities?

3.3 Future Financing

Attempting to limit future expenditures to what could be financed only through retained earnings might allow for some growth during periods of high profitability; however, during down cycles of the economy, the flexibility for long-range capital planning could be seriously constrained.

To allow for planned growth in the long run will require external financing for Crown corporations which can be raised in two ways: through debt instruments (loans, bonds, leasing, etc.) or the sale of equity (common or preferred stock).

Financing totally by debt is not financially healthy for any corporation; the risk in meeting annual debt obligations in uncertain economic conditions is great, making further infusions of capital difficult to obtain. The problems associated with high debt were recognized in the 1976-78 period when recapitalizations were approved for CN, AC and NTCL.

Various options for resolving future financing are discussed below:

a) Debt/Equity

Government should review the debt/equity levels of Crown corporations periodically. Different degrees of debt/equity may have a differential impact on the market behaviour and morale of senior management of Crown corporations. For example, a 100% government equity position might seem to totally protect the Crown corporation

and indicate that it does not compete on equal terms with its competitors, undermining the spirit of entrepreneurship. The debt/equity structure provides a degree of market discipline important for a well-functioning market corporation, because the corporation would feel somewhat accountable directly to the market (through debt).

The ability of any corporation to raise financing in the capital markets is affected, inter alia, by its debt/equity ratio. With Crown corporations, however, their status as Crown agencies provides other advantages that may offset a perceived unfavourable capital structure.

b) Private Equity

Under Bill C-123, a Crown corporation is defined as one whose shares or capital are wholly owned by the government. If the corporations had the legal power to attempt to raise equity funds in the marketplace (leaving the government as a majority or minority shareholder), the use of the corporation for serving a national purpose would be constrained by the wishes of the minority,[6] who would likely be interested in profit maximization and return on investment. (Subsidiaries or joint ventures are considered excluded from this constraint.)

The corporation would be subject to the Canada Business Corporations Act. The legal requirement to protect minority shareholders' interests could create difficulties in meeting public interest objectives. Shareholders would have a right to legal redress when corpo-

rate actions that are not legal requirements are undertaken with the foreknowledge that profitability would not be maximized. Government direction would often fall into this category.

c) Government Equity

Government equity could be provided in several ways: undertake periodic recapitalizations by conversion of outstanding debt to equity; allow corporations to retain any dividend payments to the government; resolve present financial constraints (for example, for CN grain rates, Terra Transport, CN Express, etc.), which would increase revenues and facilitate borrowing; finally, compensate Crown corporations for losses incurred by compliance with a government directive.

d) Divestiture

Divestiture is selling a portion of a Crown corporation to the private sector. It could also include the winding-up of Crown enterprises, with their functions taken over by the private sector directly or through government contracts.

A major benefit of divestiture is a reduced requirement for external financing. In light of current restraints and economic development objectives, divestiture can provide additional funds.

Areas for divestiture most likely of interest to the private sector would be the profitable parts of Crown corporations. A corporation might retain only the public interest services, causing a threat to the commercial viability of the whole company. Thus, any divesti-

ture proposal must be considered in the context of a corporate plan to ensure the principal corporate role is not affected adversely. This issue is also addressed under privatization.

3.4 Performance Framework

In a commercial setting, financial measures of performance are fairly standard: profitability, return on investment, market shares, liquidity ratios, etc.; these indicators are objective and specific. They may be compared with the industry as a whole to determine a corporation's performance vis-à-vis industry norms.

Crown corporations provide services with a view towards commercial viability and to achieve other government objectives. Corporate performance must recognize both types of goals; this leads to the acceptance of a lower overall return on total investment, or the separation of non-profitable operations, undertaken in response to specific government objectives and criteria, from the commercial parts of the corporation.

The traditional approach to measuring performance of Crown corporations is to calculate return on investment based on market criteria, and to interpret the result in light of activities that the government requires the corporation to undertake. It is difficult to judge performance, since it is not known how much to discount for non-commercial activities, and since Crown corporations receive little direction in accounting for these activities. Alternate approaches could be used to measure annual corporate

performance: one is based on developing annual goals or performance agreements, and another on a comparison of performance against a longer term corporate plan.

a) Goal and Performance Indicators

Crown corporations could identify specific government-directed activities and the government could recognize these in assessing the corporation's performance. For example, a Crown corporation may undertake a particular government-directed activity within its total system, albeit at a loss; the costs (and revenues) associated with the activity could be separated out from the corporation's commercially-oriented activities, and not included in the corporation's annual return on investment or profitability targets. The alternative would be to include the costs (and revenues) associated with undertaking government directed activities in the corporation's "consolidated" accounts and develop (lower) profitability goals that take into account these imposed unprofitable public duties.

b) Use of Approved Corporate Plans

This is a broader based approach than that described above, and is in line with the control mechanism Bill C-123 advocates.

It is necessary to have some control mechanism to ensure that the corporation properly interprets the role. Such a mechanism is a corporate strategic plan, in line with the Lambert Commission and Bill C-123. It would outline the corporation's objectives, its plans for the upcoming planning period (3-5 years), the relationship

of these plans to its role and mandate, the timing of its plans and the amount of financial support required. The combination of role and corporate plan becomes the framework for measuring corporate performance.

The corporate plan submitted in the subsequent fiscal period would document the results. The Crown corporation and the government could jointly determine reasons for any variations from the plan to determine to what extent, and why the variations were due to circumstances beyond the corporation's control. This would form the basis for assessing management performance.

3.5 Privatization: A Panacea ?

The concept of privatization has been discussed publicly in various fora for many years, specifically the last decade. Increased interest in privatization has been generated by the federal government, the business community, competitors and Crown corporations themselves, e.g. CN and Air Canada.

In general, privatization may imply the sale, in whole or part, of shares of a Crown corporation to the private sector; the winding-up of a Crown corporation and the transfer of ownership of its assets to the private sector; the total or partial winding-up of a corporation, with its functions or some part thereof undertaken by the private sector, or on the basis of government contracts; or the winding-up of a corporation without any expectation that the private sector will pick up the function.

It may be interesting to enumerate the various arguments for and against privatization.

(a) Arguments for Privatization

(i) Reduction in size of government

The government, from time to time, has expressed an interest in privatization to reduce its size, but not necessarily the scope of its control. Regulatory controls and legislation relating to taxation, labour, combines, anti-dumping, foreign investment, ownership and wage, price and profit controls have made direct government ownership less necessary to achieve public policy objectives. Government is seen as too big and pervasive. The general public would interpret the sale of highly visible and large Crown corporations as a positive response to this concern.

(ii) Reduction in government spending

Privatization would result in a reduction in government spending. Some wholly owned corporations consume significant amounts of public funds through budgetary appropriations, loans, subsidies or equities from the Consolidated Revenue Fund (CRF). As well, the borrowings of some Crown corporations are contingent liabilities against the CRF, which may contribute to the public debt. A sale would bring an immediate cash inflow to the CRF, although, the long term consequence could be a loss of dividends. Further, the sale of commercially viable enterprises would leave the non-viable corporations under public ownership where they would continue to be a drain on the public purse.

(iii) Easing the burden on Ministers/Officials

Ministers require significant time to answer Parliamentary questions, make or recommend appointments to Boards of Directors, approve budgets, or defend Crown corporations before Parliament, committees, the public and media. Crown corporations also demand significant committment of time and energy from officials. Privatization would ease this burden.

(iv) Creation of more efficient management

A widely held view exists that government management leads to waste and inefficiency, compared to private sector management of identical functions. The public would likely interpret privatization as a step to overcome this inefficiency. Many transportation Crown corporations, however, are as efficiently managed as their private sector competitors. Imposed public duties often cause relatively poor financial performances.

Inefficiency may also result from a difference in perceptions of the mandate of a Crown-owned enterprise between the managers that run it and the Minister accountable to Parliament. Further, confusion at senior management levels on the aims of the organization leads inevitably to confusion at lower management levels, which may account for this perceived inefficiency. The less restrictive environment for managerial decision making in the private sector is considered to result in more efficient management.

(v) Rationalization of the industry

Privatization is one method of reorganizing or rationalizing an industry. An industry, however, might also be changed through government creation of a powerful, publicly owned enterprise capable of commanding a sizeable portion of the market. The issue of industrial sector rationalization can be dealt with in the context of the state of the industry, and the particular existing enterprises (either public or private) as suitable vehicles for change.

(vi) Recovery of past public investments

Public investments have been made in the form of infusion of equity, entrustment of assets, conversion of outstanding debt to equity, forgiveness of loans, etc. The sale of a Crown corporation is one way of demonstrating that the country has benefited from its investment.

The divestiture, however, of a previously heavily subsidized corporation is sensitive. It is argued that a sale should not be made before some dividends are returned to the Treasury. The sale of a Crown corporation could also spark controversy; it could be seen as a way of using public money to provide a future vehicle for private profits.

Parts of the public may view current excess profits from a publicly owned corporation as a contradiction in terms; i.e., a Crown corporation should not earn a profit and any excess profits should be

used to support unprofitable, but essential services, or applied against debts owed to the government.

(b) Arguments against Privatization

(i) Diversion of scarce resources into less efficient sectors

The economic argument is that private sector capital should seek the highest economic yield available. In this case, private capital could be diverted into relatively inefficient or low-yield public enterprises.

There is also a question whether privatization is efficient. Air Canada is an example: its management seems to have responded to the present poor economic climate as effectively as, if not more than, any of its competitors,[7] through operational changes, manpower reductions and other cost-saving measures. These were pursued to minimize losses, while at the same time generating sufficient funds to finance future capital requirements.

(ii) Cost of replacing a public policy instrument

A sale of a Crown corporation could deny the government a lever to influence the attainment of non-commercial objectives. A privatized Crown corporation could, in difficult financial circumstances, seek to divest itself of certain services or operations upon which the consumer public depends. The only means available to ensure these essential services may be direct funding, which may prove more

costly than compensating a Crown corporation for publicly imposed duties.

(iii) Loss of business benefits associated with public ownership

A publicly owned enterprise may derive substantial commercial benefits from its association with government or other components of a Crown corporation. Such enterprises are considered secure risks and reliable suppliers of goods and services, perceptions that have important financial consequences in the marketplace. Several agency corporations that appear commercially viable would probably be less so without agency status.

A Crown enterprise may derive much of its business from its close operational link with other components of a Crown corporation, e.g., CN Express. Severing this connection could mean the loss of substantial preferred business, and expose the privatized corporation to risks from which it was previously sheltered.

(iv) Organized industry resistance to privatization

Organized labour believes that a Crown employer is preferable to a private sector owner who has to earn profits to stay in business. Concerns would be seniority, pension rights, layoffs and labour relations.

Shippers who perceive themselves in a potentially weak bargaining position relative to common carrier services may oppose privatization, preferring what-

ever extra security dealing with a publicly owned carrier may imply.

Other industry players, such as carriers, suppliers, competitors, etc. may also resist change. A substantial shift in competitive power within the industrial or geographic area concerned could occur after the sale of a Crown corporation to private interests. For example, the sale of CN Trucking could strengthen the market share of the new owner, a prospect that existing competitors would resist.

(v) Other Impediments to Privatization

Other often-quoted impediments to privatization include legal considerations and the time required to receive Parliamentary approval; the policy/political implications if foreign interests gained control; the difficulty of setting a fair price; and opposition by provinces and regions perceiving privatization as a threat.

4. SUMMARY AND CONCLUSIONS

Each Crown corporation was created to advance Canada's national interests at a particular time. Corporations exhibit degrees of independence ranging from close government financial and personnel controls to virtual independence. Part VIII of the Financial Administration Act indicates direction, control and accountability over Crown corporations. The FAA, however, addresses only the financial relationship between Ministers and Crown corporations on one hand, and Ministers and Parliament on the other.

Two recent initiatives proposed changes to the FAA regime of direction, control and accountability over Crown corporations. These changes include a mechanism whereby government may communicate broad policy objectives to the Crown corporations through its status as a sole shareholder. They, however, do not deal with the manner of communication of more specific policy direction and the content of this direction.

Several policy issues arose in recent years, whose consideration led to the realization that, currently, there was no specific guidance, or even general criteria, to deal with them. Further, no adequate framework existed within which these criteria could be developed. These major policy issues include diversification, future financing requirements and the need for a performance framework to enable effective evaluation of the Crown corporations. A prerequisite to effective resolution of these issues is the clear identification of the role and objectives for each corporation. The question of privatization was also raised.

Concerning diversification, several factors determine the appropriateness of particular proposals: an examination of the impact of the proposals on the long-term commercial viability of the corporation, the productivity and efficiency of the existing transportation system, the main or principal role of the corporation, and the financial burden on the government.

With regard to future financing, the factors to be taken into account relate to the source and method of equity fin-

ancing, including the corporate debt/equity ratio, the implications of private equity financing, government equity, and the possibility of divestiture as a source of funds.

Difficulties arise in measuring performance of Crown corporations based on market criteria, because non-commercial activities are sometimes undertaken to achieve government objectives. Approaches for measuring annual performance include development of annual goals or performance agreements based on a recognition of specific government-directed activities, or comparison of performance against a longer term corporate plan.

Finally, privatization of Crown corporations was addressed and arguments presented in favour and against.

In conclusion, given Canada's demography, geography, its resource-oriented economy, and the objective of a balanced economic independence from international forces, government will continue to intervene in the market system through ownership and control of Crown corporations. The degree, however, to which government will own and control parts of the Canadian market in the future, will continue to be an important subject for public debate.

REFERENCES

1. Dr. Haritos is Director General, Strategic Policy, Transport Canada, Ottawa; he is Adjunct Professor at Carleton University. Thanks are due Ralph Shlachter for his significant contribution and comments in preparing this paper. The views presented here do not necessarily reflect those of Transport Canada, or the Government of Canada. See "Transportation Crown Corporations Emerging Issues", Transport Canada, TP 3616E, Sept. 1982.

2. Royal Commission on Financial Management and Accountability, (Lambert Commission Report), Government of Canada, March 1979.

3. Marsha Gordon, Government in Business, C.D.Howe Institute 1981.

4. "Crown Corporations - Direction, Control, Accountability", Privy Council Office, 1977.

5. Crown corporations have some advantages over their private sector counterparts in financing; for instance, any funds borrowed from the government are available at less than market rates, and borrowing in the capital markets may also be at preferred rates, as a result of higher investment ratings owing to implied support by the government.

6. Section 140 of the Canada Business Corporations Act and the Business Associations Casebook, S. Beck, Getz et al, Richard de Boo Ltd, 1979.

7. J.N. Langford, "Air Canada", in A. Tupper and G.B. Doern, Public Corporations and Public Policy in Canada, The Institute for Research on Public Policy, 1981.

CANADIAN REGULATED PIPELINE TARIFFS: A SENSITIVITY ANALYSIS

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Introduction

The recent conference jointly sponsored by The Centre for the Study of Regulated Industries, McGill University and the National Energy Board in Montreal focussed on current problems with the cost-of-service regulation of oil and gas pipeline tariffs and considered alternative rate setting methodologies - particularly levelized tariffs.[1]

Another important dimension in evaluating the nature and significance of the current methods employed for regulating pipeline tariffs is the sensitivity of these tariffs to the various parameters in the cost-of-service.[2]

The purpose of this paper is to evaluate the key parameters governing the setting of Canadian pipeline tariffs by ranking them according to their relative importance. This ranking, in turn, could throw some light on policy matters relating to these tariff formulae.

Our methodology involves the use of a pipeline tariff computer simulation model based on the National Energy Board's(NEB) regulatory techniques. The sensitivity of tariffs to variations in the key parameters is evaluated by considering the effect on simulated tariffs of certain changes in input data. In particular, we calculate arc elasticities of pipeline tariffs with respect to parameter variations. The calculations translate tariffs which vary over time into a uniform equivalent real tariff. This tariff equivalence concept properly allows comparisons of elasticities of tariffs over the period of analysis as a whole, by subsuming differences in individual year calculations.

Since pipeline configuration and unit transportation costs vary significantly according to whether energy is transported in the form of oil or gas, we undertake calculations for both an oil and a gas pipeline. However, since the tariff formulae for these pipelines are essentially the same, a priori we would expect the ranking of the parameters to be similar.

The paper proceeds as follows. Section I outlines the model used to generate tariffs under the current NEB methodology and discusses the manipulations required to translate these tariffs into suitable summary statistics. Section II presents sensitivity results for variations in

the tariff setting parameters for both oil and gas pipelines. Section III summarizes our conclusions.

I. National Energy Board Cost-of-Service Tariff Setting

The method of regulation used by the (NEB) to determine a 'just and reasonable' cost-of-service can be broadly defined as 'ratebase, rate-of-return'. A pipeline's cost-of-service defines the total revenue requirement to be recovered through tolls on its throughput. Tariffs are set to cover current operating costs, taxes, depreciation of capital facilities valued at original cost and an allowed rate of return on an approved ratebase, comprising mainly the value of the original cost capital net of depreciation.

In general, 'cost-of-service' regulation can be represented by the following expression:

$$T = (C + D + TC + TO + r.k)/V \qquad (1)$$

where

- T is the average or unit cost-of-service
- C is direct operating and maintenance cost
- D is depreciation expense
- TC is corporation income tax
- TO is property and other tax
- r is the allowed rate of return
- k is the approved ratebase
- V is the volume of throughput

The definition of each component in the cost-of-service calculation is given partly by the NEB's oil and gas pipeline accounting regulations[3] and partly by precedents established under regulation.

The rate base is defined as the average value of plant in service during a 'test period' plus an allowance for working capital. If a system were undergoing major changes in the form of substantial capital additions, the Board would probably opt for a "forward test period" to include the full impact of new investment in the rate base. With respect to working capital, the standard items considered are inventories, prepayments, and a proportion of the annual cash operating expenses.

The rate of return on rate base can be defined conceptually as simply the weighted-average of the allowed rates of return on each capital component. These allowed rates of return vary. Companies holding deferred income taxes have not been allowed a rate of return on that portion of their capital structure. The allowed rate of return on debt has usually been accepted as the actual charges incurred. The allowed return on equity is chosen to reflect business and financial risk.

The remaining cost-of-service items are not overly contentious. Property taxes are included in full on a

current basis. Depreciation rates (straightline) for transmission plant are chosen to reflect the shorter of two periods: the expected physical life of the plant or the period over which it will be employed. The rates of depreciation have generally been based on an equipment life of some 35 years. Direct operating and maintenance costs include all salaries and wages, materials, power and an amount for transmission losses valued on a current basis. Additional items such as rate-hearing expenses are also allowed.

The NEB procedure for setting tariffs basically follows the United States legacy of tariff regulation, with one significant difference. Since 1940, United States regulation has attempted to incorporate the replacement value of a pipeline's original capital investment. A return is earned on the average of the original cost capital investment less depreciation and the replacement cost of the pipeline's facilities less depreciation (plus the usual allowance for working capital).[4]

The NEB tariff methodology will result in tariffs which fluctuate over time according to variations in throughput, the age of assets, the rate of investment, operating costs, inflation and like. In terms of

analysing the sensitivity of pipeline tariffs to variations in these parameters, it is not sufficient to compare tariffs on a year by year basis since the overall pattern of tariffs over time may be affected to differing degrees by variations in these parameters.

Thus, to properly investigate the sensitivity of pipeline tariffs we need a summary statistic that will in effect capture the nature of a pipeline tariff over the entire life of the system. The measure we adopt is what we call the uniform real tariff, defined as that constant real tariff which would yield the same present value revenues over the life of the pipeline as would be generated by NEB cost-of-service tariffs.[5]

The first step in calculating the uniform real tariff involves simulating annual tariffs over the pipeline's life using the NEB's cost-of-service methodology summarized in Equation (1) above. The second step is to divide projected present value revenues for the pipeline under the NEB's methodology by the total discounted throughput. This gives the uniform real tariff. Symbolically, we have:

$$URT = \sum_{t=1}^{n}\left[\frac{(T_t \times V_t)}{(1+i)^t(1+r)^t}\right] \times \sum_{t=1}^{n}\left[\frac{V_t}{(1+r)^t}\right]^{-1} \qquad (2)$$

where URT is the uniform real tariff

T_t is the nominal tariff in year t calculated according to the NEB's general method of regulation

V_t is throughput in year t

i is the rate of inflation, assumed here to be constant over the life of the project

r is the real discount rate

n is the life of the pipeline in years.

It is in terms of uniform real tariffs that the sensitivity analysis in the next section is expressed.

II. Sensitivity of Tariffs to Key Parameters

To test the sensitivity of NEB cost-of-service tariffs to variations in key parameters, two hypothetical pipeline systems were modelled, one for oil and one for gas. The reasons for making this distinction were outlined in the introduction. The technique we employ involves construction of respective base cases from which variations of the main parameters are imposed.

(a) Oil pipeline

The oil pipeline analysis is based on information available for a proposed but as yet unbuilt lateral to an existing pipeline system in Saskatchewan. This particular lateral was used because of its simplicity, the avail-

ability of information and because of the importance of modelling a pipeline from the beginning of its operation in order to see the full effects of variations in parameter inputs over time.

Gross real investment on terminalling and transmission equipment is estimated at $10 million (1981$). Long term debt is assumed to make up 50 percent of the initial capitalization, with the principal retired in equal annual installments over a 30 year period. Equity constitutes the remainder of total capitalization net of deferred taxes. Hence, the actual share of equity in total capital fluctuates from year to year as the balance of deferred taxes first increases and then subsequently is drawn down. As this implies, income taxes are treated on a normalized basis - both the current and deferred tax liability are included in the cost-of-service.

Cash operating expenses are estimated at some $400 thousand per year (1981$). Property tax is dealt with as a separate item and is assumed to equal about $60 thousand per year. Depreciation enters the calculation on a straightline rate based on a 35 year equipment life. Working capital is included as part of the rate base and is assumed to equal about 12.5 percent of annual operating costs.

All these operating costs and working capital items are established for the 1981 base year and are more or less assumed to grow in step with general inflation at a rate of 10 percent per annum. Given constant inflation and fixed capital ratios, the cost of debt and equity are held constant in the future. Throughput is also kept constant throughout the pipeline's life at about 2 million barrels (320 thousand cubic meters) per year.

In terms of examining variations in parameters, we focus on the following broad categories of inputs.

a) throughput

b) operating expenses and working capital

c) equipment life

d) rate of return

e) original investment

Uniform real tariffs and 'arc' elasticities resulting from a 10 percent increase over base case values are shown in Table 1. The 'arc' elasticity is computed as:

$$\frac{\frac{\Delta T}{URT_1 + URT_2}}{2} \Big/ \frac{\frac{\Delta I}{I_1 + I_2}}{2}$$

where URT_1 is the uniform real tariff for the base case

Table 1

Elasticity of Hypothetical Oil Pipeline Tariffs
With Respect to Cost-of-Service Variables

	Uniform Real Tariff Per Barrel ($ 1981)	Elasticity
Base Case	0.645	-
Increase in throughput with corresponding increases in operating costs and working capital	0.604	-0.689
Increase in initial capital investment	0.688	0.679
Increase in nominal overall return	0.681	0.569
Increase in nominal return to equity	0.669	0.380
Increase in operating costs and working capital	0.664	0.305
Increase in depreciation rate	0.662	0.273
Increase in nominal cost of debt	0.657	0.191

URT_2 is the new tariff

I_1 is the level of the original input and

I_2 is the new input.

These elasticities measure the relative change in tariffs as a function of a relative change in the values of the input parameters, all other factors held constant.

The results - as would be expected - show that tariffs are significantly affected by changes in throughput, a reflection of the large element of fixed costs inherent in pipeline operations: the tariff elasticities are about 0.7 and -0.7 for reductions and increases in throughput, respectively. An elasticity of similar magnitude but opposite sign holds for changes in initial capital investment. A 10 percent increase in operating expenses results in an increase in tariffs of about 3 percent. The effect on tariffs of an increase in the depreciation rate is less significant, generating a tariff elasticity of slightly less than 0.3. Equity and debt costs yield tariff elasticities of 0.38 and 0.20, respectively, while their combined elasticity is about 0.57. These latter figures are, of course, dependent on the debt/equity ratio used and respective initial cost rates.

(b) Gas pipeline

The natural gas pipeline analysis is based on estimated cost data for an hypothetical Arctic facility contained in a paper presented to the recent McGill University-National Energy Board conference.[6] Cost and throughput estimates for the assumed 1500 km, high pressure pipeline are as follows.

Gross real investment on transmission facilities before initial gas shipments is estimated at some $4 billion (1981$). As with the oil pipeline, debt is assumed to comprise 50 percent of initial capitalization. Annual cash operating expenses are estimated at $30.5 million (1981$), where this figure includes an allowance for fuel consumption of just over 3 billion cubic feet per year. For simplicity, fuel gas is valued at a constant price of $3.50 (1981$) per thousand cubic feet over the life of the pipeline. Annual property taxes are treated separately and are estimated at 1 percent of the value of gross facilities in service. Working capital is set at 10 percent of annual operating costs. With the exception of property taxes, which stay constant in nominal terms, all variable cost elements are assumed to increase in line with inflation over the simulation period. Throughput is assumed to stay constant over the life of the pipeline at about 1200 million cubic feet per day or 438 billion cubic feet a year.

For our sensitivity analysis, we consider variations in the same elements as for the oil pipeline. The different parameters considered were increased by 10 percent over the base case; the results of the analysis are summarized in Table 2.

The gas pipeline's tariffs are most sensitive to changes in original capital investment and throughput, as were the oil pipeline tariffs. However, the elasticities are considerably higher for the gas pipeline. The gas pipeline tariffs are also much more sensitive to changes in allowed equity and debt returns, but less affected by changes in operating expenses than are the oil pipeline tariffs. These results reflect the more capital intensive nature of the gas pipeline.

II. Conclusions

Uniform real tariffs are a convenient measure on which compare pipeline tariffs either for assessing different pipelines or, as we have done, in considering variations in key pipeline parameters over a pipeline's life.

The results of our analysis confirm that the large element of fixed costs inherent in a pipeline operation make tariffs most sensitive to variations in investment and throughput. More surprising is the relatively small

Table 2

Elasticity of Hypothetical Natural Gas Pipeline Tariffs With Respect to Cost-of-Service Variables

	Uniform Real Tariff Per mcf ($ 1981)	Elasticity
Base Case	0.986	-
Increase in throughput with corresponding increases in operating costs and working capital	0.903	-0.923
Increase in initial capital investment	1.078	0.935
Increase in nominal overall return	1.0587	0.745
Increase in nominal return to equity	1.034	0.492
Increase in operating costs and working capital	0.994	0.079
Increase in depreciation rate	1.023	0.391
Increase in nominal cost of debt	1.011	0.256

influence of the rate of return. The return allowed to equity excites a lot of controversy in rate proceedings, yet the analysis indicates that its influence on tariffs is much less than that of certain other elements in the overall cost-of-service.

The relative importance of the various elements of pipeline tariffs generally were similar for the hypothetical oil and gas pipelines with the exception of operating costs. However, the gas pipeline tariffs were much more sensitive to changes in most variables, suggesting the throughput cost configurations of oil and gas pipelines do differ in fundamental ways, reflecting the fact that energy is more cheaply transported in the form of oil than natural gas.

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1. National Energy Board and McGill Centre Conference "Regulation of Pipelines in an Inflationary Era", Montreal, Quebec, November 1982.

2. For earlier analysis, see R. N. Lawrey [1981].

3. National Energy Board Act, Oil Pipeline Uniform Accounting Regulations, P.C. 1977-369, February 24, 1977.

4. A further distinctive feature of United States regulation is that current operating expenses include debt interest, while the allowed rate of return is not a function of the capital structure. This can provide the opportunity to earn quite generous returns on equity.

5. For more on this concept, see R. G. Kirkby, R. N. Lawrey and G. C. Watkins [1982] and G. C. Watkins [1982].

6. See H. Fred Button, [1982].

Bibliography

Button, H. Fred, "New Approaches to the Regulation of Pipelines - Some Tariff Levelling Techniques", November 1982.

Kirkby, R. G., R. N. Lawrey and G. C. Watkins "An Alternative Rate Setting Methodology for Regulated Pipelines", May 1982.

Lawrey, R. N. "Canadian Pipeline Tariff Regulation: An Evaluation of the Key Parameters" Masters' Thesis, University of Aberdeen, 1981.

Watkins, G. C. "Perspectives on the Regulation of Pipeline Tariffs", November 1982.

RESEARCH METHODOLOGY

SIMPLIFIED APPROACHES TO TRANSPORT POLICY ANALYSIS

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INTRODUCTION

Urban transportation systems analysis, in all its forms, is a fairly young discipline, dating from the 1950s. The first efforts at developing transportation planning models began simply enough, but this simplicity was due more to naivety and ignorance than to any profound understanding of urban travel behaviour. These early pioneer efforts, however, were continually refined and grew in complexity and sophistication, aided by advances in computer size and speed, until, by the end of the 1960s, some very comprehensive and detailed (if slow and expensive) planning packages were in wide use, such as UMTA's Urban Transportation Planning System (UTPS) and the FHWA's PLANPAC programme. For the most part, these models were developed during a period when traffic congestion and the need for more and better highways were the principal impetus behind the quest for improved, urban transportation planning information. Inevitably, therefore, these earlier versions of the comprehensive planning programmes suffered, to varying degrees, a certain highway bias.

By the end of the 1960s, urban transportation systems analysis had matured considerably, and both analysts and politicians were concerned with a much wider spectrum of transportation improvements than simply more highway construction. Express transit, transit priority, traffic restraint measures, carpooling, and other shared-ride schemes are but a few of the options both politicians and other policy makers wanted to investigate. This interest in a wider-ranging and more innovative set of transportation strategies was further stimulated by the growing

concern for the environment, the differential social impact of transportation system changes, the need for energy conservation and, most recently, the fiscal crisis brought on by the taxpayer revolt against escalating government expenditures.

When transportation systems analysts, however, attempted to use "conventional," four-phase network planning models to carry out the evaluation of these innovative transportation strategies, it was soon discovered that these programmes often lacked sensitivity to the policy issues of interest; required too much staff time and field data to set up and modify; were too costly to run, especially when considering the large number of alternatives that had to be examined in at least a cursory manner; and were simply too slow in meeting the immediate and fast-changing information needs of policy makers. Conventional models, while they still have a definite and vital role in the evaluation of the impacts of that small sub-set of alternatives chosen for final analysis, were found unsuited to the task of preliminary screening of strategies and many other specialized types of analysis. The remainder of this paper discusses some of the transportation modelling techniques that have been developed to satisfy the need for a simpler, less costly procedure and discusses how these techniques can best be matched to the types of problems faced by transport analysts today.

SIMPLIFICATION OF THE CONVENTIONAL, FOUR-PHASE PLANNING MODEL

The current knowledge about the complex interactions in a transportation system has been accumulated, in a large part, through the use of the conventional four-phase planning model. It is logical for analysts to simplify the associated techniques in an effort to streamline the process while still maintaining their accumulated 'wisdom". Many studies have attempted to simplify the process, therefore, no single technique or study will be discussed, but rather, the four basic approaches to simplification are presented.

Aggregation of Networks and Zones

Possibly the most obvious approach to streamlining the conventional planning process is the aggregation of traffic zones and network links. Reducing the number of origin-destination zone pairs, and the

complexity of the road and transit network linking them, greatly speeds the computations required in all phases of the conventional modelling process.

Zonal aggregation is the straightforward process of gathering several smaller zones into one larger (super) zone. These aggregated "regional" zones can range from a combination of from 2 to 20 traffic zones depending on the application. In Montreal, for example, there are traffic zones, regional zones, and superzones used in traffic planning, medium-range transportation planning, and long-range, land-use planning respectively.

Network can be simplified in two ways; link extraction and link abstraction. Link extraction suffers from the disadvantage that a direct relationship with network capacity is lost in the extraction process, the remaining links may become overloaded, and the network may become topologically disconnected. Link abstraction is constructing an aggregate link between two points formerly connected by a set of detailed links. Link abstraction seeks to maintain the same level of service of the detailed network by combining links in bundles with average level-of-service characteristics for the bundles and summed link capacities.

Network aggregation can reduce network complexity from two to ten times with large-scale savings in computer cost, particularly considering that the cost of network algorithms is approximately proportional to the square of the number of links and nodes.

Procedural Streamlining

Large computer programmes supporting the conventional planning models are characterized by complex data exchange operations between programme elements. Streamlining the models can be achieved by reducing the number of subprogrammes to just those essential to the sketch planning task and internalizing the data manipulation task so that one programme directly feeds the next. With such simplified models, "once-through" processing is possible. The linked, "once-through" type of model thus goes a long way in making the conventional modelling approach more appropriate for the sketch planning task,

though this type of "hands-off" electronic planning may sacrifice some degree of understanding of how the system is reacting to changes.

Use of Transferable Parameters and Models

Urban transportation systems analysis has existed now for over twenty years as a fairly recognizable discipline and, in that time, a wealth of information and knowledge has been acquired and recorded in the many planning study reports on the subject. Furthermore, since the urban transportation planning process settled into the four-phase approach quite early, these data have consistently been tabled in a roughly comparable format. While differences do exist, of course, between cities in such things as trip generation rates, distribution exponents, and average auto occupany, there is a common enough base to make the transference of parameters from one model application to the next possible, at least for sketch planning applications.

Using parameters transferred from another study (region) greatly simplifies the modelling process because it completely circumvents the arduous and expensive task of collecting, screening, and analysing data to be used in calibrating the sub-models. The risk, of course, is that peculiarities in the application region, or in the data transferred, or just fundamental differences in travel behaviour may lead to erroneous results when transferred parameters are used. Where sub-models are rationally based on trip-making behaviour, such as in disaggregate modal split modelling, transferability would appear a sound approach; however, where parameters are calibrated on non-behavioural models, the question of transferability must be approached with great caution.

Simplification of the Component Sub-Models (and Manual Techniques)

Some very effective manual techniques have been devised for both traffic and transit sketch planning, particularly on the supply modelling side. With the appropriate use of graphs and simple equations, it is possible for planners to prepare "rough" estimates of service needs very rapidly. The potential of manual techniques has also been greatly enhanced in the last few years with advances in pocket calculators and micro computers, which can handle moderate amounts of data and routine calculations very efficiently.

The computational procedures for each step of the modelling process must be kept simple, and the number and complexity of the calculations required must be minimized within the limits of simulation accuracy that must be maintained. The programmed work sheet is the current technique in vogue to achieve this end. These work sheets consist of a set of programmed instructions that are logically laid out in a step-by-step fashion, following a fill-in-the blanks format.

A significant advantage of certain manual planning techniques is that the planner gets a better understanding of the data and through this, the transportation problems of the community. A second advantage of the manual approach to planning is that, of necessity, the input and output must be kept simple. This in turns leads to increased understanding and greater credibility of the entire process and a confidence in the results on the part of decision makers. The major concern of manual techniques is to ensure consistency and reproductibility where comparing alternative policy actions.

Conclusions on Simplifying the Conventional Modelling Process

An important conclusions from this overview is that despite the imagination and thought that have gone into simplifying network algorithms, this supply phase of conventional modelling remains complex, time consuming, and expensive in staff and computer resources. Finally, it can be concluded that efforts to develop suitable sketch planning tools by simplifying the conventional approach to traffic planning have not been entirely successful. The inherent structure of these models makes them difficult to adapt to a wide variety of analytic applications as is desirable of a sketch planning tool.

SIMPLIFIED DEMAND MODELS

Three of the four phases of the conventional, transportation planning procedure, namely, trip generation, distribution, and modal split, are aimed at determining the characteristics (spatial, temporal, etc.) of travel demand. Much criticism has been levelled at the artificiality of this sequential approach to modelling urban travel decision making, and much of the complexity of urban transportation planning stems from the problems of maintaining consistency between

steps and of handling the data exchange between the component parts of this often awkward procedure. Simplifying the demand estimation procedure has been, therefore, a major thrust area in the development of simpler planning techniques. Three innovative approaches to this problem are discussed in this section: "disaggregate demand models", "pivotal analysis" and "direct demand models."

Disaggregate Demand Models

Recent developments in the field of disaggregate quantal choice models have provided a new approach to simplifying the urban transportation planning process. The chief advantage offered by the use of these techniques is their sensitivity to key policy issues of interest to decision makers and their efficient use of data, an efficiency that greatly reduces the time and other resources required for data collection and preparation. Three examples of such an approach are as follows:

1. REGINA: Cambridge Systematics

A very promising application of disaggregate demand models to the problem of transit sketch planning has been developed by George Kocur and Associates of Cambridge Systematics (Kocur et al., 1978). Like detailed, conventional, urban transportation planning models, this model employs a fully defined, detailed traffic zone system. The basis of the modelling efficiency of their approach, however, is that instead of computing the modal split for each of the hundreds or thousands of trip interchanges, only a representative sample of all O-D linkages (e.g., suburb to suburb, suburb to inner city, inner city to CBD) are analysed and the results mapped onto the links of the entire system.

The authors claim that the modal split pattern of interzonal trip making is quite predictable and repetitive within like trip interchanges (e.g., suburban zones to CBD zones) and that by carefully selecting a representative sub-sample of O-D linkages and modelling in detail the modal split of these links, the modal split for all the linkages can be estimated from the result of the modal split analysis of the sample. The authors claim that as few as 18 zone linkages (provided that 4 to 6 are CBD oriented) represent the full range of mode

choice behaviour. The sample trip interchanges of course must be carefully selected to encompass the widest possible range of available modes, transit level of service, socio-economic characteristics, and trip distances. Each of the total metro-area zone linkages is then associated with that sample linkage with which it is most alike, and for the purpose of this sketch planning procedure, each of these linkages takes on the modal split characteristics of the associated sample linkage. The use of a small representative sample eliminates the need for a detailed, costly and time-consuming modal split analysis of each of the individual trip linkages and lends much to the simplicity, efficiency, and elegance of the sketch planning procedure.

To evaluate a new alternative, the analysts need only predict how the new system will change the mode shares for each market segment in the sample linkages, remap the sample linkages on the full trip table and, finally, re-assign and re-evaluate the system performance. Trips are assigned to the network in a conventional manner.

This transit sketch planning procedure represents a very imaginative approach to simplifying the transit planning procedure both in terms of the concepts of mapping a representative sample of model splits onto all trip linkages. In addition, the modal split model itself was imported from another city after some adjustment using Bayesian concepts.

2. MIT-TRANS: Area-Wide Disaggregate Sketch Planning Model

The model previously described focused on the aggregation of disaggregate demand models over regular traffic zones, with the disaggregate modelling concept only coming into play for the mode choice portion of the analysis. Trip generation, distribution, and assignment were handled by more or less conventional planning procedures. A second example of the application of disaggregate demand modelling techniques developed by Watanatada at M.I.T. (Watanatada, 1977), called the MIT-TRANS model, extends the use of the disaggregate demand modelling concept to all three portions of the travel demand process--generation, distribution, and modal split. At the same time, Watanatada's model presents a very interesting and efficient procedure using Monte Carlo techniques to handle the difficult question of aggre-

gating the results of disaggregate demand modelling, a step that is so often neglected in disaggregate demand modelling exercies and that is absolutely essential if meaningful outputs from these models are to be generated for decision makers.

The underlying principle of this model is a two-step, spatial aggregation procedures, where the trip volume between origin 'i' and destination 'j' is found by (1) summing the probabilities of an individual in area 'i' selecting each of the spatial opportunities in destination 'j'; and (2) summing the probabilities in (1) for each of the individuals in area 'i'.

Mode choice is handled as a conditional probability of the spatial choice, that is, by computing the conditional probability of an individual choosing a particular mode given that he has chosen a particular spatial alternative. Summing these conditional probabilities in the same manner as described above gives the inter-area trip-volume transfer by mode.

This type of discrete summation is, of course, impractical due to the large number of spatial alternatives and individual trip makers and the impracticality of collecting data on the choices of every possible trip maker. To overcome this problem of aggregation, Watanatada has turned to an abstract form "to represent the spatial choice process and the geographic distributions of the behavioural units, spatial alternatives, level-of-transportationservice characteristics and locational attributes. The use of mathematical functions transforms the discrete summation form of the general spatial aggregation problem into an equivalent, but much more analytically manageable, problem of integration over the urban space" (Watanatada, 1977, p.101). Smooth mathematical functions are defined in terms of polar co-ordinates centred on the CBD of the city.

Once all of these distributions have been defined, two methods of aggregation are possible: a direct integration over the urban space, or an indirect approach, which sees the integration transformed into the equialent problem of integration over the level of service and location attributes. The integration can be carried out by numerical

techniques or by generating a sample of behavioural units using Monte Carlo simulation techniques.

The great strengths of the procedures are that it treats generation, distribution, and modal split simultaneously, rather than only model split, presents a very elegant method of dealing with the problem of aggregation, and gives considerable insight into the modelling error. The procedure developed is extremely efficient, the evaluation of an alternative taking less than 0.6 minutes of computer CPU time. This is somewhat deceiving, however, because a considerable amount of time may be required to adjust the level-of-service distributions to reflect conditions under each alternative to be tested.

3. SGRP: Short Range Generalized Policy Model

The proceding model can be readily expanded to include more refined supply models, which would provide the necessary system-performance feedback information to permit equilibrium analysis. The development of such a comprehensive planning package has been attempted for the San Francisco Bay area under a consortium of consultants comprised of COMSIS, Cambridge Systematics, and Barton Aschman Associates.

The model developed partitions the total vector of household travel decisions: employment location, residential location, housing type, auto ownership, mode of work, frequency, time of day, mode for non-work trips, route, and the like, into a three-level hierarchy, depending upon the time frame (long run versus short run) in which the decisions are made. The longest-run (i.e., urban development) decisions include job and housing-type decisions; the next level or medium-run decisions include residential location, work location, auto ownership, mode to work; and the short-run decisions include household travel decisions including the frequency of non-work trips, destination and mode, route and departure-time choice for work trips--the former set being decisions made jointly by the household.

The model accepts the highest-level decisions (employment location and housing supply) on urban form as input to the process (exogenous variables). The model processes households with zero, one, and more

than one worker separately--it also distinguishes between primary and secondary workers. The hierarchical disaggregate sub-models of the process are linked in two ways: output from the lower-level models serve as input to the next higher-level model, and there is feedback from the higher to the lower levels to ensure constancy between the measures of system performance and the assumptions on the performance used in the lower-level modelling. Disaggregate demand models are used for trip distribution and modal split, and route assignment is carried out using conventional network algorithms.

In the developers' own words, "The MTC travel demand model system represents the first production-oriented system developed for use by a metropolitan planning organization which is based on a consistent theory of traveller behaviour and disaggregate model estimation" (Ruiter and Ben-Akiva, 1977, p.28). In this respect, this modelling effort represents a major advance in urban transportation planning.

Conclusions on Simplification Through the Use of Disaggregate Demand Models

These three examples, particularly the excellent work done by Watanatada, illustrate the contribution disaggregate demand models have made in the field of expanding the range of planning options available. Their policy sensitivity, their minimal data requirements, their relative simplicity (save for the aggregation problem), and their behavioural basis make this type of demand model ideally suited to the sketch planning task.

The great weakness of the models presented is the failure to match and balance the advance in the development and application of disaggregate demand models with similar advances in simplified supply modelling. Watanatada recognized this shortcoming but lacked the time to rectify the problem, and the other two models simply fell back on conventional, network supply modelling techniques.

Pivot Point and Elasticity Techniques

For many sketch planning problems the real centre of focus is the mode choice element of the process, ie. evaluating the impact on mode

choice of various transportation alternatives by varying the parameters of the modal split model and recalculating the relative mode shares under each policy. This type of analysis is often referred to as "pivot point" or short-run analysis, since this approach can only be applied to the existing known trip pattern, or to exogenously determined future trip tables, to measure short-run impacts of policy changes that effect mode choice.

For short-run changes, or for likely responses to different policies applied to some future forecast in trip making, it is theoretically possible to predict the system response using elasticity measures (i.e., change in demand given a unit change in price). It is also possible to use cross-elasticity measures to predict the change in demand for competing modes. These elasticity and cross-elasticity measures can either be estimated directly through field observation or from the coefficients of disaggregate demand models.

An attempt to comprehensively tabulate demand elasticities in urban travel forecasting has been made at Pennsylvania State University (Chan and Ou, 1978). Both measured elasticities (from field experiments) and calibrated elasticities (from modal split models) are included, and from this study it is evident that there are a great many gaps and little consistency in our knowledge about elasticities. These inconsistencies may be due to an underlying fault in the concept itself, poor data, poor analysis techniques, too much white noise in the experiments, or combinations of all these factors and more. What is evident is that, at this time, it is not possible to use elasticities or cross-elasticities in isolation to carry out pivotal analysis (although of course, in theory, it is still possible), but rather, at best, disaggregate models, which at least account for some of the interaction of the variables, particularly when considered with sound supply models, must be resorted to. Particular examples of pivot-point analysis are as follows:

1. TSPP: Highway Users Federations

This transit sketch planning procedure was developed by the Highway Users Federation (Difiglio and Reed, 1976) in response to what the federation believed to be a transit planning vacuum in the trans-

portation field. The model aims at examining "the potential changes in transit ridership resulting from alternative transit capital and operating policies."

The transit demand model developed is sensitive to such key policy issues as transit accessibility, speed, and fares, as well as auto (the competing mode) speed and parking costs. Travel time is split into two categories--"out of pocket" and "in vehicle"--and converted to a dollar cost with a higher value of time being assigned to out-of-vehicle costs on the premise that this portion of the total trip is the most onerous. The difference between the generalized cost of auto and transit travel is then used to factor (ie. pivot on) the non-captive transit market (the captive market is modelled separately) into auto and transit trips using the non-linear "logit" probability function.

Model calibration is based on a very aggregated zonal system--there being but three circumferential zones for an entire metropolitan region: the CBD, the inner city, and the suburbs. A trip table is generated for work trips within each zone and between all zone pairs (nine trip linkages in all).

One of the most interesting aspects of this model is the handling of the aggregation bias. The aggregation of disaggregate demand models is one of the most important problems in disaggregate modelling, yet due to the difficulties of producing aggregate demand estimates, many disaggregate demand modellers simply stop short of this problem or adopt the naive approach of using zonal averages of the parameters in the calibrated models, which can result in severe aggregation bias. This aggregation bias is due to the non-linear nature of functions such as the logit model, which when used to estimate modal split based on zonal averages, tend to bias the estimate downward. To overcome this problem, the researchers in this study calibrated a linear function relating the aggregate modal split to the modal split estimate using the average zonal values for the parameters and the variance of these independent variables (particularly access, egress, and wait time). Using this bias correction and adjusting travel time estimates, the model is calibrated to give the base year modal split.

The developers then used the model to test alternative transit improvement schemes. They recommended that the analysis of transit options be done by changing one variable at a time to ensure that the impact of individual policies could be disentangled.

2. RAND: Sketch Planning Model

In 1973, the RAND Corporation developed a sketch planning model to be used to assess the impact of transportation policies on the environment, particularly air quality (Bigelow et al., 1973).

More will be said about this model in the following section dealing with simplified supply models, but in this section, the focus will be on the pivot point approach to demand forecasting used in this planning procedure. The model is not a forecasting model; rather, given a forecast of some nominal future situation, the model predicts the changes in demand for the competing modes resulting from various policy options. The demand model "pivots" on the forecast for the future year.

To be realistic, the model cannot be tied to the trip volume predicted for the future year under study because, of course, the actual demand will be a function of the policy being studied. To accommodate this shift in total demand as well as the change in demand for each mode, a concept called the "potential trips approach" was employed. The number of potential trips is the total number of all trips that would be made if service were ideal. Knowing the difference between this value and the actual number of trips taken in the forecast year gives a measure of the trips forgone. By relating the number of forgone trips to the measure of system performance (called "conductance" in the RAND study, where conductance is a function of out-of-vehicle time, in-vehicle time and cost), it is possible to estimate the reduction in forgone trips due to increased conductance using a simple ratio of conductances to factor up the total trips estimate. Thus both total trips and modal split change simultaneously with the introduction of new policies to be tested.

Since the number of potential trips varies with trip purpose, the model will be greatly improved by considering trip type. Two trip

purposes are considered: essential trips such as work trips, which are considered very inelastic and, hence, have little or no forgone trip component; and non-essential trips, which do have a forgone component.

The RAND model adopted an n-dimensional, logit modal split model calibrated for San Diego by Peat Marwick and Mitchell, and defined the passenger miles by mode to be the integral of the modal split function over all trip lengths times the expected number of trips (for essential trips) where the integration is done numerically.

3. CRA: Charges River Associates Model

Brief mention is due on another study related to the use of elasticities and pivotal analysis--a disaggregate demand model developed by Charles River Associates (CRA) for the U.S. Department of Transportation (Charles River Associates, 1976). The aim of the CRA model was to estimate the national impact on urban transportation of major changes in the price of gasoline. Both local and national data were used in model calibration.

The CRA study is very similar in nature to the transit sketch planning model developed by the Highway User's Federation and described at the beginning of this section in that it pivots on the present situation (i.e., looks only at the short range) and does not include any trip volume forecasting.

Unlike the transit sketch planning model, however, the CRA model involves the calibration (rather than transfer) of disaggregate behavioural demand models for both a nation-wide (from the National Transportation Study data) and zonal (from data drawn from the Los Angeles area) models. A procedure developed by Antti Talvitie and based on a Taylor series expansion was used to aggregate the models. The model output consists of estimates of modal split, vehicle miles of travel (VMT), and their elasticity to gasoline prices. Both work and non-work trips were modelled; however, the latter were modelled using linear regression rather than "logit" models.

Conclusions on Pivot Point and Elasticity Techniques

The coefficients calibrated in a disaggregate demand model such as those described in the previous section can be used to determine elasticities and, in fact, this is often done to verify whether the results of model calibration are reasonable. The distinction between pivot point (or elasticity analysis) and disaggregate demand modelling is, therefore, a fine one, as witnessed by the CRA model where a disaggregate mode choice model is the pivoting device. Most of the conclusions concerning disaggregate demand models cited in the previous section are equally applicable to pivotal analysis.

As described, pivotal analysis is not truly a forecasting technique, but rather a method of carrying out sensitivity analysis. In the three examples, pivotal analysis is confined to the mode choice question. While a sketch planning model must possess this sensitivity analysis capability, it must also include, as an integral element, forecasting models.

A serious problem with pivot point models of this type is the question of constant elasticities. Can any inference be made about the impact of higher fuel costs, based on today's elasticity for fuel? If the cost of fuel increases by an order of magnitude or even triples, will the response in demand be at all predictable, using the price sensitivity today? Obviously, since there are no data embracing the effect of fuel price of this order of magnitude, the model must be extrapolated beyond the limits of the data--at best a very dangerous practice. The same criticism can be applied to disaggregate demand models.

Finally, measures of elasticity drawn directly from field experiments or disaggregate models are not appropriate techniques for developing sketch planning models. Tabulations of these elasticities indicate that there are many holes, little consistency, and no guarantee that the interactive effects of more than one service variable changing at the same time are taken into account.

Direct Demand Models

The third innovational approach to simplifying the demand portion of the planning process to be described in this section is the "direct" demand modelling approach. The term "direct" refers to the fact that the demand estimation procedure attempts to directly estimate the number, destination, and mode choice (and possibly route choice) of trips between communities in an urban area.

While direct demand models have enjoyed some success in modelling intercity trip making, they have not been extensively employed in modelling intracity travel. Even in the case of intercity travel, where the data sources tend to be somewhat more reliable, the results of direct-demand modelling calibrations to date have been somewhat marginal. The lack of adequate data in urban areas and the poor performance of the intercity models have discouraged greater experimentation with the models for urban travel.

For example, in an early attempt made at M.I.T. to fit a direct demand model (Plourde, 1968) to data from the Boston area, only very poor statistical fits were realized with R values ranging from a high of 0.65 to values as low as 0.16. The 't' values also indicated that few of the key policy variables of interest were significantly different from zero. Since it is difficult to believe travel decisions are random, it can only be concluded that the research team either failed to find adequate measures with which to model the decision process or that the process could not be distilled to a form as simple as a single equation.

SIMPLIFIED SUPPLY MODELS

Supply models serve two central functions in the sketch planning process.

1. To provide the transportation system level-of-service inputs into the demand models (ie. make conversion from supply measures such as bus hours of service to measures of the users experience such as waiting time).

2. To translate the transportation system level-of-service performance into meaningful output measures (i.e., dollar costs, gallons of fuel consumed, pounds of emissions generated,etc.).

Ideally, supply models should permit interaction with the demand models to ensure that a consistent (equilibrated) set of assumptions between supply and demand is attained. As previously mentioned work on simplified supply models, in general, has not kept pace with the work on demand models. This is due to a number of factors including the fact that until recently demand models themselves have not been sufficiently sensitive to policy issues benefit from improved supply models, and supply modelling to some extent is a more difficult problem and has not benefited from any procedural breakthrough, such as the development of disaggregate quantal choice models. Furthermore, developments in supply models have lagged because of the highway bias that has existed in most earlier modelling work, which saw the transportation problem as strictly a capacity problem, with the result that work on non-road network supply issues such as transit supply, parking supply, and ride-sharing supply received little attention. Despite the fact that work on supply models, particularly sketch planning supply models, has lagged, in general, there have been some notable advances and these are described and discussed in the following section.

It must be kept in mind while reviewing these models that the supply model components discussed form only part of larger planning procedures, and the peculiarities of certain of the sub-models stem from assumptions made in formulating other parts (particularly demand models) of the entire planning techniques.

CRISTAL - An Abstract Network Model

As described in the section on simplifications of the conventional, four-phase computer modelling approach, one of the largest consumers of computer costs and staff resources is the processing of network algorithms. This situation has led researchers to seek alternative non-network-based supply models for use in sketch planning. Before progressing to an analysis of these pure non-network approaches to the problem, it is worthwhile examining an interim approach, developed by researchers at the Transport and Road Research Laboratory (TRRL), which

is based on an abstract network concept (Tanner et al., 1972, 1973).

The TRRL model called CRISTAL was developed to serve as a "rapid method of assessing the economic benefits of alternative transport investment strategies" (Tanner et al., 1973, p.1); and to reduce the time and cost of network analysis so as to achieve this goal, an abstract, symmetrical radial network (actually separate networks were developed for freeway, street, and rail systems) was formulated with ring routes and equally spaced radials. Trip origins and destinations were generated symmetrically at the intersection points of the network permitting the problem of network performance simulation to be reduced by orders of magnitude, since flows on one segment of the network are the same as flows on all other segments.

The CRISTAL model uses generalized cost functions in both the supply and demand models, that is to say, the demand models characterize demand as a function of the generalized cost of travel by mode and route, and the supply models describe the relationship between the generalized cost of travel (mostly time) and the volume of trips. Trips are assigned to the network so as to minimize generalized cost.

The CRISTAL model's abstract network, due to its symmetry, obviously cannot cope with the peculiarities of local geography. By careful calibration, however, in which the layout of the radial spacing and position of the ring roads are made as near that existing on the ground in a real city as possible, it is possible to gain important insights into the impact of alternative transportation strategies on the main corridor traffic volumes.

Parametric (Non-Network) Supply Models

As previously mentioned, possibly the single, largest contributing factor to the cost of urban transportation modelling is associated with the network simulation models. It is not surprising, therefore, to find that the development of innovational planning models that do not involve network analysis has been the prime target of a number of researchers attempting to develop effective and efficient, simplified, urban transportation planning procedures. The following four models illustrate the results of some of these efforts.

1. Charles River Associates - Study of Urban Travel Policies

The supply models used to generate the level-of-service parameters for the disaggregate demand models used in the Charles River Associates (1976) study discussed previously are relatively crude and represent the simplest type of supply model. Average values are assumed (for both suburban and inner city travel) for out-of-vehicle time at the origin and destination ends of the trip, vehicle speeds and out-of-pocket cost (ie. transit fare, parking cost in CBD, vehicle operating cost per kilometer). Estimates of these averages are made separately for auto and transit trips. These values are then applied to assumed average trip distances for trips between the CBD centroid and inner city centroid, and the CBD centroid and suburban centroid. Obviously such simple, sweeping assumptions about urban travel are only suited to the analysis of the impact of very broad policies such as global changes in transit fare or changes in fuel prices. The supply models, while very easy to use tell nothing about sub-areas of a city or specific routes. In considering this supply model it must be remembered that it was aimed at analyzing some very general urban transportation issues of national interest but still can be very useful for transportation planners who would like to quickly estimate the potential impact of a policy such as free transit for example.

2. CAPM: The Community Aggregate Planning Model

An excellent example of the non-network class of urban transportation planning models is the Community Aggregate Planning Model developed for UMTA by Creighton, Hamburg and Associates (Schleifer et al., 1976). This model totally eliminates network modelling for the arterial street system and also all but eliminates it for the freeway system.

The CAPM programme was a direct outgrowth of the Transportation Resource Allocation System (TRANS) sketch planning model developed from the U.S. national transportation survey (Schleifer et al., 1976). The aim of the CAPM programme was to produce a similar capacity (to TRANS) to yield a quick response on multicriterion evaluation of urban transportation options but on an individual community basis rather than on a nation-wide basis.

The developers of CAPM recognized the need for (a) simple, easily obtained inputs; (b) ease of computer operations; and (c) readily comprehensible outputs. They also wanted to develop a model that would (a) give the magnitude, location, and function of transportation investment, (b) aid in the formulation of highway strategies to achieve environmental, social, and energy conservation objectives; and (c) examine the implication of land-use strategies. To achieve these ends, the researchers developed a three-part model consisting of a total vehicle miles of "travel (VMT) generator," a "travel distributor," and an "evaluation package," which translated the resulting travel data into information of interest to decision makers such as pounds of emissions, gallons of fuel consumed, and number of residents displaced.

The aspect of this model of greatest interest in this section, however, is the approach to supply modelling--an approach that does not use computerized network simulation. Instead of nodes and links, the model inputs consist of macro measures of highway supply, namely, lane miles of arterial per community and lane miles of freeway per freeway route.

The internal workings of the CAPM model are quite simple and are based on the constant, travel-time budget concept and several reasonable assumptions about individual travel behaviour. In the first step, total region-wide vehicle miles travelled (VMT) is generated as a function of the total vehicle trip ends, average trip distance, and the highway supply. Total VMT is made sensitive to the highway supply through the assumption that the average trip time in a region is a constant (travel-time budget concept). Speed is made a function of the ratio of VMT to highway capacity. Increasing highway capacity increases speed, which increases the distance that can be travelled in the constant travel time, and hence total VMT.

In the second step, the distribution sub-model allocates the total VMT generated among the communities using a probabilisitic trip distance function applied to internal, internal-external, and through trips.

The VMT totals for each community and the average speeds for each road type are then input into the evaluation model to generate the desired system performance measures.

3. The RAND Model

The RAND sketch planning model also referred to earlier in the demand modelling discussion (Bigelow et al., 1973) presents one of the best attempts to date to construct useful, simplified supply models for the major urban transportation modes, that is, auto, shared ride and transit (bus). It is worthwhile, therefore, to examine each of its components in some detail.

a) Highway Supply Sub-Model

The primary focus of the RAND highway supply sub-model is the question of congestion and its impact on highway travel speeds and hence travel times experienced by both buses and autos. This is possibly the most difficult feature of transportation supply to model in any simplified yet meaningful manner because networks are involved, and any type of network simulation such as used in conventional planning models is inherently complex.

The approach adopted by the RAND research team avoids network modelling by classifying the highway network into five categories: (1) congestion-prone freeways, (2) non-congested freeways, (3) congestion-prone arterials, (4) non-congested arterials, and (5) local streets, and then loading (assigning) the total vehicle miles of travel onto the inventory (miles) of each street type in proportion to the present recorded distribution of vehicle-miles travelled (VMT) on each type of facility. Finally, the average operating speed on each type of facility is determined from the loaded volumes and capacity of the street.

For buses, of course, the free-flow street speed is only one factor, so bus speeds are further adjusted to account for frequency of stops, acceleration/deceleration performance, and passenger loading times.

This highway supply sub-model presents a fairly elegant solution

to area-wide highway modelling and completely avoids the complexities of network modelling while at the same time permitting an equilibrated solution to be found. The principal limitation of this approach is that it assumes that traffic is distributed uniformly over the road supply and, unlike network models, does not account for spatial (local) concentration of traffic. This failing is likely to underestimate congestion effects.

b) Ride-Sharing (Carpooling) Sub-Model

The primary supply factor affecting the ride-sharing mode, which causes it to differ from the auto drive-alone mode, is the extra inconvenience (i.e., time and distance) incurred in picking up/dropping off extra passengers. The RAND model estimates this added cost as a function of the probability of finding a neighbour nearby with shom to share the ride to work. Where this probability, in turn, is considered to be a function of the density of workers in the neighbourhood with similar trip distances.

c) Bus Supply Sub-Model

The transit (bus) supply model is based on a series of simple equations which relates, (a) the route miles of service to the area served and the route spacing and (b) the number of buses required to the route miles, average speed and headways. From these two relationships the total bus miles and bus hours of service can be determined and the cost of the service estimated. Express bus service can be also modelled in this fashion with the exception that extra route miles must be added to account for the distance travelled in connecting non-contiguous service areas. Access time to transit was estimated based on a system wide assumption about walking times.

4. Deterministic Queuing Models for Transportation Level of Service

A simplified highway and transit supply model has been developed in a series of studies under the direction of Antti Talvitie. The purpose of this research was to develop "an analytical method of properly representing the level-of-service for all the people in the zone" (Talvitie and Hilsen, 1974, p.3), level of service referring to

quantifying the access and egress portions of transit and auto trips as well as the line haul portion of the trip. The need for such simplified supply models has arisen from the development of disaggregate demand models, which as previously mentioned suffer aggregation bias if used with only zonal average data for the model input parameters. Much of this bias can be eliminated if the within-zone variance of the parameters can be estimated along with the means and, consequently, Talvitie's work focuses on calibrating simple supply models for both the mean and variance of the access/egress time parameters.

Multiple regression was used to calibrate the model parameters. In the first study (Talvitie and Hilsen, 1974), home interview data drawn from a Chicago transportation study were used to calibrate supply models for three separate modes of access: drive, walk and feeder bus. The results of this first study were quite disappointing, with very little of the variance of either the parameter means or standard deviation being explained by the model (less than 50 per cent). A second series of studies, however, using simulation to generate the data (Talvitie and Leung, 1976), yielded much better results.

A number of simplifying assumptions were made in carrying out the simulation of data such as square zones, uniform street spacing, even distrubtion of vehicles among the lanes. These are discussed in more detail in the reference. It must also be mentioned that a large number of explanatory variables were tested, including frequency of stops and coverage (percentage of area within one-half mile of the bus line).

Talvitie and his associates further refined their parametric, non-network model and extend it to the auto mode by using deterministic queuing concepts (i.e., "point bottle-neck model") and applied the results to a single freeway corridor. The "point bottle-neck" model assumes that the capacity of any section of a major transportation facility is governed by the point of lowest capacity, or bottle-neck. If volumes exceed the bottle-neck capacity, queuing takes place behind the constriction, whereas, at volumes below capacity, free-flow conditions prevail.

In the model, roads running along corridors are broken into segments chosen such that the performance on each segment is governed by

an identified bottle-neck. Speeds up to the bottle-neck are assumed to be freespeed. The travel time over the full segment of the freeway is given by the combination of travel time up to the bottle-neck plus the queuing delay through the bottle-neck.

This single road concept can be extended to include more than one facility (i.e., freeways and arterials) in a single corridor by assuming drivers will distribute themselves to minimize their travel times (Wardrop's First Principle), and this can be simulated in the model by simply summing up the facility capacities. Drivers are assumed to choose the minimum time between the time in motion plus queuing delay on the freeway versus the time by the arterial.

From the earlier discussion of the formulation of disaggregate demand models, it is known that the probability of an individual choosing a particular mode is related to travel time by that mode; the total demand for a particular facility is a function of the probability of commuters choosing that mode; and, finally, travel time is a function of total demand. This full circle of relationships requires equilibration, that is, consistency of all terms in order to realistically simulate real world conditions.

5. Two-Stage (Micro-Macro) Approach to Sketch Planning

An innovative indirect approach to developing sketch planning models has been developed a research team (Bellomo et al., 1972) from Alan M. Voorhees and Associates, Inc. This micro-macro model "relates investment to transit supply, supply to level of service, and level of service to demand" on a city-wide basis.

The approach adopted by the team uses the conventional, four-step detailed urban transportation planning model as the basic analytic tool to conduct a series of simulation experiments on a full range of alternative transportation strategies in the first phase of the exercise. In the second phase of the approach, the resulting micro-model outputs of transit and highway travel times and modal splits are then plotted against macro measures of system performance (transit seat miles per capita, highway capacity per capita, travel time, and cost difference) to produce the macro model relating demand to investment.

The experimental design chosen consists of thirteen highway/public transportation systems composed of various likely combinations of three levels of highway service and three levels of bus transit service or rail transit service. These experimental systems were matched against one of two urban activity systems--a highly concentrated pattern characteristic of older cities, and a dispersed pattern characteristic of more recent auto-oriented development.

The core of the model is a mode choice model that relates the percentage using transit to the marginal disutility of transit usage and auto ownership level. The simulation procedure forecasts total trip tables from projected activity and socio-economic characteristics for the year 1990. The trip tables are then split into auto and transit trips using the modal choice model. The auto ownership level required for the modal choice model is determined from a relationship linking auto ownership with income and transit level of service, the income factor being forecast, the level of service being given by the experimental design. The entire model is iterated to ensure equilibrium is achieved.

The variables output from the simulation experiments are used to calibrate the macro model. Relationships are then plotted for supply versus level of service. The resulting macro model permits very rapid assessment of key trade-offs, for example, "For a given level of investment, a measure of supply in terms of rapid transit seat-miles per capita can be used to determine the level of transit service for that level of investment. From a prespecified highway supply, the highway level of service can be determined. Knowing both the highway and transit levels of service, one can estimate the percentage of transit trips" (Bellomo et al., 1972, p.8).

Conclusions on Simplifying the Supply Modelling Process

The CRISTAL model presents an interesting analytic tool to examine the impact of area-wide transportation strategies such as the spacing of major arterials, setting of transit frequencies, and transit fare changes, although it may be a difficult model to fit to Canadian cities unless a grid equivalent can be developed. The requirement of model symmetry makes it a transport strategy-specific model rather than a

city-specific tool. The model is appropriate in assessing the overall potential of general transportation strategies.

By using an idealized symmetrical abstraction of the actual network layout, the laborious tasks of network coding and complex, large-scale, network minimum path algorithms are avoided. At the same time, the model still preserves a network structure and, after all, networks are a real and vital part of transportation systems. There is a serious risk that when planners move away from network simulation, they ignore some of the most important and interesting problems in transportation system analysis, such as the conflicts and delays at intersections.

The CRA "supply" models illustrate just how simple supply models can be. This type of supply model suffices when feeding disaggregate demand models that are aggregated by simple enumeration of the original calibration sample. Problems obviously arise with this type of model, however, when one wants to forecast, and there are no reported speeds or distances. Furthermore, the model of this level of simplicity is not truly sensitive to parameters such as out-of-vehicle time, as there is no way to translate the assumed values of transit service requirements (coverage, frequency, etc.) resulting from local policy options into out-of-vehicle time inputs other than through some gross average measures.

The CAPM programme is an excellent model encompassing many of the ideal features sought in any sketch planning procedure. It has very simple inputs; the modelling concept is easy to understand and hence more credible; detailed network coding and calculations are, for the most part, avoided; the model outputs (VMT) are sensitive to system performance (capacity and speed), and the model outputs are translated into straightforward measures that decision makers can easily grasp. The highway bias aside, the CAPM programme clearly illustrates what can be achieved in sketch planning without recourse to detailed network simulation. The concept of using macro parameters of supply, such as lane miles of arterial per unit area and lane miles of freeway per route, is of great interest.

Both the RAND supply models and Talvitie's supply models represent

excellent attempts at achieving that ideal balance between model simplicity and simulation accuracy required in sketch planning.

The RAND models, by maintaining an area-wide perspective and by using macro supply measures, permit elgantly simple and easily understood supply measures and cost calculations. Talvitie's work, on the other hand, while somewhat more complex computationally, is particularly policy sensitive and is structured to be compatible with the input requirements of the disaggregate demand models.

Talvitie's non-network parametric highway equilibrium supply model in particular marries effectively the elegance and simplicity of deterministric queuing supply models with the policy sensitivity of disaggregate demand models and, hence, represents a very significant step forward in the development of improved sketch planniong techniques.

The two-stages (simulation-correlation) approach to the sketch planning problem, with its vey elegant nomograms, represents a very imaginative approach to sketch planning. Two particular strengths of the approach are the use of very simple macro parameters as inputs to the model and the simplicity of the means of tracing the output trade-offs between investment levels, modal split, and level-of-service performance of each mode. The investment output measures are particularly useful as this is the language decision makers understand. The great weakness of the two-stage model approach is its failure to account for the differential impacts of system changes and geographic urban peculiarities--two factors that make this approach useful only for the crudest analysis of large-scale alternatives.

OVERVIEW AND EVALUATION OF SKETCH PLANNING MODEL PERFORMANCE

Up to this point, attention has been focused on describing the concept and strengths and weaknesses of individual sketch planning techniques. In this concluding section, however, the various approaches described up to this point will be compared and constrasted. The purpose of this comparative review of the state-of-the-art in sketch planning is to provide a means of matching model approach to the

nature of the planning problem. The key trade-off, of course, is that of "simulation detail" for "cost savings" where the cost savings in staff time, computer time, and data collection requirements can, if desired, be translated into a larger number of alternatives examined. In somewhat more technical jargon, the key trade-off is that between "simulation error" and the "error of analysis."

There are, of course, important criteria other than cost and accuracy that also must be kept in mind when choosing sketch planning models to analyze urban transportation problems. These include:

(a) Supply/Demand Orientation

As indicated by the rough organization used in presenting the models described in this paper, certain approaches to sketch planning tend to focus on the problem of demand estimation (in certain instances, almost exclusively), while other approaches focus on the supply problem. Ideally, a balance between supply and demand emphasis should be struck, but this is difficult to achieve while retaining computational efficiency. In choosing a model an analyst must consider where the focus of the problem lies in the demand side or the supply side.

(b) Short versus Long Run

Ideally, a sketch planning model should be capable of evaluating at least medium-run planning decisions as these constitute a significant portion of the information needs of decision makers. Some of the modelling approaches presented were restricted to the evaluation of very short-run alternatives (i.e., only modal split modelled), while other approaches were capable of modelling medium-to long-run options (i.e., included trip distribution, generation sub-models). In choosing a planning technique an analyst must carefully consider the planning horizon and the strengths of the various models as forecasting tools as well as sensitivity analysis tools.

(c) Geographic Level of Analysis

Either through geographic specificity or some other method, a sketch planning model ideally should be capable of differentiating the impact of transport alternatives on sub-areas within a city as decision makers at the local (city) level are interested in isolating the impact of alternative transportation policies for, at least, the corridor level of geographic specificity. Many of the sketch planning techniques however do not offer this degree of geographic/social specificity and analysts must carefully consider what level of such detail they require when making a choice.

(d) Highway/Transit Orientation

The two major components of the urban transportation system are the highway-auto system (with the autos being privately owned) and the transit system (for the most part, publicly owned). There is a great deal of interaction between these two components; therefore, ideally both should be modelled together in a sketch planning technique. Again however this type of balance is difficult to achieve with computational efficiency and analysts must assess where the strategic heart of their problem lies in electing a particular analytic approach.

(e) Degree of Automation in Planning

Ideally, sketch planning models should be simple. Dependence on sophisticated computer systems requires programming expertise and access to computer systems, which detracts from this goal of simplicity and flexibility. Ideally, therefore, a sketch planning model should not be overly main-frame computer dependent when used in forecasting. How important this criteria is in choosing a modelling technique will depend on the resources available and the comfort each analyst has with computer systems.

(f) Technical Knowledge Requirement

In a similar spirit to the previous issue, sketch planning models ideally should be simple enough that they can be

understood, used, and believed by decision makers and analysts. In choosing a sketch planning model an analyst must carefully consider the degree of technical knowledge required to implement each model, where an ideal model is considered to require little or only moderate levels of skill and expertise, and weight these requirements against available resources.

(g) Innovativeness

Elegance and innovativeness of approach are key factors in developing better sketch planning techniques. The degree of creativeness, originality, and elegance of approach evident in each of the models should be carefully considered when choosing a sketch planning model. Assessing this criteria demands that analysts free themselves from the bias imposed by judging new approaches based on the accepted norms in planning (i.e., the conventional approach).

(h) Data Requirements

One of the most serious stumbling blocks in the development of improved sketch planning procedures is data quality and availability. Conventional (aggregate), transportation planning data sources tend to be unwieldly and the data required for new disaggregate modelling techniques, while much more limited in size, are far more complex and difficult to collect. Ideally, a sketch planning model should draw on available data sources. Data issues can be a major constraint on choice of planning techniques and must be carefully considered before options for a particular planning technique.

(i) Turn Around Time

Detailed planning information that is obtained to late to influence planning decisions is worthless. Sketch planning is aimed at providing approximate (i.e., good enough) answers quickly. How quickly each of the planning procedures being considered responds to the information needs of decision makers at reasonable levels of staff and computer input is therefore an

important choice criteria.

(j) Policy Sensitivity

There are a great many questions in urban transportation requiring evaluation and answers. In choosing a planning technique ananlysts must ask how comprehensive and flexible each of the candidate planning techniques is in providing information to decision makers on the range of policy options of interest.

The above "dimensions" are not totally independent; for example, to be highly policy sensitive, a model must also include a balanced highway-transit orientation, and models requiring low skill levels also will not likely be highly computer dependent. Every effort has been made, however, to include all of the important measures of sketch planning performance.

To illustrate the strengths and weaknesses of the models described earlier in this paper each model has been evaluated using the above criteria. This evaluation has been done by first summarizing each of the models according to approach in Table 1 and assigning each a number. The numbers corresponding to each of the sketch planning models was then located along a dimensional rating scale presented in Figure 1 indicating where the model lies with respect to its performance against the criteria (i.e., data requirement, turn around time, etc.). Because of the complexity of these dimensions, no attempt is made to measure them in hard and fast units, but rather intuitive judgement is exercised to spot each model relative to the other models. The comparison, therefore, must be considered qualitative rather than quantitative and the ranking of models, more or less an ordinal one.

Table 2 presents a summary of the strengths of each of the models or model classes described in Table 1. While all of the strengths certainly are not of equal importance, scanning the columns gives a rough estimate of the overall success of each of the models as sketch planning tools. Furthermore, scanning the rows indicates which of the strengths have proven the most difficult to achieve.

It is interesting to note the greatest number of the models

Table 1

SUMMARY OF SKETCH PLANNING MODELS

SERIAL	MODEL	DEVELOPERS	GENERAL METHOD OF APPROACH
1. a.	TASSIM	Harvard for U.S. DOT (Fauth & Kroch, 1975)	• Zonal aggregation, link aggregation, once-through processing
b.	STPCP	Ontario MTC (1976)	" " " " " "
c.	TRIMS	Met. Washington C. of G. (1976)	" " " " " "
d.	COMPACT	MacKinder (1972)	" " " " " "
2.	REGINA	Cambridge Systematics (Kocur et al., n.d.)	• Set of modal split derived from disaggregate modal choice models, then mapped onto a full trip table of interzonal linkages
3.	MIT-TRANS	Watanatada (1977)	• Disaggregate quantal choice models applied to modal split and trip distribution with aggregation by integration of smooth functions describing service levels and the activity system
4.	SGRP	Cambridge Systematics (Ruiter & Ben-Akiva, 1977)	• Hierarchical set of nested disaggregate demand models including an auto ownership model
5.	TSPP	Highway Users Federation (Difiglio & Reed, 1976)	• (Transit sketch planning procedure) application of disaggregate demand model to develop a non-linear diversion curve, aggregation bias corrected by linear model, applied to three-ring-zone city system
6. a.	CRA	Charles River Associates (1976)	• Application of disaggregate demand modelling techniques to sketch planning area-wide analysis aimed at broad policy evaluation
b.	TRANS	FHWA (Weiner et al., 1973)	
7.	RAND	Rand Corp. (Bigelow et al., 1973)	• Traffic VMT loaded onto street inventory by type of street, equilibrium estimated, area-wide parametric transit model
8.	CAPM	Creighton, Hamburg & Associates for U.S. DOT (Schleifer et al., 1972, 1973)	• Loading total VMT onto street system by street type (freeway, local, arterial) and proportion of mileage travelled on each type, equilibrium based
9.	CRISTAL	TRRL (Tanner et al., 1972, 1973)	• Use of a radial, uniform abstract network
10.	UTDF	ITE Berkeley (McFadden, Talvitie & Associates, 1977)	• Development of non-network parametric models that interface with the input requirements of disaggregate demand models, model developed for corridor planned
11.	TRB	COMSIS for NCHRP (Sosslau, Hassam & Carter, 1978)	• Tabled values and procedural worksheets for manual urban transportation planning using conventional procedures
12. a.	Street Planning	Gruen Associates (1973)	• Graphs, tables, nomograms for determining route capacity and spacing
b.	Macro-Micro	Bellomo et al. (1972)	• Two-step process involving detailed simulation of scenarios followed by plotting of nomograms

Figure 1

STRENGTHS AND WEAKNESSES

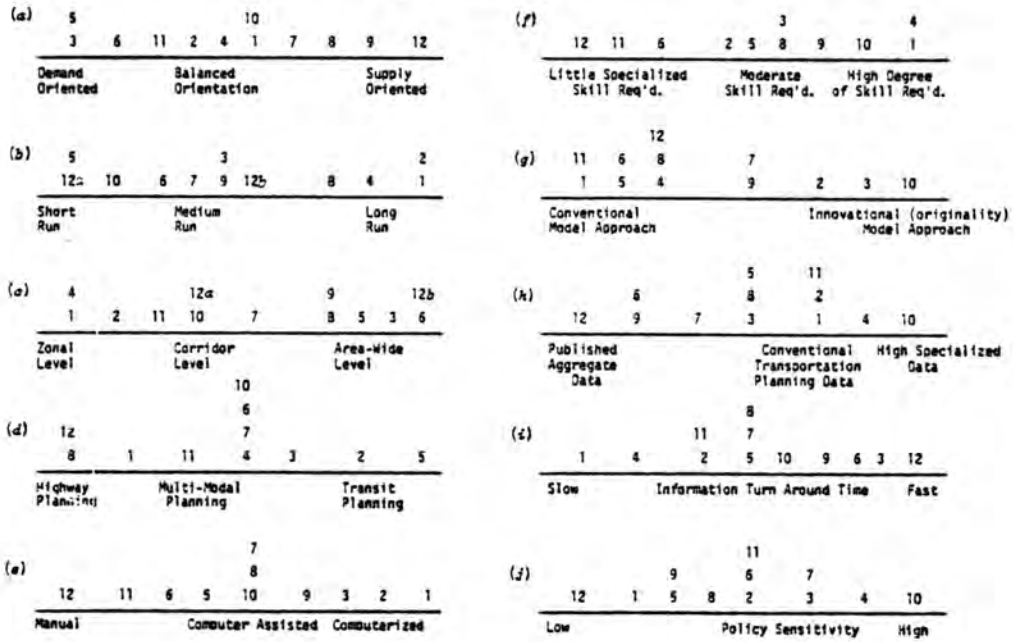


Table 2

ASSESSMENT OF MODEL STRENGTHS
BY SKETCH PLANNING MODEL NUMBER

STRENGTH	1	2	3	4	5	6	7	8	9	10	11	12
Balanced supply and demand orientation	X	X		X						X		
Medium- or long-run application	X	X	X	X			X	X	X			X
Zonal or corridor-level geographic specificity	X	X		X						X	X	
Multimodal planning (auto-transit)			X	X		X	X		X	X	X	
Manual or computer assisted techniques					X	X					X	X
Little or moderate level of technical skill required						X					X	X
Originality of approach		X	X				X		X	X		
Use of published or readily available data						X			X			X
Policy sensitivity			X	X			X			X		
Information turn-around time			X			X						X

displaying strengths (assuming equal importance for each dimension) are Watanatada's MIT-TRANS model, Cambridge Systematics' SGRP model (though it must be kept in mind that this model is still unproven), the CRA national transportation policy model, and the excellent work done at Berkeley by McFadden and Talvitie.

It would appear that the most difficult strengths to achieve in a sketch planning procedure are

- o Balanced supply/demand (equilibrium) orientation
- o Limited requirement for high levels of technical skill and/or computer assistance
- o Freedom from reliance on specialized and difficult-to-obtain data
- o Policy sensitivity
- o Speed in information turn around.

These problem areas have been, therefore, should be the primary focus of future research.

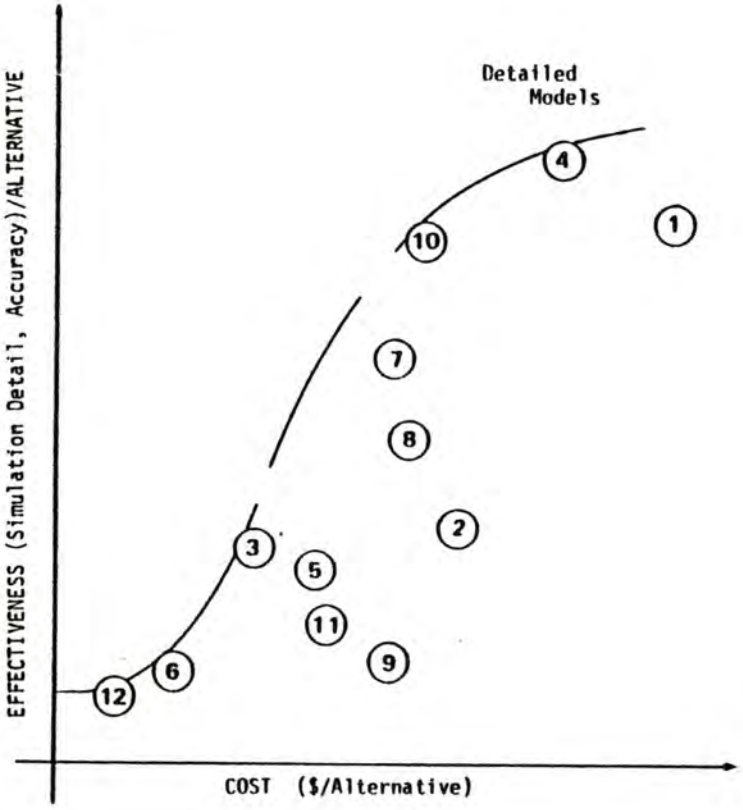
Finally, Figure 2 attempts to put this entire issue in perspective by returning to the fundamental trade-off in sketch planning presented at the beginning of the paper, namely, that of simulation accuracy versus the number of alternatives evaluated. Each of the models listed in Table 1 is spotted in Figure 2 as a function of simulation detail (accuracy) versus cost (in terms of staff time, computer time, data collection costs, etc.), where cost is inversely proportional to the number of alternatives that can be examined given a fixed budget. Again, due to the complexity of this question, this positioning is done judgementally, and no attempt is made to fix cardinal measures to the axis.

As can be seen, the basic slope of the envelope traced out by the most efficient models is that of a production function where, initially, there are definite increasing returns over a portion of the scale, but above a certain level of investment and simulation detail, there are diminishing marginal returns in terms of the extra information provided decision makers.

In choosing a planning technique it must be kept in mind that the goal of effective sketch planning is to optimize the information made available to decision makers, given the scarce resources available for evaluation of transportation plans just as planning itself seeks to optimize the benefit to society of the investment made in transportation improvements.

Fugyre 2

PRODUCTION FUNCTION FOR SKETCH PLANNING TECHNIQUES



BIBLIOGRAPHY

Bellomo, Savatore J; Turner, Christopher G.; and Johnston, Denis K. 1972. "Modal-Choice Model for Relating Demand to Investment." in **Transportation Demand and Analysis Techniques**, pp. 1-12. Highway Research Record 392. Washington, D.C.: National Academy of Sciences.

Bigelow, J.H.; Goeller, B.F.; and Petruschell, R.P. 1973. "A Policy-Oriented Urban Transportation Model: The San Diego Version." Report prepared for the County of San Diego, Office of Environmental Management. Santa Monica, Calif.: Rand Corporation.

Chan, Yupo. 1976. "A Method to Simplify Network Representation in Transportation Planning." **Transportation Research 10** (June): 1979-91.

Chan, Y. and Ou, F.L. 1978. "Tabulating Demand Elasticities for Urban Travel Forecasting." In **Transportation Forecasting and Travel Behavior**, pp. 40-46. Transportation Research Record 673. Washington, D.C.: National Academy of Sciences.

Charles River Associates. 1976. "Disaggregate Travel Demand Models. Project 8-13: Phase I Report." 2 Vols. Report prepared for the Transportation Research Board, National Cooperative Highway Research Program. Washington, D.C.: National Academy of Sciences.

Difiglio, Carmen and Reed, Marshall F. 1976. "Transit Sketch Planning Procedures." In **New Approaches to Travel Forecasting**, pp. 1-11. Transportation Research Record 569. Washington, D.C.: National Academy of Sciences.

Dunbar, Frederick C. 1976. "Estimating the Effects of Urban Travel Policies." Report prepared for the U.S. Department of Transportation, Office of the Secretary, Transportation Energy Policy Staff. Cambridge, Mass.: Charles River Associates.

Eash, Ronald W. and Morlok, Edward K. 1977. "Development and Application of a Model to Evaluate Transportation Improvements in Urban Corridors." in **Transportation Systems Evaluation Techniques**, pp. 14-19. Transportation Research Record 639. Washington, D.C.: National Academy of Sciences.

Fauth, Gary R. and Kroch, Eugene. 1975. "Additional Traffic Assignment Options for the TASSIM Model." Report prepared for the U.S. Department of Transportation, Office of the Secretary. Cambridge, Mass.: Harvard University.

Gruen Associates. 1973. "Simplified Guidelines for Major Street Planning." Report prepared for the U.S. Federal Highway Administration, Office of High Planning.

Gur, Yehuda. 1972. "Development and Application of Direct Traffic Estimation Methods." In **Transportation Demand and Analysis Techniques**, pp. 76-88. Highway Research Record 392. Washington, D.C.: National Academy of Sciences.

Heathington, Kenneth W. and Brogan, James D. 1977. "Simplified Procedures for Preliminary Evaluation of Public Transportation Alternatives." In **Transportation Planning Techniques for Small Communities**, pp. 1-7. Transportation Research Record 638. Washington, D.C.: National Academy of Sciences.

Heightchew, Robert E. 1974. "Procedures for Small Staffs." **Traffic Engineering** 44 (March): 10-12.

Hillegass, Tom; Fleet, Christopher; and Heaune, Kevin. 1973. "A Proposal for a Simplified Urban Transportation Planning Modeling Process." Washington, D.C.: U.S. Federal Highway Administration, Office of Highway Planning, Urban Planning Division.

Jones, A.D. and Grecco, W.L. 1972. "Procedure Manual for Determining Traffic Patterns for a Simplified Planning Procedure for Major Thoroughfare Planning in Small Urban Areas. Interim Report." Lafayette, Ind.: Purdue University, Engineering Experiment Station, Joint Highway Research Project.

Jones, A.D. and Grecco, W.L. 1973. "Simplified Procedure for Major Thoroughfare Planning in Small Urban Areas." In **Transportation Forecasting**, pp. 1-16. Highway Research Record 472. Washington, D.C.: National Academy of Sciences.

Kocur, George; Rushfeldt, Thomas, and Hillican, Richard. (n.d.) "A Sketch Planning Model for Transit System Analysis and Design." Cambridge, Mass.: Cambridge Systematics, Inc.

Levinson, Herbert S. 1972. "Simplifying the Comprehensive Transportation Planning Process--Prospects and Perspectives." Paper presented at the 51st Annual Meeting of the Highway Research Board. Washington, D.C.: Wilbur Smith and Associates.

MacKinder, I.H. 1972. "COMPACT: A Simple Transportation Planning Package." **Traffic Engineering & Control** 13 (March/April): 512-16.

McCoomb, Lloyd A. 1981. "Simplified Urban Transportation Planning Procedures Using Census Data." Ph.D. dissertation, University of Toronto.

McFadden, Daniel and Talvitie, Antti and Associates. 1977. "Demand Model Estimation and Validation." Urban Travel Demand Forecasting Project. Phase I, Final Report Series, Vol. 5. Berkeley: University of California, Institute of Transportation Studies.

Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board. 1976. "TRIMS Model--for Subarea and Quick Response Transportation Planning--Users Manual." Technical Report No. 9. Washington, D.C.

Mikolowsky, William T.; Stanley, William L.; and Goeller, Bruce F. 1974. "The Effectiveness of Near-Term Tactics for Reducing Vehicle Miles Traveled: A Case Study of the Los Angeles Region." Santa Monica, Calif.: Rand Corporation.

Ontario, Ministry of Transportation and Communications. 1976. **Simplified Transportation Planning Computer Programs: User's Manual.** Toronto: The Ministry.

Organization for Economic Co-operation and Development. 1974. **Urban Traffic Models: Possibilities for Simplification.** Paris: OECD.

Peat, Marwick, Mitchell & Co. 1979a. **Simplified Aids for Transportation Analysis: Annotated Bibliography of Analytical Aids.** Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration.

Peat, Marwick, Mitchell & Co. 1979b. **Simplified Aids for Transportation Analysis: Derivation and Use of Automobile Availability as a Variable for Estimating Travel Demand.** Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration.

Peat, Marwick, Mitchell & Co. 1979c. **Simplified Aids for Transportation Analysis: Estimating Annual Ridership and Operating Expense for Fixed Route Bus Systems in Small Urban Areas.** Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration.

Peat, Marwick, Mitchell & Co. 1979d. **Simplified Aids for Transportation Analysis: Estimating Fringe Parking Site Requirements.** Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration.

Peat, Marwick, Mitchell & Co. 1979e. **Simplified Aids for Transportation Analysis: Methodology for Estimating Parking Accumulation.** Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration.

Peat, Marwick, Mitchell & Co. 1979f. **Simplified Aids for Transportation Analysis: Methodology for Transit Route Evaluation.** Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration.

Plourde, Rodney Paul. 1968. "Consumer Preferences and the Abstract Mode Model: Boston Metropolitan Area." Research Report R68-51. Search and Choice in Transport Systems Planning, Vol. 12 of a series. Cambridge, Mass.: Massachusetts Institute of Technology, Department of Civil Engineering, Transportation Systems Division.

Rose, Kenneth. 1975. "Design Charts for Estimating Transportation Planning Statistics from Area Population." **Transportation** 4: 55-66.

Ruiter, Earl R. and Ben-Akiva, Moshe. 1977. "A System of Disaggregate Travel Demand Models: Structure, Component Models, and Application Procedures." Cambridge, Mass.: Cambridge Systematics, Inc.

Schleifer, Harry; Zimmerman, Samuel L.; and Gendell, David S. 1976. "The Community Aggregate Planning Model." In **Innovations in Transportation System Planning**, pp. 14-27. Transportation Research Record 582. Washington, D.C.: National Academy of Sciences.

Soberman, Richard M. 1974. "Urban Transportation Planning: Some Reflections on Relevant Techniques." Paper presented at the Canadian Transportation Research Forum, Quebec City, 13 May.

Sosslau, Arthur B.; Carter, Maurice M.; and Hassam, Amin B. 1978. "Manual Techniques and Transferable Parameters for Urban Transportation Planning." In **Transportation Forecasting and Travel Behavior**, pp. 32-40. Transportation Research Record 673. Washington, D.C.: National Academy of Sciences.

Sosslau, Arthur B.; Hassam, Amin B.; and Carter, Maurice M. 1978. "Manual Techniques and Transferable Parameters for Urban Transportation Planning." Paper prepared for the 57th Annual Meeting of the Transportation Research Board. Wheaton, Md.: COMSIS Consultants.

Sosslau, Arthur B.; Hassam, Amin B.; Carter, Maurice M.; and Wickstrom, George V. 1978a. **Quick-Response Urban Travel Estimation Techniques and Transferable Parameters: User's Guide.** National Cooperative Highway Research Program Report 187. Washington, D.C.: National Academy of Sciences.

Sosslau, Arthur B.; Hassam, Amin B.; Carter, Maurice M.; and Wickstrom, George V. 1978b. **Travel Estimation Procedures for Quick Response to Urban Policy Issues.** National Cooperative Highway Research Program Report 186. Washington, D.C.: National Academy of Sciences.

Talvitie, Antti. 1978. "Planning Model for Transportation Corridors." In **Transportation Forecasting and Travel Behavior**, pp. 106-12. Transportation Research Record 673. Washington, D.C.: National Academy of Sciences.

Talvitie, Antti and Hasan, Ibrahim. 1977. "An Equilibrium Model System for Transportation Corridors and its Application." Berkeley: University of California.

Talvitie, Antti and Hilsen, Neil. 1974. "An Aggregate Access Supply Model." Paper presented at the Transportation Research Forum Meeting in San Francisco, October. Norman: University of Oklahoma.

Talvitie, Antti and Leung, T. 1976. "A Parametric Access Network Model." In **Perception and Values of Travel Demand**, pp. 44-49. Transportation Research Record 592. Washington, D.C.: National Academy of Sciences.

Tanner, J.C.; Gyenes, L.; Lynam, D.A.; Magee, S.V.; and Tulpule, A.H. 1972. "Development and Calibration of the CRISTAL Transport Planning Model." TRRL Technical Note TN737. Crowthorne, Berkshire: Department of the Environment, Transport and Road Research Laboratory.

Tanner, J.C.; Gyenes, L.; Lynam, D.A.; Magee, S.V.; and Tulpule, A.H. 1973. **Development and Calibration of the CRISTAL Transport Planning Model.** TRRL Report LR574. Crowthorne, Berkshire: Department of the Environment, Transport and Road Research Laboratory.

U.S. Department of Transportation. Federal Highway Administration. 1977. **Computer Programs for Urban Transportation Planning. PLANPAC/BACKPAC General Information Manual.** Washington, D.C.: Government Printing Officer.

Université de Montréal. Centre de recherche sur les transports. 1975. "Survey and Inventory of Computer-Based Urban Transportation Planning Techniques. Final Preliminary Report." Study prepared for the Transportation Development Agency, Montreal.

Université de Montréal, Centre de recherche sur les transports. 1979. "EMME: Equilibre Multimodal/Multimodal Equilibrium. Summary Report." Montreal: Transport Canada, Canadian Surface Transportation Administration, Urban Transportation Research Branch.

Watanatada, Thawat. 1977. "Application of Disaggregate Choice Models to Urban Transportation Sketch Planning." Sc.D. dissertation, Massachusetts Institute of Technology.

Watanatada, Thawat and Ben-Akiva, Moshe. 1978. "Spatial Aggregation of Disaggregate Choice Models: Areawide Urban Travel Demand Sketch-Planning Model." In **Transportation Forecasting and Travel Behavior**, pp. 93-99. Transportation Research Record 673. Washington, D.C.: National Academy of Sciences.

Weiner, Edward; Kassoff, Harold; and Gendell, David S. 1973. "Multimodal National Urban Transportation Policy Planning Model." In **Transportation Planning Improvement Priorities**, pp. 31-41. Highway Research Record 458. Washington, D.C.: National Academy of Sciences.

Wohl, Martin and Martin, Brian V. 1967. **Traffic System Analysis for Engineers and Planners.** New York. McGraw-Hill.

RISK ANALYSIS: REGULATORY IMPLICATIONS FOR DANGEROUS GOODS TRANSPORTATION*

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ABSTRACT

This paper attempts to review the existing theories,methodologies, and empirical studies of risk to derive meaningful regulatory implications. Existing theories of risk attempt to explain it in terms of an expected value and/or variance. Empirical studies reveal that estimated risk varies according to a number of factors: the mode of transport for given types of dangerous goods, route characteristics, population density adjacent to the route, types of dangerous goods, types of transport equipment utilized for a given mode, and the speed the agent releases from the container. To further improve safety, a comprehensive system of safety measures is required, including: (i) development of a data base; (ii) risk analysis and evaluation programs; and (iii) implementation of safety programs.

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INTRODUCTION

Just before midnight on Saturday November 10, 1979, a CP Rail freight train derailed at Mavis Road in the City of Mississauga, Ontario. Among the 24 rail cars that were derailed were 21 tank cars, 19 of which were carrying dangerous commodities such as chlorine, propane toluene, and caustic soda. Fire ensued and three cars carrying propane exploded causing considerable damage to neighbouring properties. Almost a quarter of a million people were evacuated from their homes and businesses for periods of up to six days in order to prevent possible harmful consequences from chlorine gas which was released from one of the tank cars. After the spectacular derailment at Mississauga, railway safety in relation to dangerous commodity traffic received nationwide attention. Derailments involving dangerous commodities, however, remain possible.

Estimates by Transport Canada (1980 a and 1980 b) for 1979 indicate that 207,371 cars carried dangerous commodity traffic by rail in Canada while the for-hire truck industry made 1,047 shipments (i.e., about 22 million metric tonnes) during that year. Total dangerous commodity shipments as a percentage of total commodity traffic by the for-hire trucking industry was about 3.2% in 1979. Unfortunately, a similar figure for railway traffic is not available at this moment. There were however, 350 derailments which took place during that year, and 42 cases or 12% of the total derailments were accidents where dangerous commodities made up all or a

portion of the train involved in the mishap (Canadian Transport Commission).

Since derailments involving dangerous goods continue to remain a top national concern, it seems appropriate to develop an appreciation and understanding for the subject of risk analysis and its application to the field of transport. Such an endeavor entails a review of the existing theories, methodologies and empirical analyses. This insight may prove useful in the formulation of improved safety regulations.

The objectives of this study, therefore, are threefold: i) to review literature on the theory of risk and methodologies applicable to risks associated with dangerous commodities transportation; ii) to review empirical studies and evaluate their findings from selected studies; and iii) to assess regulatory implications in relation to dangerous commodity traffic.

THEORY OF RISK

(1) Concept of Risk

A review of the literature on risk analysis appears to offer no universal concensus as to the notion of risk. The term has been employed in numerous fields of endeavor ranging from finance to mathematical statistics. Inasmuch as the notion of risk differs depending on the field of application, the respective theory of risk inevitably varies accordingly. Following the statisticians approach for example, the definition of risk commonly adopted is in terms of losses (consequences) and their respective probabilities. In actuarial

literature, the word "risk" traditionally followed Tetens' definition of "one half of the mean deviation". This terminology, now obsolete, persisted in actuarial circles until the Second World War, and led to the eventual development of risk theory (Borch). Economists may recall Frank Knight's distinction between the concepts of "risk" and "uncertainty". According to Knight, risk is present in a situation where an action can lead to several different, mutually exclusive outcomes each of known probability. If these probabilities are unknown, the situation will, according to Knight, contain uncertainty (Hirshleifer, p. 215.) Recently, this distinction between risk and uncertainty has become less clear because the Bayesian approach to probability assumes that all probabilities are subjective and that there is hardly ever a complete lack of knowledge. The development of the Bayesian approach to statistics and decision theory seems to have made Knight's distinction between the concepts obsolete, or at least to indicate that the distinction is not essential to a systematic study of the subject (Borch).

(2) Theories of Risk

Since the notion of risk differs depending on the scientific field, the respective theory of risk will inevitably vary to some extent. In addition, there exist different theories for risk preference, risk estimation and risk management. For the purpose of this paper, only theories related to risk estimation will be discussed.[1]

[1] This section relies largely on the work by Schaefer, and Borch.

Modern Utility Theory

Modern Utility Theory (pioneering work of vonNeumann and Morgenstern) treats risk in the following manner. A lottery, L, is defined as a probability distribution over outcomes, i.e., the lottery yields outcome x_i with probability P_i, where i = 1, 2, ..., n. The uncertain outcomes of a lottery are conceived as a random variable $\tilde{x}$. The expected outcome is given by

$$\bar{x} = E\{(\tilde{x})\} = \sum_{i=1}^{n} p_i x_i \qquad (1)$$

and the expected utility by

$$E\{u(\tilde{x})\} = \sum_{i=1}^{n} p_i u(x_i) \qquad (2)$$

where $u(x_i)$ denotes the utility attached to outcome x_i. It is assumed in this theory that the decision-maker wishes to choose the lottery which maximizes expected utility.

The certainty equivalent of a lottery is the amount $\hat{x}$ such that the decision-making is indifferent between lottery L and the sure thing (riskless) $\hat{x}$. The utility of $\hat{x}$ is given by $u(\hat{x})$, the utility of the lottery is defined by its expected utility in equation (2), so we have:

$$u(\hat{x}) = E\{u(\tilde{x})\} \qquad (3)$$

The certainty equivalent $\hat{x}$ is smaller than the expected outcome of $\bar{x}$ of lottery L; this is generally

true for all risk averse decision-makers who have increasing utility functions over non-degenerate lotteries.[2]

The difference between $\bar{x}$ and $\hat{x}$ is called risk premium (RP), as shown in Figure 1, since the decision-maker is cautious in the sense that he is willing to give up some amount as compared with the expected outcome in order to get a smaller amount $\hat{x}$ for sure:

$$RP(\tilde{x}) = \bar{x} - \hat{x} \qquad (4)$$

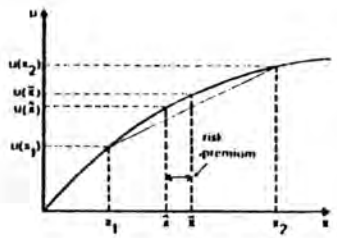


FIGURE 1: EXAMPLE OF A UTILITY FUNCTION OF A RISK AVERSE DECISION MAKER

Source: Schaefer, Ralf E., p. 10.

In other words, the risk premium equals the difference between the expected consequence ($\bar{x}$) and

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[2] A lottery is called non-degenerate if no single consequence has the probability of one of occurring; a sure thing is therefore a degenerate lottery.

the certainty equivalent ($\hat{x}$).

Expected Risk Theory (Huang's)

Huang (1971) proposed a theory of risk in which "risk" is defined as expected risk:

$$ER = \sum_{x \in X} P(x)\ f(x) \qquad (5)$$

where ER = expected risk; f = a real valued function on x, the risk function; $x \in X$ = an outcome, or consequence; P = a probability measure on X; and X = the set of all possible outcomes.

A lottery or gamble g_1 is subjectively not more risky than g_2, $g_1 \lesssim g_2$, if the following conditions are fulfilled[3]:

$$g_1 \lesssim g_2$$

$$\text{iff } r(g_1) \leq r(g_2);\ \text{iff } \sum_i P_{1i}\ f(x_{1i}) \leq \sum_i P_{2i}\ f(x_{2i})$$

Lottery g_1 is no more risky than g_2 if the risk value of g_1 is less or equal to that of g_2, which is the case if the weighted sum of the risk values of the outcomes, i.e., $f(x_1)$ of g_1 is not greater than that of g_2. The weights are the probabilities of occurrence, therefore, the risk function is called expected risk function.

Expected utility theory is a special case of expected risk theory in that the probability component is the same, but $u(x_i)$ is replaced by $f(x_i)$. Expected utility for discrete probability distributions can be

[3] $\lesssim$ = is not preferred.

written as:

$$EU = \sum_{x \in X} P(x)\, u(x) = \sum_{x \in X} (u(x) - x)\, p(x) + \sum_{x \in X} p(x)$$

$$= EV + \sum_{x \in X} (u(x) - x)\, P(x) = EV + R \qquad (6)$$

where EU = expected utility; R = the influence of a "risk" factor which relates the expected value to the expected utility; and EV = the expected value.

Pollatsek and Tversky's Risk Systems

Risk theory developed by Pollatsek and Tversky (1970) is based on a set of assumptions on the orderings of perceived risk. A relational system such as $< S, O, \succsim >$ is a risk system if the axioms of extensive measurement (i.e., weaker order, monotonicity, compatability, positivity, solvability, archimedean, etc.) are fulfilled. A relational system leads to an important theorem: if $< S, O, \succsim >$ is a regular system, then there is one and only one θ, $0 < \theta \leq 1$, such that for all A, B in S (with finite expected value and variance):

$$A \succsim B \text{ iff } R(A) \geq R(B), \text{ with}$$
$$R(A) = \theta V(A) - (1 - \theta)\, E(A) \qquad (7)$$

where V = variance; E = expected value; S = A, B, C, ... probability distribution over R; $\succsim$ = binary relation of corporative risk, i.e. "$A \succsim B$", is to be read as "A is at least as risky as B".

This result shown in Equation (7) states that, in a regular risk system, a risk ordering is generated by a linear combination of expected value and variance, i.e.,

the perceived riskiness of a lottery depends only on the expected value and the variance and on a single parameter, θ, which, of course, is person specific.

Actuarial Theory of Risk

The actuarial risk theory, to a large extent, was developed outside the mainstream of the probability theory and mathematical statistics.

Most people dislike risk, and are willing to pay something to get rid of it. The function of an insurance company is to accept and carry risk against compensation, in the hope of usually making profits. The basic concept in insurance is the insurance contract. An insurance contract by definition will give a person -- the insured -- the right to claim an amount of money, S, from the company, if certain events should occur. The insured pays the company a premium, P, to be entitled to this right.

If the probability of events leading to a claim is p, the premium is determined so that

$$P = pS \qquad (8)$$

This equation illustrates the principle of equivalence, which constitutes the very foundation of insurance theory. This principle states that the expected value of claim payments under a contract should be equal to the expected value of premiums received.[4]

[4] Strictly speaking the equation determines the so-called net premium. In practice one must add to this premium a "loading" to cover the expected administrative costs of the company.

A more general insurance contract can be defined by using a probability distribution F(x), where F(x) is the probability that claim payments under the contract shall not exceed x. The net premium for this contract is, by the principle of equivalence,

$$P = \int_0^\infty x dF(x). \tag{9}$$

In order to obtain a measure of the risk of a contract, Tetens defined risk as expected loss to the company, if the contract leads to a loss. This gives the risk as:

$$R = \int_P^\infty (x - P) dF(x) = \frac{1}{2} \int_0^\infty |x - P| dF(x). \tag{10}$$

Tetens' definition shown in Equation (10) led to suggestions that risk should be defined as M (standard deviation of claim payment), where M is determined by the following equation:

$$M^2 = \int_0^\infty (x - P)^2 \, dF(x). \tag{11}$$

The Equation (11) represents actuarial risk in the classical theory of risk.

Despite the numerous theories and approaches to the subject, a common element involved in risk estimation appears to be the notion of the variance or some deviation from the expected value. As will be evident from the subsequent sections, the methodological approach to risk estimation involves an additional step. Once the

probability distribution has been ascertained, the variance is known. The level of risk according to operations research literature is then the product of the probability and a consequence component.

RISK ANALYSIS METHODOLOGIES APPLICABLE TO DANGEROUS COMMODITY TRANSPORTATION

In applying risk analysis to the subject of transportation of dangerous goods, certain methods would appear to be more appropriate, namely: the Delphi Estimation Process, Bayesian Statistics, Fault Tree Analysis, and the Expected Value Model (e.g. Atzinger et al.; Philipson et al.; Horodniceanu et al.). Analysts may often use a combination of methods in the estimation of risk and associated costs.

(1) Delphi Estimation Process

The Delphi process is a method of developing values for the parameters associated with a risk analysis model (e.g., likelihood and cost) from subjective estimates by experts. This method is particularly useful in cases in which adequate statistical data does not exist.

The Delphi process employs an initiation period and three successive survey and analysis phases. In the Initiation period, a panel of experts is assembled. The panel focuses on the development of accident likelihood data, normal shipment costs, and the average costs of accidents for different possible accident severity classes under normal transportation environmental conditions. It is emphasized to the panel members that the responses given in the questionnaires will be held in

strict confidence. The results of the analysis of each questionnaire are summarized statistically with no identification of individual inputs. The final results are a group assessment and not an individual projection.

This Delphi method can be integrated with Bayesian statistics by combining the Delphi estimates with statistical data from observations of accident frequencies and costs. The Delphi process that has been described results in the values of the lower and upper limits of the middle 50% range of each likelihood estimated, as well as an estimate of the likelihood value itself (given by the mean of the estimates provided by the panel). If a particular distribution function is assumed by the panel to hold for the set of estimates of this likelihood, these 50% limits and the mean will, in most cases of practical interest, permit the specification of the parameters of the distribution. This distribution can then be assigned to the role of the a priori distribution in a Bayes revision process, becoming improved when a sample of actual accident experience data is introduced. The mean of the improved distribution then provides an improved estimate of the value of the likelihood under consideration, combining both the Delphi and sample information.

(2) Bayesian Statistics

Bayesian statisticians believe that it is possible, at any time, to express the state of knowledge about a random variable in the form of a probability density function. Any quantity whose value is unknown is

considered a random variable by Bayesians. As additional experimental evidence becomes available, Bayes' Theorem is used to continue this evidence with the previous probability density function in order to obtain a new posterior probability density function representing his updated state of knowledge. In turn, this serves as a quantitative basis for any future decisions.

A Bayesian statistician attempts to show how the evidence of observations should modify previously held beliefs in the formation of rational opinions, and how on the basis of such opinions and of value judgements, a rational choice can be made between alternative available actions. He is concerned with judgements in the face of uncertainty, and he tries to make the process of judgement as explicit and orderly as possible.

(3) The Expected Value Model

The risk calculation for any given segment of the transportation system is determined by an expected value risk model. It computes the probable number of injuries, fatalities, and dollars of property damage associated with the transport of dangerous commodities summed over all possible events.

"Expected value" is defined as the likelihood of a loss-generating event times the amount of loss resulting from that event. In this model, all loss events must be preceded by an incident: splash, fire, explosion, etc. And, since all possible occurrences leading to loss events must be considered, the model requires a summation of the expected value of loss for each type of incident.

It has been assumed that risk would change along a route according to the phase of transport operation underway and according to the demography associated with each phase. Therefore, risk values are determined separately for each segment and are then summed across all segments for an entire route.

According to this model, "risk" is the product of a level of loss for each segment (in injuries, fatalities, or dollars of property damage) and the likelihood of incurring that level of loss. In turn, this loss is really the product of three likelihoods: that of an accident, the probability of an incident given an accident, and the probable severity level given that incident. The term "accidents" refers to those events during any part of a shipment which are potential causes of incidents. "Incidents" are the unintended release of hazardous materials. "Severity levels" are usually described in terms of injury, fatality and damage radius with respect to incident location.

(4) Fault Tree Analysis

Fault tree analysis (FTA), similar to decision tree analysis, depicts a graphic diagram of decisions that lead to a major failure. It provides information to enable the assessment of the magnitude of the potential hazards that exist. Fault tree analysis is a technique which uses logic diagrams to represent and record a deductive reasoning process. This type of analysis serves as a useful aid in identifying structural or design failures and human errors.

The foundation of a fault tree is the notion of "logic gates", which was borrowed from the field of electrical engineering. The gates indicate whether a single event or a combination of them is required to produce the next level of events. To perform a fault tree analysis, only two types of gates are necessary: AND and OR gates. The AND gate is defined as a logical operation which produces an output event requiring the coexistence of all the input events. The OR gate is defined as a logical operation which produces an output event if one or more of the input events exist.

EMPIRICAL STUDIES ON RISK ANALYSIS BY MODE OF TRANSPORTATION

Four major empirical studies were selected to illustrate risk analysis and their empirical findings. Philipson et al. (Research Center of the University of Southern California) investigated the feasibility of applying the Delphi process to develop subjective estimates of parameters of the risk analysis model. The study combines estimates of various likelihoods of several types of accidents (e.g., enroute, loading/unloading, leaks, externally caused) with hazardous materials, likelihoods of several severity classes consequential to accidents (e.g., explosion, fire and escape of toxic liquids or gas), and the costs potentially accruing to the occurrence of a particular type of accident. The specification of the model is:

$$\text{Total Cost} = \text{Normal Cost} + \text{Risk} \qquad (12)$$

where the normal cost is that of shipping the particular

material in the specific manner defined, and for the given instance. Risk has three components including expected property damage, injuries, and fatalities.

The risk model is specified as

$$R_i = \sum_{jkl} \sum \sum L_{ijkl}{}^{D} \cdot C_{ijkl}{}^{D} \qquad (13)$$

where $L_{ijk}{}^{D}$ denotes likelihood of an accident due to kind j, resulting in severity class k and causing loss of kind 1; $C_{ijkl}{}^{D}$ refers to cost of an accident due to kind j resulting in severity class k and causing loss of kind 1; i refers to index of alternatives involving mode, material, route, etc.; j refers to index of accident kind such as enroute accidents, loading/unloading, leaks and container failure, and external causes (fires, etc.). In estimating parameters associated with the normal cost and the risk component of the model, Philipson et al. used the Delphi process. Philipson et al. have concluded that very low risk accrues to a single shipment of H_2S (hydrogen sulfide) in any of the four modes considered -- tank truck, flat bed truck, rail tank car, and rail flat car. By comparing relative levels of risk among four modes, Philipson et al. concluded that the rail tank car has the lowest risk and total cost. Moreover, the tank truck has the highest risk with an estimated total cost below average.

Garrick et al. (Holmes & Narver, Inc., Los Angeles, California) developed a working mathematical model to evaluate the risk associated with handling and

transporting biological weapons in stockpile-to-target-sequence (STS). The risk is measured in terms of the number of initial infections which may be expected when transporting a specific biological weapon system through an identified STS. Actual computation of risk is performed by organizing STS's into a network of storage nodes and transportation links. For each node and link (S), a set of probabilities, P(S,Q), is generated for discrete magnitudes, Q, of biological agent release. Concurrently, the number of people infected N(S,Q), is estimated for each release magnitude. The expected number of infections at location S with the transport of one bio-weapon is formulated as:

$$E(S) = \sum_{\text{all } Q} P(S,Q)N(S,Q), \qquad (14)$$

for each set of nodes and links which form an STS path, P. A risk estimate, R(P), for that path is therefore,

$$R(P) = \sum_{S \in P} E(S). \qquad (15)$$

Garrick et al. derived minimum and maximum risk estimates based on four sets of situations (standard case, expedited delivery, changed agent and changed container). The minimum risk, 2.75×10^{-10} infections/trip, would be achieved when transporting the agent in an improved shipping container via the shipbased route (i.e. STS path 1). The maximum risk, 1.38×10^{-5} infection/trip, would occur with expedited delivery via the air route (i.e.,STS path 2). In addition, Garrick et

al. examined the relative significance of three release types: instantaneous, large continuous, and small continuous. Results show that the instantaneous release (type 1) is the dominant source of risk.

Kloeber et al. (ORI, Inc., Silver Spring, MD), conducted a risk assessment study comparing the transport of certain hazardous materials by air with the transport of these materials by alternative modes - rail, highway and water. The materials analyzed were Class A Explosives (CAE) namely TNT, dynamite, Slurries and blasting caps, and Flammable Cryogenic Liquids (FCL) such as liquid hydrogen (LH_2).

The risk calculation for any given segment (S) is determined by an expected value risk model. The specification of the model is:

$$R(S) = \sum_{ijk} L(i)S \cdot L(j/i) \cdot L(k/j) \cdot C(jk)S \quad (16)$$

where R(S) is the likelihood of incurring a certain level of loss; L(i)S is the likelihood of accident type i in segment S; L(j/i) is the likelihood of incident j given an accident i; L(k/j) is the likelihood of loss in severity level k, given incident j; and C(jk)S is the potential loss associated with severity level k and incident type j in segment S.

Kloeber et al. estimated risks in terms of the expected number of injuries, fatalities, and dollars of property damage associated with the air and non-air route alternatives. The relative risks of the air

alternatives, for both CAE and FCL carriage, are generally lower than their respective non-air alternative routes. However, relative risks among modes are highly route dependent. The reason for the lower air risks is due to the low risk characteristic of the in-flight phase. Air is relatively safe over longer distance routes, since its risks are more contingent upon take-off and landing than on distance. Rail risks, on the other hand, are dominated by terminal risks due to high population densities surrounding rail terminal areas, and highway risks are dominated by truck accident rates and by population densities.

Ang et al. (Department of Mechanical Engineering, University of Illinois) developed the overall framework for the systematic risk analysis. The basic risk model is:

$$f_A = \sum_{i=1}^{n} P(A/f_i) \cdot f_i \qquad (17)$$

where f_A is the frequency of accident A; f_i is the frequency of fault i; $P(A/f_i)$ is the proportion of fault i that will lead to accident A.

Ang et al. have demonstrated practical usage of the model by using numerical illustrations of three modes of transportation - air, highway, and rail. Let us take the Highway mode, for example, Ang et al. considered specific factors on accident occurrence such as the steering free play, tiretread depth, brake lining thickness, and tire inflation pressure since these factors account for the majority of vehicle accidents. Fault trees for the

highway mode were also developed and they were divided into the human, machine (i.e., vehicle) and environmental aspects in the process of illustrating the model.

Based on the review of selected empirical studies, it was found that the estimated risk varied according to a number of factors: the mode of transportation for given types of dangerous goods, the route characteristics, the population density adjacent to the route, the type of dangerous goods, type of transport equipment utilized for a given mode, and the speed of release of agent from the container.

REGULATORY IMPLICATIONS

Regulations pertaining to the transportation of dangerous commodities in Canada are administered by a number of Federal government agencies. Railway regulation is administered by the Railway Transport Committee (RTC) of the Canadian Transport Commission (CTC). Air and water modes are regulated by the Regulations and Licensing Branch of the Civil Air Operations and Regulations Division and the Marine Regulations Branch, respectively, of Transport Canada. Regulatory authority over the transport of dangerous commodities by road[5] and by private railway rests with the Explosives Division of the Department of Energy, Mines and Resources. It should be noted that because of the difference in conditions between the various forms of transportation, commodities classified as dangerous for

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[5] Transportation by road of dangerous commodities other than explosives is controlled by the provinces concerned.

one mode of transportation may or may not be so classified for the other modes of transportation. Therefore, in cases where more than one type of transportation is to be used, the shipment must satisfy the regulations of each.[6]

The Transportation of Dangerous Goods Act, which applies intermodally, was proclaimed in 1980 and is designed to augment existing regulations. The Act will be directed at federal transport undertakings, including railways which are governed by the Railway Act [7] of Canada, all air transportation, all marine and water transportation and highways that cross provincial boundaries.

Regarding transportation of the rail mode, which is administered by the Commission, the Railway Act [8] of 1903 (and subsequent amendments) provides most of the railway safety requirements which include: inspection, accident investigation, and grade crossing and

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[6] Canadian Transport Commission, Regulations for the Transportation of Dangerous Commodities by Rail, p. 479.

[7] According to Sections 295 and 296 of the Railway Act, it is a requirement that dangerous commodities not be transported over railways subject to the jurisdiction of the CTC except in conformance with the Commission's regulations. In addition, Sections 383 and 384 of the Act provide penalties for violation of the Commission's regulations.

[8] The National Transportation Act was enacted in 1967. It established the CTC and transferred to it the functions previously assigned to the former Board of Transport Commissioners.

dangerous commodities safety-related activities. The RTC inspection programs include: track, car and locomotive operations, dangerous commodities, fire prevention, mechanical equipment, structures, signals, and grade crossings.

To further improve safety associated with dangerous commodities transportation, regulatory agencies may require a comprehensive system of safety measures which include (i) the development of data base programs, (ii) the development of risk analysis and evaluation program, and (iii) the implementation of safety programs.The interface of such a comprehensive system is illustrated in Figure 2.

(1) The Data Base

Accident occurrence by location, material, mode, type of container, severity level and associated costs of property damage are the kinds of basic information needed for risk analysis. These data enable the estimation of the incident type and severity loss likelihoods and costs required for the risk analysis model. Supplementary data such as causes of certain types of accidents over time is also needed to develop predictive models on accident causes and effects. Data requirements for such a causality model are freight-train activities (e.g., train hours of operation, miles of track, freight car-miles, various measures of operating expenses, dangerous commodity traffic etc.).

The foundation for evaluation of safety prospects

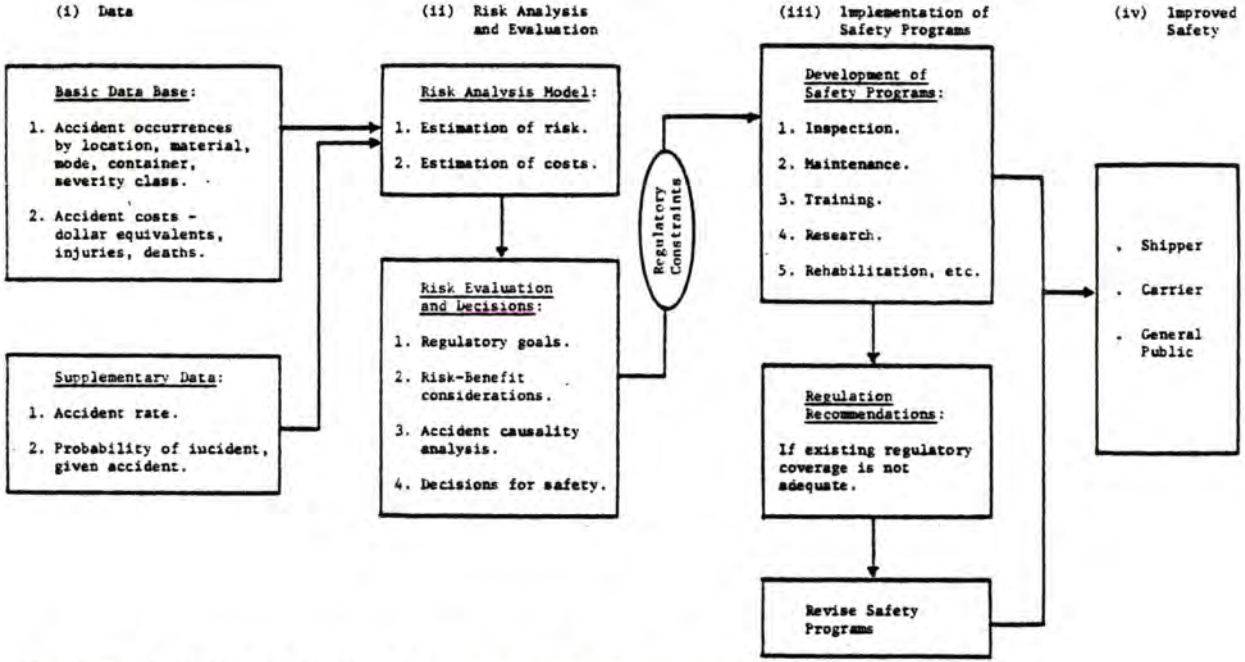


FIGURE 2: INTERFACE OF ACCIDENT DATA, RISK ANALYSIS, AND SAFETY REGULATIONS

rests on the answers to the questions, "What causes accidents?" and "What can be done to reduce their incidence and severity?" The answers to these questions -- cause, effect, and remedial or preventive action -- must be expressed, ideally, in physical terms so that risks and benefits can be identified and quantified. It is not sufficient to know the percentage of deaths and property damage caused by 'derailments', it is necessary to know why derailments occur, what the probability of derailment is, and how a specific action will change the distribution of derailments and the distribution of the consequences of derailments (Schwier, Lake and King).

(2) Risk Analysis and Evaluation

Risk analysis offers one of the planning tools necessary to cope with the anticipated problems related to public safety. Risk analysis, therefore, provides a prediction model from which regulators might benefit by obtaining the following information: (i) description of a sequence of events leading to an accident; (ii) description of the interrelationships of the human (operator, passenger, etc.) -- machine (vehicles, equipment, etc.) -- environment (weather, road conditions, etc.) and managerial infrastructure (procedures including rules and regulations); (iii) determination of the points at which traffic flows could be terminated or redirected to moderate the consequences by considering population density surrounding terminal areas as these areas account for high probabilities for all three risk measures: injuries, fatalities, and

property damage; and iv) a means for the comparison of risks between modes of transportation and/or between routes (i.e., providing a framework for quantitative assessment of vulnerability) and also counter-measures by comparing sensitivity test results for certain safety improvement measures (e.g., impact of increased rail car inspection (both vehicle and material related) on the lowering of risks).

To evaluate safety measures, identification of goals is an important first step in the development of a risk-reducing strategies. Salem et al. (1980) suggested the use of one of the following: minimization of maximum accident consequence; probability of most probable accident; both accident and normal operational risk; only accident risk; socially perceived risk; peak risk; as low as reasonably achievable risk; equitable share of risks and benefits; or equalization of personal risks (both general and occupational population).

Whichever goals are chosen, a risk-benefit analysis is required to evaluate safety measures. The following are two of the major areas of methodological problems associated with risk-benefit analyses.

The first problem is the determination of benefits from reducing the risks of certain situations. The major benefit from reducing risks is usually the saving of lives. To determine the extent of the benefit obtained from reducing the risk, in terms of lives saved, an explicit value for life, in dollar terms, is required (Bailey). The second major area of debate is the degree

of certainty about the level of risk. Both decision makers and the public do not appear to be willing to accept the probability of risk. They prefer to know exactly the odds, and not play any games.

To determine the public's acceptance levels of risk, two methods are usually employed; revealed preferences and expressed preferences. The revealed preference method advocated by Starr (1969) assumes that, by trial and error, society has arrived at a nearly optimal balance between the risks and benefits associated with any activity. The expressed preference method is a more straight forward means of determining what people find acceptable. The method involves the expression of individual preferences.

Theoretically speaking, safety programs should be undertaken if the benefits in terms of increased safety exceed the cost of implementation. In addition, at the evaluation stage, multi-modal consideration should be given. The implementation of rigorous safety measures must be appreciated with reference to the competitive position of the mode. Undesireable modal shifts may result in certain commodities being carried by 'less safe' modes of transport.

(3) Implementation of Safety Measures

In pursuing the ultimate objective of reducing risks, regulators are required to upgrade safety programs within the boundaries of the existing regulatory framework. A rigorous enforcement of rules or regulations is required, in the context of multimodal

transport or even beyond the transportation industries to include manufacturers of transportation equipment, manufacturers of dangerous commodities and packages, and shippers handling procedures.

Since risk is not invariant of time, the interface of data base, risk analysis and evaluation, and implementation of the safety program (as shown in Figure 2) should be reviewed periodically to make the system up-to-date. Revision of regulations may be recommended if existing ones are not adequate.

Safety improvement measures may be effected through the development of a diverse and comprehensive safety program incorporating such facets as inspection, maintenance, manpower training, research and development, and rehabilitation. The implementation of such measures should ultimately be reflected in the improved safety for the parties concerned, namely the shippers, the carriers, and the public in general.

REFERENCES

Ang, A. H-S. J. Briscoe, et al. (1979), Development of a Systems Risk Methodology for Single and Multi-Modal Transportation Systems, Report No. DOT/RSPA/DPB-50/79/16, Final Report Under Contract: DOT-OS-50238, U.S. Department of Transportation, Washington, D.C. 20590.

Atzinger, E.M., Brooks, W.J., Chernick, M.R., Elsner, B., and Foster, W.V. (1972), Compendium on Risk Analysis Techniques, U.S. Army Material System Analysis Agency, Aberdeen Proving Ground, Maryland, Special Publication No. 4.

Bailey, Martin J. (1980), Reducing Risks to Life, Measurement of the Benefits, American Enterprise Institute for Public Policy Research, Washington, D.C.

Borch, Karl (1974), The Mathematical Theory of Insurance, Lexington Books, D.C. Heath and Company, London.

Canadian Transport Commission, Summary of Accidents, Incidents Reported to the Canadian Transport Commission, Year 1981, Rail Transport Committee.

Coombs, C.H., and Huang, L.C., (1970), "Polynominal Psychophysics of Risk", Journal of Mathematic Psychology, 7, pp. 317-338.

Coombs, C.H., and Huang, L.C., (1970), "Test of a Portfolio Theory of Risk Preference", Journal of Experimental Psychology, 85, pp. 23-39.

Garrick, B.J., Gekler, W.C., Baldonado, O.C., Elder, H.K. and Shapley, J.E. (1969), A Risk Model for the Transport of Hazardous Materials, Final Report July 1968 - June 1969, prepared for Department of the Army, Fort Detrick, Frederick, Maryland.

Hirshleifer, J. (1970), Investment, Interest and Capital, Prentice-Hall Inc., Englewood Cliffs.

Horodniceanu, M. and Cantilli, E.J., (1979), Transportation System Safety, Lexington Books, D.C. Heath and Company, Lexington, Massachusetts.

Kloeber, G., Cornell, M., McNamara, T., and Moscati, A. (1979), Risk Assessment of Air Versus Other Transportation Modes for Explosives and Flammable Cryogenic Liquids, Vol. I and Vol. II: Risk Assessment Method and Results, Report No. DOT/RSPA/MTB-79/13 and 14, prepared for U.S. Department of Transportation, Washington, D.C. 20590.

Philipson, L.L., Pounders, C.J., and Helmer, O. (1974), Investigation of the Feasibility of the Delphi Technique for Estimating Risk Analysis Parameters, Report No. TES-20-74-5, prepared for Department of Transportation, Office of Hazardous Materials, Washington, D.C. 20590.

Pollatsek, A., and Tversky, A. (1970), "A Theory of Risk", Journal of Mathematical Psychology, 7, pp. 572-596.

Salem, S.L., Solomon, K.A. and Yesley, M.S. (1980), "Problems and Procedures in the Regulation of Technological Risk" in Schwing, R.C. and W.A. Albers (eds.), Societal Risk Assessment, New York, Plenum Press.

Schaefer, Ralf E. (1978), What Are We Talking About "Risk"? A Critical Survey of Risk and Risk Preference Theories, Joint IAEA/IIASA Risk Assessment Project, International Atomic Energy Agency, P.O. Box 590, A-1011 Vienna, Austria.

Schwier, C., Lake, R.W., and King, A.W. (1981), Evaluation of Railway Safety Projects, Report No. 80-19, Canadian Institute of Guided Ground Transport, Queen's University at Kingston, Ontario.

Starr, C. (1969), "Social Benefit versus Technological Risk", Science, 165, pp. 1232-1238.

Transport Canada (1982a), The Transport of Dangerous Goods by Rail in Canada, Transport of Dangerous Goods Branch, Ottawa.

Transport Canada (1982b), The Intercity For-Hire Trucking of Dangerous Goods in Canada, Transport of Dangerous Goods Branch, Ottawa.

ADVANCED TECHNOLOGY

IN

TRAIN CONTROL

Prepared For The

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Advanced Technology In Train Control

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ABSTRACT

Railway signalling systems have evolved significantly in the last century. Recent demands of efficiency, performance and capability have resulted in dramatic changes, while retaining the fundamentals of safety which must be inherent in a train protection/control system.

This paper addresses the differences between railway signalling systems and train control systems and how computer technology can be safely utilized to implement both of these functions.

The use of computers configured in a checked-redundant manner has been developed over the last fifteen years in revenue rail traffic operations.

The system is inherently flexible and the concept allows for significant growth and can be realized in a cost effective manner. The required degree of complexity can be implemented with an upwardly compatible expansion at any time. In this manner, presently unsignalled territories can be given partial train control until traffic demands lead to an incremental upgrading. This enhancement continues and leads to a full Train Control System encompassing Automatic Train Protection, Automatic Train Supervision and if required, Automatic Train Operation.

INTRODUCTION

An integrated system of train control, which takes full advantage of modern computing technology to safely and economically provide all of the control functions required in railroad applications.

To meet the requirements of an improved railway traffic flow in unsignalled territories an upgradable system has been developed by SEL Canada. This system, at its simplest, and least expensive concept, provides train position information and can be enhanced to the point where continuous cab signalling/train control is achieved by additions of hardware and software.

The provision for Train Operations Management is also an integral part of its capabililty, maximizing the performance of the Track/Dispatcher/Train System through advanced automatic detection and resolution of traffic conflicts. Provided with this aid, dispatchers can more consistently control traffic with minimum delays. These features ensure that the needs of the railroad are being met now and in the future. Progressive development of this railway signalling concept over the last fifteen years has led to its use by urban transit and main line railways, resulting in higher speed operations and capacity increases.

HISTORY

In the early days of railway operation it was found that as traffic density increased some basic wayside signalling was required. This began as a manual operation with the wayside staff establishing when it was safe for a train to proceed. Although this was an improvement, accidents happened and further development was necessary, to support ever increasing traffic complexities.

Development of the track circuit allowed automatic detection of train presence. This was integrated with basic electromechanical devices to provide the first "interlocking" of the manual control system for train protection. Increased traffic demands and related problems, in the then existing signal systems, encouraged continued development.

Signalling with track circuits, relay interlocking and power operated switch machines has now been operational for many years. In combination with remote control communication systems these electrical interlockings are frequently operated by a centrally located dispatcher, rather than wayside operators. Such a signalling system is known as Centralized Traffic Control (CTC).

Accidents caused by train drivers not obeying the signals (i.e. running past a red signal) forced the addition of automatic train stop devices. These devices are a method of enforcing that the train stops, by allowing the signal system to activate the train emergency brakes when it moves past a red signal. These devices are used primarily in transit applications in North America.

Increasing traffic densities and operating speeds demanded more performance from the wayside plant (track work). This required restructuring the signal system and/or adding tracks. In the mid-60's the European railroads decided to minimize the wayside plant changes and set out to develop a Train Control System which would provide safe operation at high speeds (200 kph) and closer headways. This system was to be overlaid on the existing signalling and enforce safe operation by direct communication with a control unit mounted on the locomotive.

ITT successfully implemented such a system on the German Federal Railway in 1972. The success of this is demonstrated by continued implementation on the railways (approximately 500 km are now equipped), with further extension plans through the 1990's.

An adaptation of the system known as SELTRAC has been implemented for the Intermediate Capacity Transit

System (ICTS) developed by the Urban Transportation Development Corporation of Ontario. The SELTRAC system has been in operation on the ICTS test system since 1980. It will also be used in the Vancouver ALRT system, the Scarborough ICTS system in Toronto and the Detroit downtown people mover system.

SELTRAC is presently in operation on one line of the Berlin Transit system, providing revenue service with decreased headways since 1981.

All of the implementations of these new systems exploit computers for safe (VITAL) functions. Communication with the on-board locomotive computer system is implemented such that safe operation is ensured. Accident free operation (related to the new signal system) over the last decade demonstrates the safety of this concept.

CONCEPTS

Signal systems are wayside located and provide detection of trains with information in the form of an aspect (Red, Green, Yellow) given to the train driver as he approaches the next block or signal. Train information available to the dispatcher (only in the case of CTC) is limited to the time of entry into a block. Degraded train operation does not come to the attention of the dispatcher until verbal communication takes place. This lag in information makes it difficult for the dispatcher to make decisions relating

to total traffic movement.

Two functional changes are required in order to minimize the wayside equipment and provide timely control information to the dispatcher. There are:

* Vital On Board Locomotive Control
* Vital Data Communication Between Locomotive And Central Control.

Implementation of these functions is accomplished by taking advantage of the very great potential of computer technology. A checked-redundant minicomputer system at Central and checked-redundant microcomputer system on the locomotive provide this required capability. Furthermore, a checked-redundant microcomputer system is implemented at the trackside switches to provide for remote control and position verification of switches.

A schematic representation of this system is shown in Figure 1.

The dispatcher now has information available relating to the train performance at all times, as the communication with the on-board computers continuously updates his displays. Furthermore, as the information exchange is implemented in a vital manner, the system supervises train speed and position at all times, thus preventing hazardous movements.

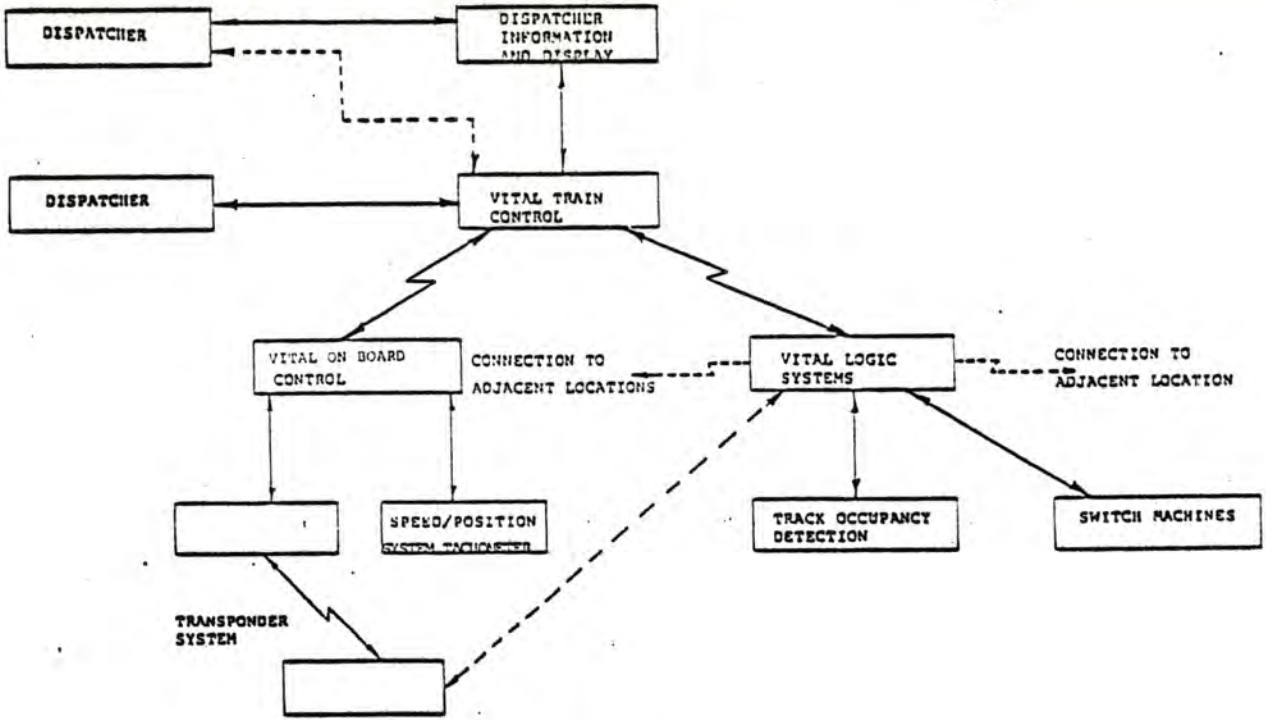


Figure 1 Train Control System Schematic

Additional functions available to the railroad with the ITT developed system are:

* Enforced supervision (VITAL) of Train Stopping Point
* Enforced supervision of Train Speed (VITAL)
* Central dispatcher control of temporary speed restrictions which are then enforced (VITAL) by the on-board locomotive system
* Continuous information of train position, speed, etc.
* Ability to slow down trains to avoid the fuel consumption of stop and go operation
* Closer headway operation, as the exact position of trains is known (VITAL).

These functions are available with reduced wayside equipment as supervision of operation is by the locomotive carried equipment.

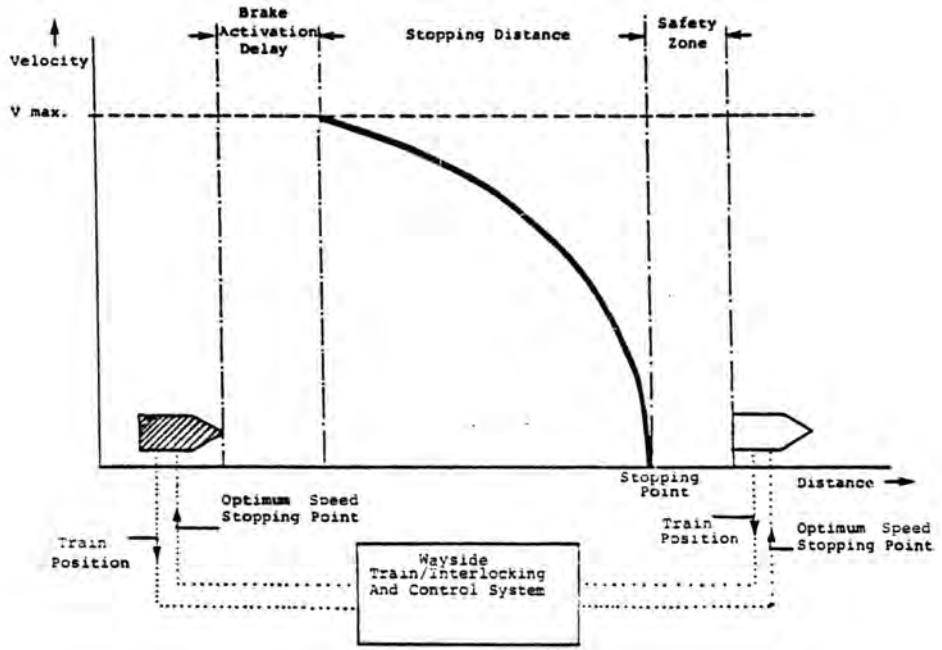
THE MOVING BLOCK

In conventional signal systems trains occupy a "Block" of fixed length. Following moves cannot enter this physical area until the previous train has progressed to the next block. Many cases exist were additional signals and "Blocks" are required to increase track capacity with closer headway (train separation) operation.

The described ITT Train Control system operates on the basis of the required stopping distance of the train at the speed its travelling. Because of the high resolution of the position detection system, a following train may safely close-up to a point which is a safe braking distance from the last verified position of the rear end of a preceding train. For many applications, a significant reduction in headway relative to fixed block systems is possible. Reduced headway translates directly into increased system capacity.

Because this feature is inherent to the system, no wayside signalling changes are necessary when closer headway, follow on moves, are required.

Figure 2 shows the basic principles of a moving block system. If overlaid on an existing signal system, the signal aspects are reflected in the supervised speed and allowed position profile.



MOVING BLOCK - SAFETY SEPARATION CONTROL STRATEGY FOR TRAINS

FIGURE 2

FUNCTIONAL STRUCTURE (See Figure 3)

The ITT Train Control System is developed around four basic control levels:

* The Central Dispatcher Information And Display System (DIAD)
* The Train/Interlocking Control System (TICS)
* The VITAL On-Board Control System (VOBC)
* The Vital Wayside Control Logic (SELSIG Unit).

In addition for situations requiring more support for the dispatcher, the DIAD is replaced with the more powerful Train Operation Management System (TOMS).

DISPATCHER INFORMATION AND DISPLAY

This subsystem communicates with the Train/Interlocking Control system and provides a display of train position, speed, performance, etc., to the dispatcher. The dispatcher can also communicate with the train (engineman) via a CRT input to the system. Control activities such as route setting are implemented at this level.

All normal functions of central dispatcher control are implemented at this level to provide supervisory support and commands to the vital Train/Interlocking Control System.

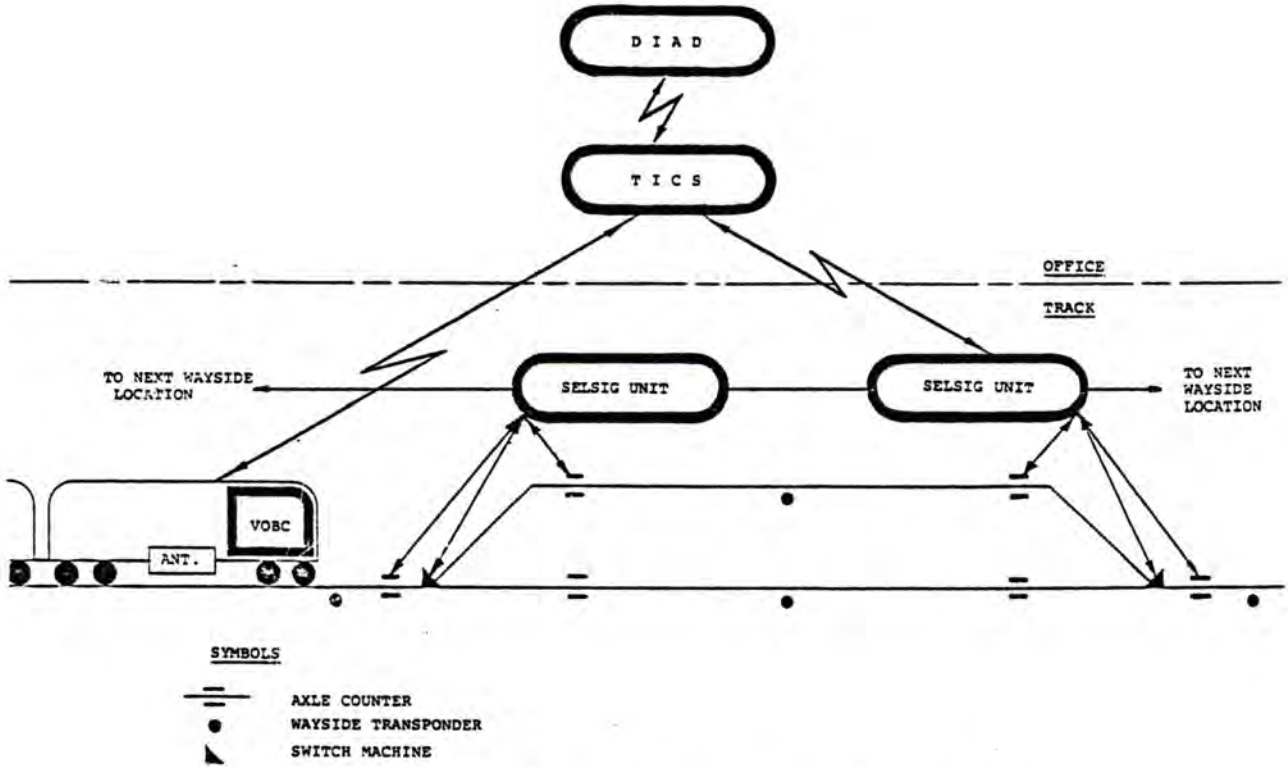


Figure 3 FUNCTIONAL STRUCTURE M007-A

TRAIN INTERLOCKING CONTROL SYSTEM (TICS)

This centrally located checked-redundant (2 out of 3 voting arrangement) computer system provides the VITAL functions of switch control, train separation, enforcement of permanent or temporary speed restrictions, etc. The dispatcher can implement, by direct input to this subsystem, functions such as temporary speed restrictions, enforced track blocks (i.e. no trains may enter), or even command a particular train to emergency brake if an unsafe situation is identified.

Continuous communication with the locomotive on-board equipment provides detailed information on train location, speed and locomotive health status. Topographical data stored in the computers (such as grades, speed limits, switch positions, etc.) in combination with the received information is then processed to implement the moving block train operation.

VITAL ON-BOARD CONTROL (VOBC)

The subsystem is implemented in a dual microcomputer, checked-redundant configuration. It is responsible to ensure safe operation of the train within the limits of travel direction, speed and stopping points imposed by the Train/Interlocking Control system. These limits are provided via a

vital, duplex communication link with central control (TICS). In the event of data communication loss, the train is allowed to proceed to the last safe stopping point received.

The VOBC also ensures that the driver applies his brakes when entering restricted speed areas or is to come to a stop. If adequate braking is not applied, a warning alarm is sounded. Should the driver not respond to the alarm, the on-board control system will automatically apply the emergency brakes.

VITAL WAYSIDE CONTROL LOGIC (SELSIG Unit)

To provide for the vital control required in this unit, a dual microprocessor checked-redundant configuration is implemented. Equipment type and configuration is similar to the Vital On-Board Control Unit.

This subsystem provides for a vital communication link between the TICS and wayside equipment, such as switch control and status, block occupancy detection and other information exchange. Through the use of full redundancy (for safety i.e., both systems must agree) in equipment and data format, the SELSIG unit provides a vital control link between Central and wayside equipment. Additionally, communication with adjacent wayside SELSIG units allows for system flexibility, particularly, as related to fallback operation.

ADDITIONAL FEATURES

Wayside Block Occupancy Detection

As shown in Figure 3, Wayside Block Occupancy detection can be provided by an Axle Counter system. The benefits of this are that rail bonding and insulated joints are not required. Furthermore, ANY length of block can be achieved (track circuits are limited to about 1 or 2 miles) simply by locating the detection heads at the appropriate positions.

By counting the number of axles into and out of a track section and declaring it 'Clear' only at a count of zero, it is possible to ensure that no cars remain on the track. Redundancy and special information handling techniques ensure that the function is executed in a vital manner.

It should be noted however that the flexibility of the described train control system, allows the use of track circuits to provide track occupancy detection, if desired by the railroad.

The wayside block occupancy detection system allows for operation of trains not equipped with a Vital On-Board Control unit.

Communication Links

Communication between the various distributed

components of the ITT system can be handled in various ways, ranging from telephone type links in a transit environment to radio or microwave links in remote areas. The system components are designed to be adaptable to any new communications technology as it becomes available and economical.

TRANSPONDERS

Passive (i.e. no battery of local power required) transponders are mounted at the track and provide exact wayside and position datum for the VOBC. The information transmitted includes:

- exact position on the track
- civil speed limit at this point
- distance to the next transponder.

In the event of a data communication interruption with Central Control (TICS) the train continues operation on the basis of such information.

SAFETY PHILOSOPHY AND TECHNIQUES

Throughout the design and development of the system hardware and software, fail safe principles have been rigorously followed. Any failure at any level causes the system to revert to a safe condition.

The cyclic advancement of the commanded stopping point for a train requires validation that the preceding train has advanced or other restrictions

have cleared. System design is such that any failure within the TICS/Data Communications, to the VOBC or Remote Interlocking control units will result in the stopping points for affected trains not being advanced.

A number of techniques are used to verify the integrity of the data communications:

- redundancy bits accompany data transmitted to ensure rejection of data corrupted through interference
- transmitted data is updated cyclically. Commands transmitted to the VOBC's are updated or confirmed in each new telegram with a maximum cycle time of less than one second between the wayside and each train
- plausibility and persistency checks are performed on received data. The Train/Interlocking Control System tests data received from the VOBC against what is expected according to previous telegrams. The VOBC requires that critical information (e.g. travel direction change) be received persistently and be consistent with previous commands to be deemed acceptable.

TRAIN OPERATION

The train control system shown in Figure 3 differs from a conventional system in that wayside equipment

has been reduced to the minimum required for operation of switches and block protection.

Operational capabilities are:

* Cab Signalling Operation for equipped trains and train order operation for non-equipped trains.
* Vital reporting of train position and speed.
* Vital block occupancy detection and information for all trains in the territory.
* Vital speed and position supervision for equipped trains.
* All expected activities automatically and continuously compared against train performance, for example train position vs. train order.
* Vital train separation protection.
* Vital switch control and switch position supervision.

The dispatcher is usually provided with a colour graphics monitor. On this monitor is a full-colour pictorial representation of the track in the territory and the position on the track of each train in the territory. This provides the dispatcher with real-time information on the activities of each train. The display also indicates each controlled switch position in the territory and alerts the dispatcher to locked (or unlocked) switch status.

The dispatcher is also provided with a black and

white CRT as a tool to prepare train orders and command train routing information. On request, a representation of a train order and routing form appears on the screen.

The equipped trains entering the territory automatically identify themselves to the system. The system in turn notifies the dispatcher of the new train arrival by flashing a message on the display. The dispatcher now handles this train by clearing a route for it.

Motion of equipped trains in the territory is controlled by TICS which, according to the train route priority and track occupancy, assigns a target point, a switch position and a velocity profile to the train. The distance to the target point and the commanded velocity profile is displayed in the cab to the engineman.

For non-equipped trains entering the territory, the dispatcher must revert to train order operations, but the task of monitoring the position of these trains is greatly simplified. The engineman notifies the dispatcher via voice communication that the train has entered the territory. This is also confirmed by the indicated block occupancy in TICS.

Train orders are entered into the system by the keyboard. The system maintains a temporary filing system for all train/routes prepared by the dispatcher,

which can be printed on hard copy if required.

The dispatcher then assigns a train number to the train entering the territory. From this point on the dispatcher tracks non-equipped train movements in the territory by monitoring block occupancy information and switch position information.

In case the TICS determines that a violation exists between two train, the equipped trains involved in the conflict are emergency braked and an alarm sounds to alert the dispatcher to the incident. The dispatcher then intervenes to facilitate stopping of non-equipped trains.

The system also monitors all information provided to it in the way of train orders, train position, etc. It alerts the dispatcher if it detects any discrepancies. For example, if a train's position does not agree with the train orders, the dispatcher is alerted.

If an unequipped train inadvertently enters a track section already "occupied" by an equipped train, the system alerts the dispatcher and automatically stops the equipped train. System safety is thereby enforced.

BENEFITS

The benefits of a train control system as

described in this paper are a result of its modularity, flexibility, ease of adaption to requirements and reduction in wayside installed equipment and its requirement for wayside maintenance.

The ITT Train Control System enhances present signal system concepts by incorporating an additional vital control link from the train (engine) to the Train/Interlocking Control system. Since the traffic system performance is influenced by three elements (TRAIN, TRACK, DISPATCHER) this additional link allows supervision and system performance optimization not possible before. This comes about as a result of providing continuous monitoring and optimization of control at all three levels of the traffic system. Various levels of automation/dispatcher aids can be provided on an 'as required' basis, up to and including a Train Operation Management System, which provides conflict detection and resolution by automated forecasting and advance planning. Furthermore, the ability to stop a train by direct command enhances safe train operation.

Increased territory capacity is possible due to the ability to provide following moves with reduced headways between equipped trains.

The need to slow or stop trains is decreased reducing wear and fuel consumption. Trains will continue to operate at the same average speed, but

this is accomplished by more continuous motion and less operation at higher speeds with subsequent stops.

Train speeds and safe stopping points are enforced by the train control system to enhance operational safety. Supervision of these critical parameters is implemented by the locomotive-borne equipment which continuously monitors present performance against allowable safe values determined by the vital Train/Interlocking and Control system.

System flexibility allows implementation of subsets of the full capability. In this way, a railroad could implement a much simplified system (NON-VITAL) for dispatcher information only in the beginning. This economical implementation would not require the checked-redundant computer systems since it is only an information system. As traffic requirements increase the additional subsystem elements are (previously implemented equipment is simply upgraded) implemented. The full capability of the ITT Train Control system is now available.

SUMMARY

The needs of railroads in the future will be met only if effective train control can be utilized to meet the demands of increased efficiency and performance. Changes in traffic patterns will call

for cost effective means to modify the operation/ control of traffic flow in a responsive, timely manner. These increases in traffic flow and throughput will continue to put additional stress on the system to provide for safety and accident-free operation. In many cases it will be more expedient to improve the train control system to allow for higher traffic densities then to increase the size of the physical rail plant.

The described Train Control System has been designed to allow modular installation and growth up to its full capability. At all times safety is provided for and in a fully implemented system equipped trains are automatically brought to a stop if a safety parameter is violated.

A COMPUTER THERMODYNAMIC MODEL OF A RAIL TANK-CAR ENGULFED IN FIRE

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ABSTRACT

A computer model of a propane filled rail tank-car exposed to an engulfing fire has been developed. The model is a 2-dimensional representation, and therefore temperature gradients along the axis of the tank are not accounted for.

The model can predict tank pressure, wall temperatures, wall stresses, vapour and liquid mean temperatures, flow rates through pressure relief devices, and liquid level, as functions of time. The model can also represent the effects of a variety of thermal protection devices, such as thermal insulation (with thermally induced degradation), thermal insulation with steel jacket, intumescent coatings, thermal radiation shielding, temperature activated pressure relief devices and 'Explosafe'[1], a material placed inside the tank. The model was validated using the available results from full-

1 'Explosafe' is a registered trade mark of Vulcan Industrial Packaging.

and fifth-scale fire tests conducted on tanks filled with propane.

Model predictions are presented for the cases where the tanks are protected with thermal insulation, fusible plugs, thermal radiation shielding, and 'Explosafe'.

INTRODUCTION

This study involved the formulation of a mathematical model of a cylindrical tank, filled partially with vapour and partially with liquid, with its exterior surface exposed to an engulfing fire. The model was intended to represent a rail tank-car like those used for transporting pressurized commodities such as liquified petroleum gas (LPG). The model can also be applied to other cylindrical tanks such as those used in highway transport vehicles and storage facilities.

The computer model developed in the present study is a 2-dimensional representation of a tank-car. It is capable of simulating the transient thermodynamic response of a tank/lading system to an intense heat input, such as from an engulfing fire. The model predicts wall temperatures, tank internal pressure, mean liquid and vapour temperatures, mass flow rates through pressure relief devices, liquid level, and wall stresses.

This study was motivated by the fact that more and more dangerous commodities are being transported by rail and road every day. Major accidents involving both rail and highway vehicles, while not frequent, do occur regularly in

North America, resulting in property losses in the hundreds of thousands of dollars, and sometimes loss of life. The overall aim of the present study was to aid in the development of a technique of protecting all types of pressurized transport and storage tanks from the effects of accidental fire impingement.

Thermal protection devices such as external thermal barriers, improved pressure relief devices, and concepts such as 'Explosafe' are being considered by various groups. Each of these devices can be incorporated into the tank design in a variety of ways, and therefore the object of this study was to develop a computer based model which could be used to assess the performance of these various systems.

PREVIOUS STUDIES

In the early 1970's a major study was initiated by the U.S. Federal Railroad Administration/Department of Transportation (FRA/DOT), the American Association of Railroads (AAR), the Railway Progress Institute (RPI), major railroads, tank-car builders, and various shipping organizations. The project scope was to cover all types of tank cars and hazardous materials, but with emphasis being placed on pressure cars carrying materials which are commonly involved in severe accidents such as LPG, ammonia, and vinyl chloride. Results obtained in studies sponsored by this tank-car safety research program form the major portion of the data base used in the present

study. The model predictions for an unprotected tank were verified using the results of the full- (1) and fifth- (2) scale fire tests. A brief overview of these tests, and others, can be found in Reference (3).

As well as the studies conducted in the U.S., there have been several Canadian studies, sponsored by the Transport Canada Research and Development Centre (TC R&DC), into the thermal effects on tank-cars . Most notable are the fifth-scale fire tests (4) on the performance of the internal protection device known as 'Explosafe'.

All the fire tests that were conducted involved full- or fifth-scale tanks filled with water or propane. In the tests, the tanks were exposed to engulfing fires fueled by JP4. The engulfing flame was used because it represents what many consider to be the worst case possible in an accident situation.

The tanks were instrumented to measure the internal fluid temperature distributions, the tank wall temperatures and the tank internal pressure. Due to the extreme conditions of the fire, many of the instruments failed during the tests.

In addition to the experimental investigations that were conducted, a previous attempt had been made to develop a computer model (5) which could predict the response of the tank/lading system when exposed to an engulfing flame. However, this model proved to be of limited value as a design tool because of its simplistic approach to modelling the various

thermodynamic processes.

MODEL STRUCTURE

As mentioned previously, the overall model predicts wall temperatures, tank pressure, mean liquid and vapour temperatures, mass flow rates through relief valves, liquid level and wall stresses. The model is also capable of representing the effects of a variety of thermal protection devices. To accomplish this, sub-models were developed to represent the various processes taking place in and around the tank. These processes include,

i) Flame-to-Tank Heat Transfer, including,
   - thermal radiation,
   - convection.

ii) Tank Wall Temperature Distribution in the,
   - steel wall,
   - thermal insulation,
   - 'Explosafe',
   - radiation shielding.

iii) Relief Device Characteristics including,
   - pressure-activated relief-valves,
   - fusible plugs,
   - temperature-activated relief-valves.

iv) Interior Surface Heat Transfer,
   - in the vapour space,
   - in the liquid space.

v) Thermodynamic Properties of Propane.

vi) Thermodynamic Process, including,

- temperature stratification in the lading.

vii) Wall Stresses and Material Properties, including,

- pressure- and temperature-induced stresses,
- temperature-induced degradation of the wall material properties.

Each of the sub-models is based on the fundamental principles of heat transfer, fluid mechanics, thermodynamics and stress analysis. A brief overview of how these sub-models are based can be found in Reference (6). A detailed description of the model, including equations and numerical solution procedures can be found in Reference (7).

As mentioned earlier, the model has been validated for the case of unprotected tanks using some of the results from the full- and fifth-scale fire tests. The results of these validation runs can be found in References (6) and (7).

RESULTS and DISCUSSION

Model predictions are presented for the following cases: 1) full-scale tank protected with fusible plugs, 2) full-scale tank protected with thermal insulation, 3)

full-scale tank protected with thermal radiation shielding. 4) full-scale tank protected with one configuration of the thermal protection device 'Explosafe'. In all cases the tank lading is pure propane, and the tank is assumed to be in an upright condition. In addition to the thermal protection devices mentioned above, each tank is assumed to have a standard sized relief valve. Fire and tank conditions were assumed to be similar to the fire test conditions reported in Reference (1).

The model predictions are summarized into four diagrams for each of the four different cases. These diagrams show the predicted tank pressure, tank wall temperatures, liquid level and wall stresses as functions of time. For comparison purposes, the model predictions for a full-scale unprotected tank have been included on each of the diagrams. A discussion of the unprotected tank simulations can be found in Reference (7). As mentioned earlier, these predictions for the unprotected tank have been validated by comparing them with measurements from the full-scale fire test.

The diagram showing tank stresses requires some explanation. The stresses are calculated by adding the pressure-induced hoop stress to the appropriate component of the thermally-induced stress. With this calculation method the inner and outer fibres of the tank wall experience different levels of stress. The diagrams showing wall stresses include the stress predictions for both the inner and outer fibres of the tank, and therefore

give an indication of the range of stress existing in the wall. When the material tensile strength crosses over the predicted stress then probable failure is indicated.

It should be pointed out at this time that the tank initial-fill conditions for these simulations were not all the same. For cases 1 and 4, the tanks were assumed to be filled to 95% of capacity, which is the same as for the unprotected tank run. In cases 2 and 3, the lading initial temperatures were slightly lower (these runs were originally made to compare with the full-scale insulated tank fire-test data (1), and therefore, they had a lower initial lading temperature than for the full-scale unprotected tank), and therefore it was assumed that the tanks were filled to 85% capacity.

Case 1: full-scale tank with fusible plugs.

Figures 1,2,3 and 4 present tank pressure, wall temperatures, liquid level, and wall stresses for the case of a full-scale tank equipped with fusible plugs. In this case it has been assumed that the fusible plugs have a total orifice area twice that of the relief valve. It was also assumed that the valves melt out when the outer wall temperature at the top-dead-centre of the tank reached 430° C.

Figure 1 clearly shows the effect of the fusible plugs as they come into play. Because the fusible-plug orifices remain fully open, the tank pressure drops rapidly. Of course as the tank pressure drops below the relief valve

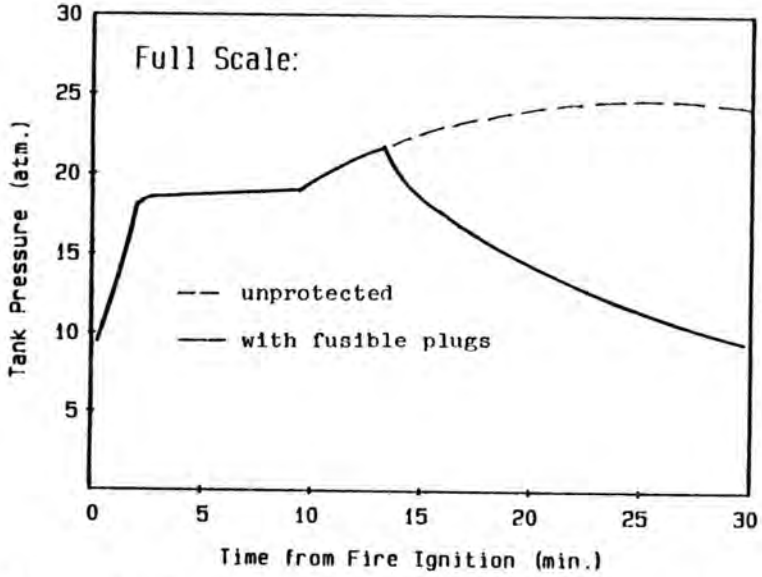


Figure 1 Predicted tank pressures for a fusible plug equipped full-scale tank and an unprotected full-scale tank.

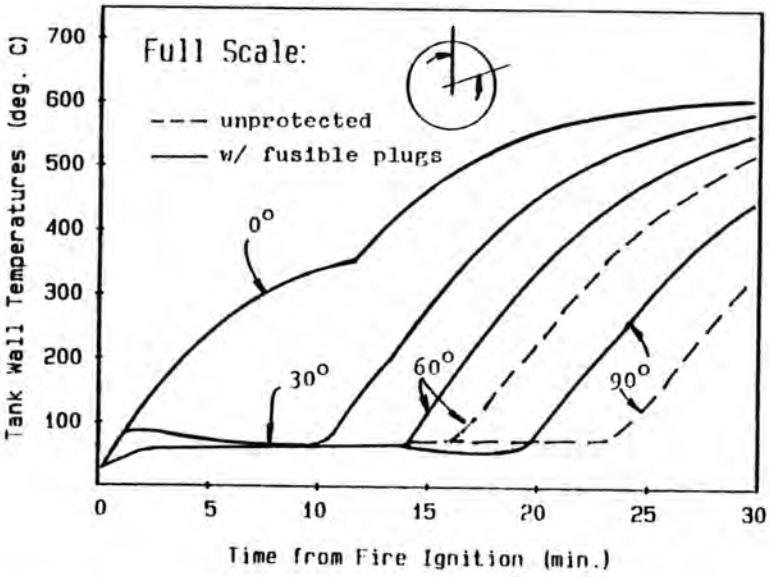


Figure 2 Predicted inner wall temperatures for a fusible plug equipped full-scale tank and an unprotected full-scale tank.

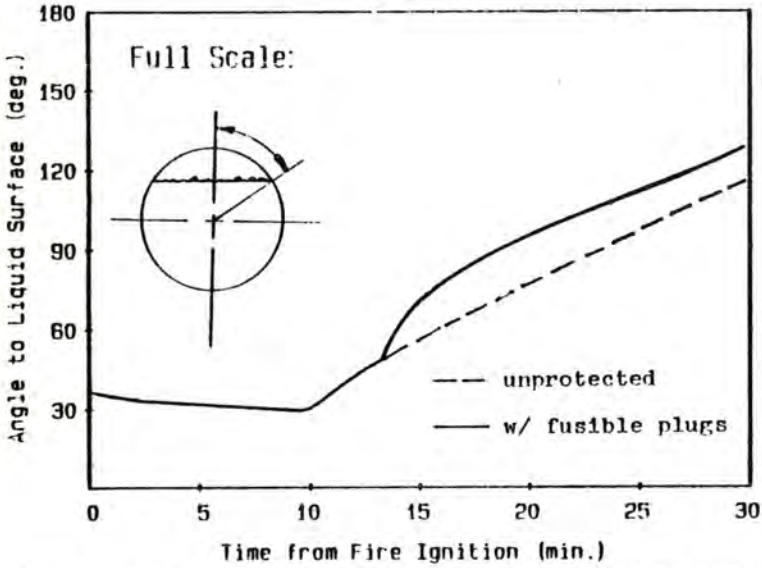


Figure 3 Predicted liquid levels for a fusible plug equipped full-scale tank and an unprotected full-scale tank.

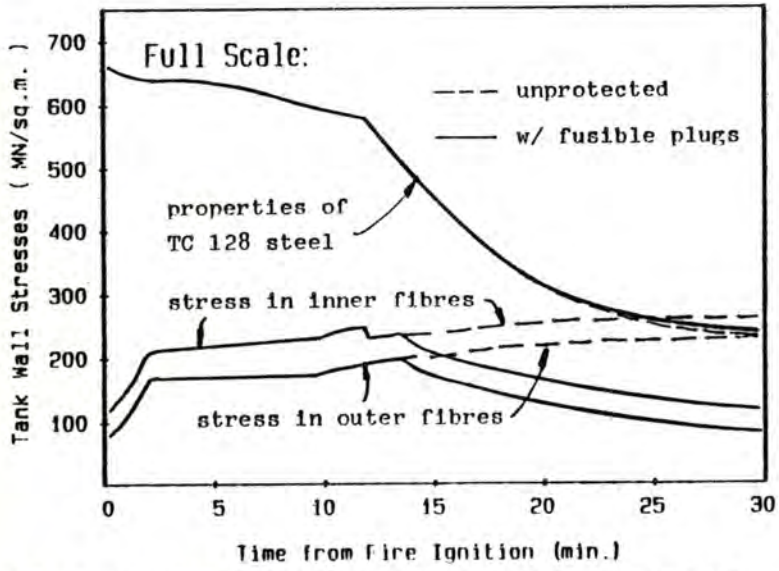


Figure 4 Predicted tank wall stresses and material tensile strength for a fusible plug equipped full-scale tank and an unprotected full-scale tank

closing pressure, the relief valve closes.

As seen from Figure 2, the fusible plugs had little effect on the wall temperatures. The only effect on the temperatures is a result of the liquid level dropping more rapidly, and therefore, the temperature break points occur earlier.

Figure 3 shows the predicted liquid level. As can be seen from the Figure, the liquid level drops very rapidly when the plugs first melt out. After the tank pressure has dropped, the venting rate is reduced. The net effect is that the tank empties earlier than it would have if only a relief valve were present.

Figure 4 presents the predicted wall stresses and material tensile strengths. The model predicts that the tank will not fail as a result of the significant reduction in the tank pressure. However, the model predicts that high wall temperatures will still be established, and therfore, the tank wall material will undergo some metallurgical changes.

This simulation indicates that the use of devices such as fusible plugs can reduce the chances of tank rupture in an engulfing fire situation. These devices can be installed at strategic points on the tank, so that preferential venting of vapour can always be assured no matter what orientation a tank takes after an accident. This is a considerable benefit because venting of vapour is the most effective means of pressure relief.

Case 2: full-scale tank with thermal insulation.

Figures 5,6,7 and 8 present tank pressure, wall temperatures, liquid level, and wall stresses for the case of a full-scale tank with a 6.4 mm thick layer of asbestos insulation.

Figure 5 clearly shows that the model predicts a significant reduction in the tank pressurization rate. The model also predicts that the peak pressure is much lower than in the case of an unprotected tank. These differences are, of course, caused by the reduced heating rate resulting from the presence of the thermal insulation.

The effect of the reduced heating rate is clearly shown in Figure 6 which presents the tank inner wall temperatures. The model predicts that the rate of temperature rise and the peak temperatures will be significantly reduced by the presence of the thermal insulation.

Figure 7 shows the predicted liquid level. The Figure clearly shows that the reduced heating rate results in a much slower rate of regression for the liquid level. This, of course, means that the tank remains partially full-with lading for much longer, and therefore, the risk of a severe explosion also lasts for a much longer period of time. This problem has been discussed in more detail in Reference (3).

Figure 8 shows the predicted wall-stresses and material properties. Because of the significantly lower

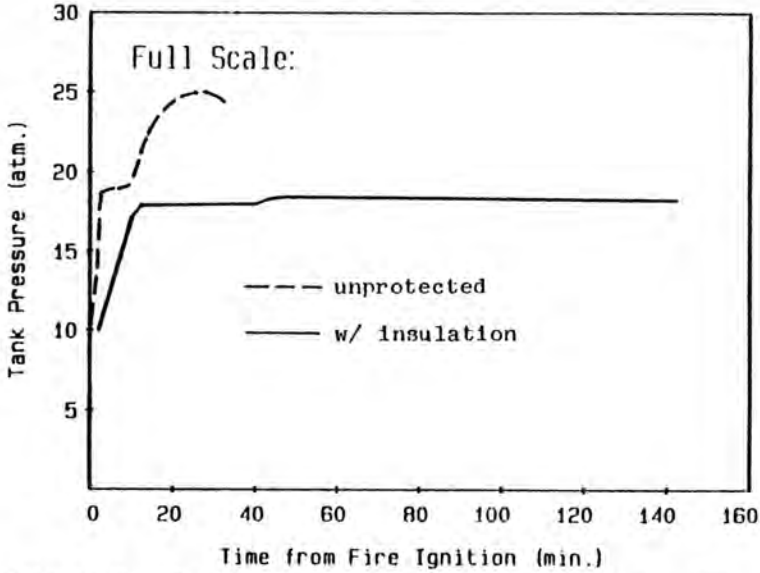


Figure 5 Predicted tank pressures for a thermally insulated full-scale tank and an unprotected full-scale tank.

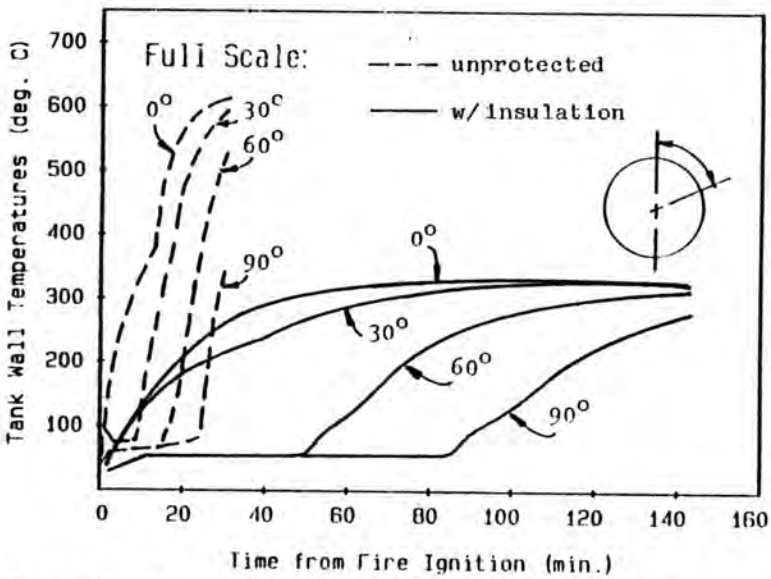


Figure 6 Predicted inner wall temperatures for a thermally insulated full-scale tank and an unprotected full-scale tank.

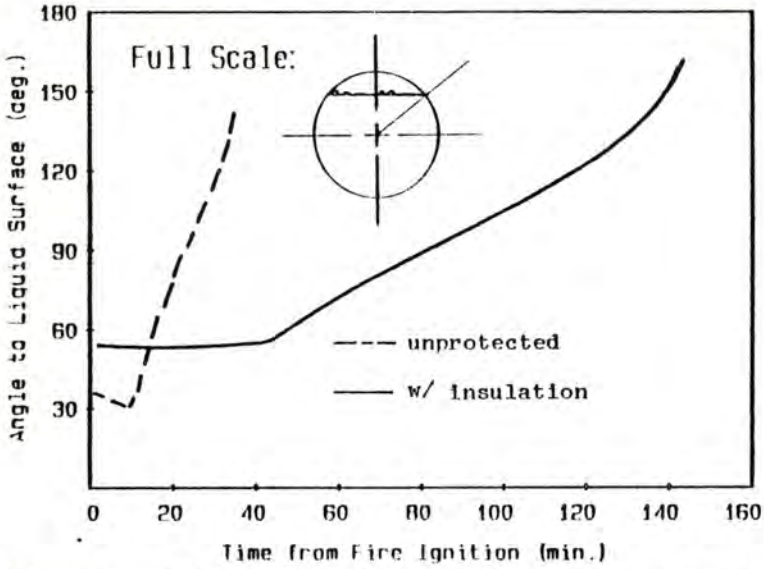


Figure 7 Predicted liquid levels for a thermally insulated full-scale tank and an unprotected full-scale tank.

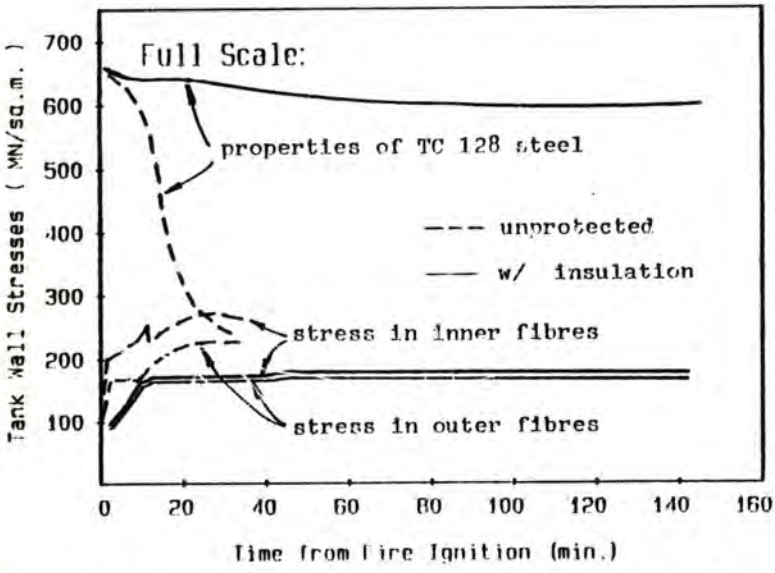


Figure 8 Predicted tank wall stresses and material tensile strength for a thermally insulated full-scale tank and an unprotected full-scale tank.

wall-temperatures and tank pressure, the model predicts that the tank will not fail.

The model predictions indicate that thermal insulation can reduce the risk of thermally-induced tank ruptures. However, the model also indicates that the insulation prolongs the period over which the tank is partially filled with a potentially hazardous commodity.

A problem with externally applied thermal insulations is that they may be damaged in an accident situation. If the insulating layer is damaged, its effectiveness may be significantly reduced. For this reason, thermal insulation alone should not be considered as a solution.

Case 3: full-scale tank with thermal radiation shielding.

Figures 9,10,11 and 12 present tank pressure, wall temperatures, liquid level, and wall stresses for the case of a full-scale tank with thermal radiation shielding. The shielding in this case consists of a 'thin' steel sheet surrounding the tank. It was assumed that a gap of 3 cm. existed between the shielding and the tank shell, and that this gap was filled with a stagnant volume of air.

The model predictions for a tank protected with thermal radiation shielding are very similar to those shown in case 2 for a tank protected with thermal insulation. The thermal insulation was more effective, however, the overall effects were the same. If the surface emissivities of some of the shielding surfaces can

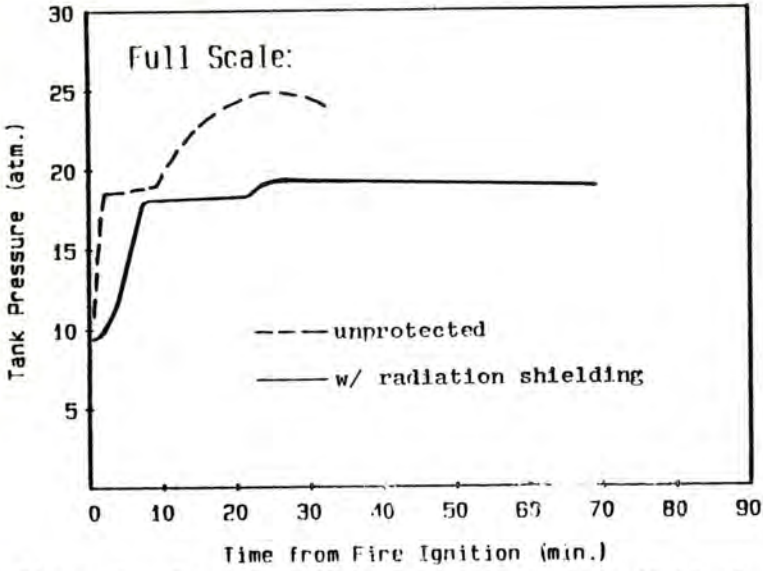


Figure 9 Predicted tank pressures for a radiatively shielded full-scale tank and an unprotected full-scale tank.

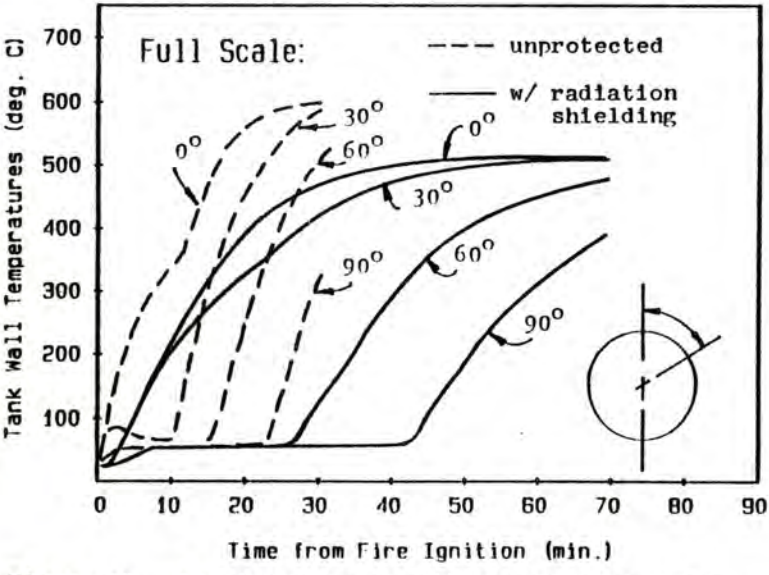


Figure 10 Predicted inner wall temperatures for a radiatively shielded full-scale tank and an unprotected full-scale tank.

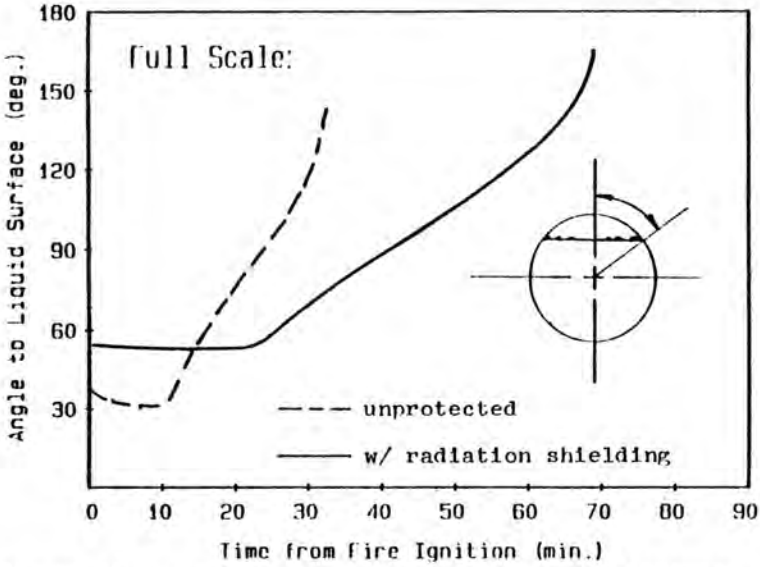


Figure 11 Predicted liquid levels for a radiatively shielded full-scale tank and an unprotected full-scale tank.

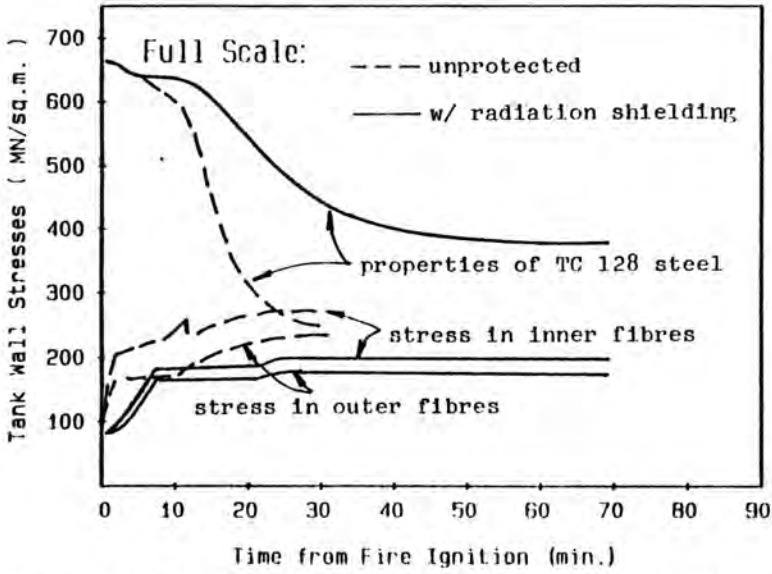


Figure 12 Predicted tank wall stresses and material tensile strength for a radiatively shielded full-scale tank and an unprotected full-scale tank.

be reduced in some way, then the radiation shielding can be made even more effective. This is discussed further in Reference (7).

The results of this simulation indicate that thermal radiation shielding could be a cheap and effective means of reducing the risk of thermally induced tank rupture. The radiation shielding could also act as additional structural protection for a tank.

Many tanks are presently protected with a thermal insulation layer covered with a steel jacket. This steel jacket is escentially a radiation shield if the jacket is not in firm contact with the insulation. In some cases, the insulating material is subject to degradation at high temperatures, and if the insulation degrades and separates from the steel jacket, then the jacket acts exactly as a thermal radiation shield.

Case 4: full-scale tank with 'Explosafe'.

'Explosafe' consists of aluminum foil which has been sliced, expanded and stacked to form a highly porous and light matrix with good thermal conduction characteristics. When applied to the inner surface of a rail tank-car it is a means of increasing the heat transfer coefficient on the inner surface of the tank wall, especially in the vapour-wetted areas. This has two net effects, it increases the rate at which energy is added to the lading, and it reduces the wall temperatures in the vapour-wetted regions.

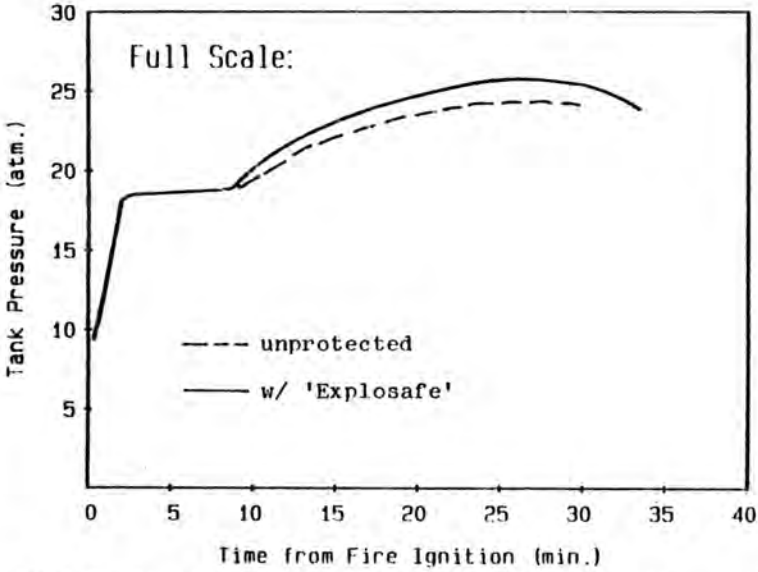


Figure 13 Predicted tank pressures for an 'Explosafe' equipped full-scale tank and an unprotected full-scale tank.

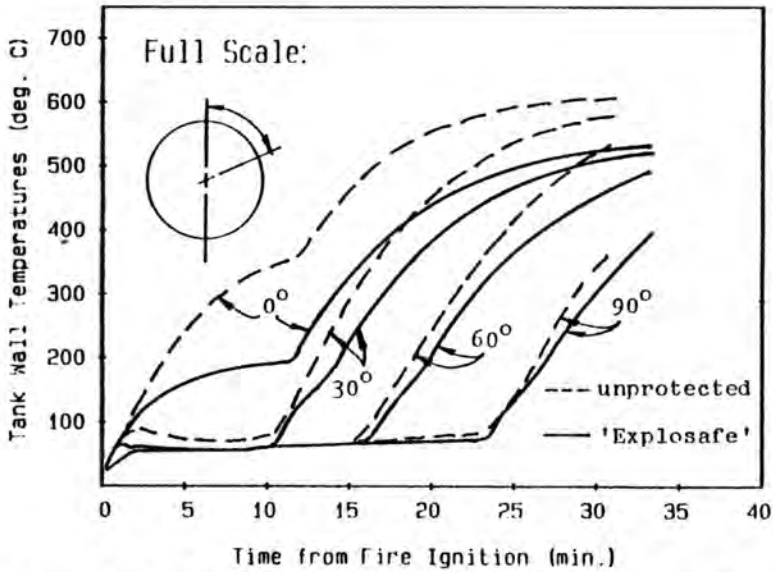


Figure 14 Predicted inner wall temperatures for an 'Explosafe' equipped full-scale tank and an unprotected full-scale tank.

Figures 13,14,15 and 16 present tank pressure, wall temperatures, liquid level, and wall stresses for the case of a full-scale tank equipped with the internal thermal protection device known as 'Explosafe'. In this case it has been assumed that a 13 cm. annular section of 'Explosafe' exists in firm contact with the inner wall of the tank. The 'Explosafe' is oriented so that the path if highest thermal conductivity is radial, and the next highest conductivity path is circumferential. More details of this simulation can be found in Reference (7).

Figure 13 shows the predicted tank pressure. Because of the presence of the 'Explosafe', the model predicts that the tank pressure will reach a slightly higher peak value. This is due, of course, to the slightly higher rate of heat addition.

Figure 14 shows the predicted tank wall temperatures. Because of the higher heat transfer coefficients at the inner surface of the wall, the model predicts lower wall temperatures.

Figure 15 shows the predicted liquid level for the 'Explosafe' equipped tank. Because of the slightly higher heating rate, the model predicts that the tank will empty at a slightly increased rate. This prediction may be in error because the presence of the 'Explosafe' has some effect on the flow patterns in the tank, and therefore, on the flow through the relief valve. This effect has not been accounted for in the present model.

Figure 16 presents the predicted wall stresses and material properties. The model predicts that the tank

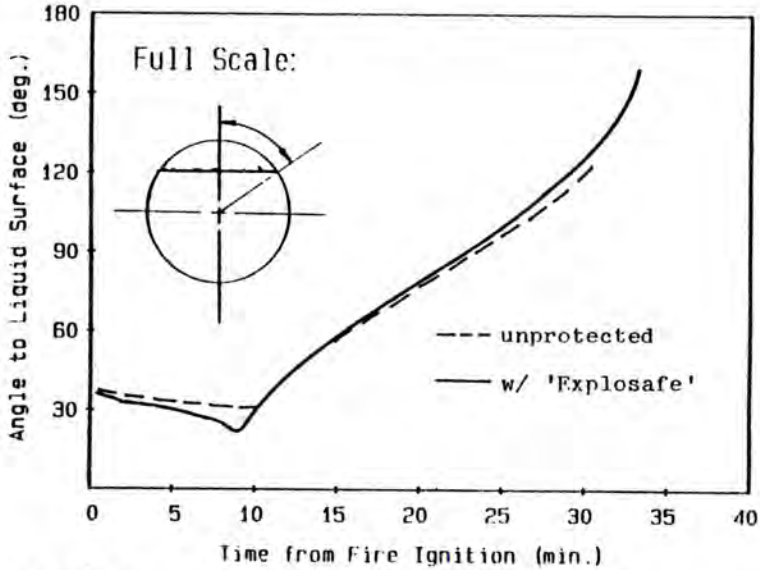


Figure 15 Predicted liquid levels for an 'Explosafe' equipped full-scale tank and an unprotected full-scale tank.

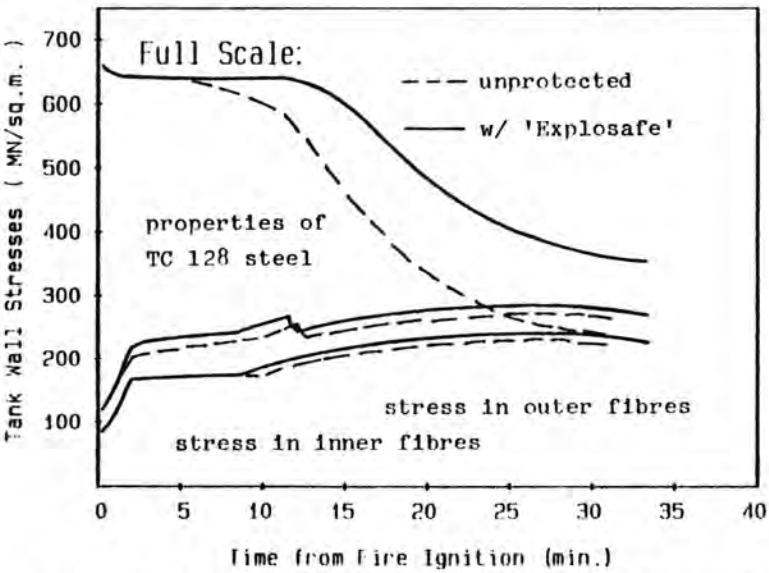


Figure 16 Predicted tank wall stresses and material tensile strength for an 'Explosafe' equipped full-scale tank and an unprotected full-scale tank

will not fail as a result of the reduced wall temperatures. However, the safety margin is not large.

The effectiveness of the 'Explosafe' material in assuring reduced wall-temperatures in a tank-car relies on firm contact between the matrix and the tank inner-wall surface. Assuring this has proven to be a formidable engineering task. Other problems such as corrosion, slosh-loading and cleaning also exist. Further study of this device is needed.

CONCLUSIONS and RECOMMENDATIONS

A model has been developed which accurately represents the processes taking place in and around an unprotected rail tank-car engulfed in fire. This model has been extended to include the effects of a variety of thermal protection devices. Model predictions for tanks equipped with some of these devices have been presented. These predictions indicate that there are a number of devices that can reduce the risk of thermally induced tank rupture.

Before the model can be used as a design tool, it requires further validation so that its predictions are trusted by industry. This will require further experimental work similar to the full- and fifth-scale testing, as well as laboratory type work. Once this detailed validation process has been completed, the model will be a valuable aid in the design of safer transportation and storage vessels.

REFERENCES

1) Railroad Tank Car Safety Research and Test Project; Phase II Report on Full Scale Fire Tests. AAR-RPI, RA-11-6-31, AAR-R-201, US6 AFI 17-75 ENG(BK).

2) Railroad Tank Car Safety Research and Test Project; Phase II Report on Analysis of 1/5 Scale Fire Tests. RPI-AAR, RA-11-5-26, US6 AFI 17-73 ENG(PF).

3) C.E. Anderson; Rail Tank Car Safety by Fire Protection, 6th International Fire Protection Seminar.

4) R.D.Appleyard; Testing and Evaluation of the Explosafe System as a Method of Controlling the Boiling Liquid Expanding Vapour Explosion, Transport Canada Report No. TP 2740, 1980.

5) K.W.Graves; Development of a Computer Model for Modelling the Heat Effects on a Railroad Tank Car. FRA-OR&D 75-33, 1973.

6) A.M.Birk, P.H.Oosthuizen; A Thermodynamic Model of a Rail Tank-Car Engulfed in Fire, ASME paper, 1983.

7) A.M.Birk; Development and Validation of a Computer Thermodynamic Model of a Rail Tank-Car Engulfed in Fire, Ph.D.Thesis, Queen's University, Kingston, Canada. 1983.

INTER-CITY PASSENGER TRANSPORT

INTERCITY TRANSPORT COMPARISONS: ISSUES IN ANALYSIS

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There are three kinds of lies: lies, damned lies, and statistics. -- Disraeli

ABSTRACT

Comparisons of modal performance are an important part of transportation planning and policy development. Aggregate comparisons are useful in directing attention to problem areas or opportunities, but, in a broader public policy context, often give a misleading impression of appropriate future roles for the various modes. Examples are given of passenger transportation comparisons (economic performance, energy use and government subsidies) that can be misinterpreted. The conceptual basis for sound transportation comparison is then explained in relation to the transportation product and its market, the time frame for comparison, and indicators of performance.

INTRODUCTION

The growth of intermodal competition, coupled with

1 The assistance of CIGGT staff in reviewing earlier drafts and discussing conceptual issues is gratefully acknowledged. However, views expressed are those of the author and not necessarily those of CIGGT or its sponsors.

substantial public funding of transportation services and infrastructure, has brought with it an endless procession of statistical comparisons displaying the relative merits of the various modes of transport. Typical of the questions to which these comparisons are addressed are:

- Do (or can) railway passenger services offer greater energy efficiency than the air and highway modes?
- Which of these modes offers either the lowest costs or the best use of public funds?
- Is intercity truck transport more or less energy efficient than railway piggyback?
- Do truck operators receive more or less subsidy than railway operators?
- Is highway transport of grain less costly than branch-line railway transport?

Answers to these questions are important, yet many modal comparisons offered in support of one view or another are obscure or misleading. The purpose of this paper is to illustrate this contention and to provide a conceptual basis for useful intermodal comparisons.

While this paper focusses on transport system analysis, the dominance of argument as a mode of discourse has several implications for the analytical function. In argument, 'truth' has been decided by the participants, and all that remains is to see who can muster the most convincing case for his own option or against his opponent's position. This adversarial system may produce a balanced presentation of modal attributes, but only coincidentally.

Assuming that it is possible to develop a 'pure' analysis of modal attributes (comprehensive and

unbiased), such an analysis will be quickly defeated by argument (the latter always makes better media copy). Moreover, if the modal comparison has any substance it will offend at least one interested party, and it will therefore be attacked (in the argument mode). Under these conditions, the professional analyst faces a dilemma. He may maintain his purity, preparing comparative analyses as honestly and completely as possible, leaving it to others to interpret and argue. The likely result is that the analyst will be assigned to manage the office coffee service or be declared redundant. Alternatively, he must be prepared to cut corners (resources are rarely available for a complete analysis), to interpret the results, and to advance and defend the apparent conclusions of his work. But to do so effectively means to decide what is relevant and important, hence to evaluate. This immediately places the analyst outside the realm of pure analysis and labels him as a participant in the decision-making process.

There are, therefore, practical limitations[2] on comparative analyses of modal performance. The analyst must choose what he will study, with an eye to his budget, and must present some subset of the results in a convincing fashion. Of course, he should not engage in argument for argument's sake, and he certainly should not lie or distort the facts.

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2 There may also be some theoretical limitations. For example, the order in which attributes are presented to a decision-maker often implies a ranking of importance.

EXAMPLES

The three examples that follow have been selected to illustrate conceptual difficulties with intermodal comparisons. While the examples refer to passenger transport performance, similar defects in conception or use can also be observed in freight systems analysis.

Example 1: The 'Alternatives to Air' Study

The Canadian Institute of Guided Ground Transport undertook a thorough study, lasting almost three years, of the costs of high-speed ground transportation systems on the Toronto/Ottawa/Montreal route.[3] The object of the study was to determine whether such systems could be economically viable. Although the level of traffic available to the profitable Shinkansen system could not be expected in Canada, it was found that economic operation could be achieved on the specific route. Moreover, for the railway systems studied, the average cost per passenger, including capital costs, was not dissimilar from railway fares existing at the time the study was completed. In other words, the existing service, which covers less than fifty per cent of its costs, could be converted to a high-quality service which would cover one hundred per cent of costs with little or no increase in fares. This conclusion was bound to refuel the railway

3 R.W. Lake et al., Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor, CIGGT Report No. 80-4, July 1980.

passenger debate with some justice. Unfortunately, there was a 'catch', one that cast in doubt the comparison of these new systems to existing modes of transport. While some of the cost savings come from increased utilization of equipment and facilities, a large portion was founded on the assumption of an entirely new system, organized and constructed from scratch, including a purpose-designed management structure, an integrated operating strategy, and new work rules. But who would develop and operate such a system? An obvious candidate is VIA Rail, a company burdened not only with obsolete equipment, but also with an obsolete way of operating and managing a passenger system. Can VIA evolve the kind of passenger system envisioned in the 'Alternatives to Air' study? If the answer is 'no', then the basis for comparing the favourable results of that study with the performance of existing modes has surely been lost or at best distorted.

Example 2: Energy Consumption

Table 1, from a recent Science Council report,[4] shows relative energy consumption for passenger transportation.

Comparisons such as these have readily found their way into the background 'lore' of transportation policy debate. For example, in 1976 the Canadian Transport

4 Transportation in a Resource-Conscious Future: Intercity Passenger Travel in Canada, Science Council of Canada, Report No. 34, Sept. 1982.

TABLE 1: APPROXIMATE DIRECT ENERGY CONSUMPTION BY MODE

Mode	Kilojoules per Passenger-kilometre
Air - CTOL	3,606
- STOL	3,147
Auto	2,295
Rail	918
Bus	656

Commission held hearings on the future of Western transcontinental passenger train services. Many participants in these hearings expressed the belief that trains were an energy-efficient alternative to cars and aircraft, basing their statements on statistics similar to those in Table 1. But transcontinental trains are not typical. On average, a long-distance train with dining and sleeping accommodation might offer twenty-five spaces per car, compared to more than seventy for a 'typical' intercity train with coach and club accommodation. Thus, the energy consumption of a long-distance train might well be higher than auto or air modes.

Damaging as it is, the misuse of 'typical' performance statistics is not the most serious criticism of energy comparisons. The relevance of energy analysis is founded on two suppositions:

(1) that the social value of energy is understated by its price in the market (otherwise, a comparison of costs, including energy, would be sufficient)

(2) that it is energy itself that is valuable.

The second supposition may have some validity. However, most energy-related initiatives have been aimed

at conservation or displacement of oil. If petroleum savings are the priority, then a straight energy comparison will only obscure the alternatives.

The first supposition, perhaps restated in terms of oil, is arguable. With current oil pricing agreements between federal and provincial governments, and the recent slump in world oil prices, domestic prices are rapidly approaching world levels. To the extent that world prices reflect the value of oil (and this is not clear), the dominant concern should be transport costs, of which energy costs are a part, rather than energy costs in isolation. The former view admits certain economic trade-offs that the latter view does not. Either view leads to a need for analysis of the usage of scarce energy resources, but the 'total cost' view places energy use within its context.

Example 3: Subsidies

Table 2, prepared by Transport Canada,[5] shows deficits (covered directly or indirectly by government) for intercity and urban transportation.

It is exceedingly difficult to obtain accurate and unbiased estimates of modal subsidies. However, even if the estimates in Table 2 can be considered technically acceptable, conceptual limitations remain:

(1) As system averages, the statistics cannot capture performance within specific markets.

5 Transport Costs and Revenues in Canada, 1969-1979, Report TP 3737E, July 1982.

TABLE 2: PASSENGER TRANSPORT DEFICIT, 1979

	Deficit ($ millions)	Deficit per Passenger-Km (cents)
Automobile	$2,588	0.9
Bus: Intercity	12	0.4
Urban Transit	424	4.6
Rail	298	14.1
Air	490	1.1

The large deficit per passenger-kilometre for rail invites the conclusion that railway services should be discontinued as soon as possible. However, unit deficits are much lower than average on the Toronto/Montreal route, for which higher-than-average traffic density is experienced. At the same time, the unit deficit for air transport is likely to be (though not necessarily) higher than average on shorter links such as Toronto/Montreal. While it is unlikely that specific analysis of this market would close the gap between the rail and air measures, the gap might be sufficiently narrowed to justify analysis of railway improvement options.

(2) Presentation of a uni-dimensional figure of merit, the deficit per passenger-km, implies that there is only one important measure of performance. Where the context is a financial evaluation, it may be helpful to compare deficits per passenger trip, or modal cost recovery (the latter is often used to set performance targets for urban transit systems). In a broader context, other attributes (safety, environmental impact, etc.) may be relevant.

(3) The various passenger modes differ considerably in their current state of development. The highway and air systems are relatively mature; therefore recent history should offer some guidance. Yet there are uncertainties. The future liability for road repair or replacement is uncertain, as is the share that should be attributed to auto users. Also uncertain is the impact on road and air traffic of possible future fuel prices. The bus mode has had a mixed past: growing, then declining as auto ownership rose, and now seeking its appropriate role, particularly in relation to railway passenger services. The existing railway passenger system is largely

worn out and obsolete. Consequently, the current financial status is an ambiguous indicator of likely or potential future performance.

Despite technical and conceptual limitations, comparison of aggregate modal subsidies does serve a useful purpose. It draws attention, in a dramatic way, to problem areas -- in this case the inadequate financial performance of the railway passenger system. The comparison does not tell us what to do about problems, but it does tell us that something is wrong.

THE BASIS FOR MODAL COMPARISONS

The objective of a modal comparison plays a critical role in shaping analysis. If the objective is to identify broad problem areas, comparison of aggregate financial performance, as in Table 2, is appropriate. However, an understanding of modal differences will require comparison of contributory elements (e.g. equipment utilization, labour productivity). If funds are to be allocated among modes, comparative financial information will be needed for options defined in the light of specific transportation tasks. Clarification of objectives will be helpful in defining the features of the comparative analysis, including:

(i) relevant transportation systems (the product)
(ii) the market of interest
(iii) the time frame covered by the comparison
(iv) the relevant indicators of performance.

The importance of clearly defining the transportation product and the market to which it is (or will be)

offered cannot be over-emphasized. In the case of passenger systems, important product attributes include comfort, convenience, frequency, speed, on-board amenities, and safety. For a valid comparison it is not necessary that the modes compared offer the same attributes -- it is only necessary that the attributes which are not being compared be approximately equivalent in the eyes of the user. This kind of equivalence is particularly important where one is comparing costs or energy use. For example, a comparison between high-speed, high-frequency railway service with existing intercity bus service is much less coherent than a comparison with short-haul air service. In the former case, the products are sufficiently dissimilar that substantially different markets are involved. A comparison between existing short-haul railway and intercity bus is much sounder, though not without its flaws.

Markets may be defined in general terms (e.g. the tourist market), but where funding decisions are to be made, more specific definition will be required, including origins and destinations and the characteristics of the travellers to be served. For example, the elderly and handicapped may experience considerable difficulty in using conventional bus service. For this market, a simple comparison between bus and railway costs would obscure an essential feature. For businessmen travelling long distances, bus and railway services are generally not valid options. Where product and market definition indicates no basis for a modal comparison, a

stand-alone evaluation, based on broader measures of financial, economic and social performarce, will be required.

It may also be found that the most interesting transportation products are packages, in which modes are integrated (coordinated) to provide a 'through' service. For example, a very effective demonstration of STOL transportation was mounted between Ottawa and Montreal in the 1970's. A contributor to that success was the development and marketing of an easy-to-use transportation package (incorporating ground transfer). A raw intermodal comparison would not be immediately helpful, because the same kind of packaging was not available for competing modes (CTOL, bus, railway).

In defining a proper comparison, it is also essential that the correct time frame is specified. The difficulties of comparing modes that are in different stages of their 'life cycle' has already been noted in the context of retrospective evaluations. In prospective evaluations, existing services are often compared with proposed future services. However, in the heat of debate it is often forgotten that new services cannot be introduced instantly. Where development, construction, and testing are required, the lead time for new service introduction may well be measured in decades. In this period, the existing transportation system must continue to function, including maintaining the shorter-term integrity of its physical plant.

Where reasonably comparable product/market pairs can be defined and applied to the time frame of interest, it remains to define indicators of performance.[6] In public policy discussions, costs, energy use, and subsidies are typically offered as performance indicators. While these may be useful, they often fail to reflect the real reasons why one mode would be selected over another for a particular task. Costs are obviously important, but their minimization (implied by its use as an indicator) is only justifiable where revenues or benefits are constant for all the options compared. Estimates of future prices and revenues are difficult, but not impossible, given a budget for market research. Certainly, few private sector companies would survive that did not estimate the market for a new product and the expected profitability.

Even for longer-term projects, the short-term economic climate will play an important role in mode selection. During an economic downturn, the financial community may resist borrowing for capital projects. As a consequence, capital requirements can be an important indicator in modal comparisons.

Businesses and government are often more concerned with minimizing the potential for adverse outcomes than maximizing expected profits. This motivation will be strongest where business survival is emphasized and where a range of uncertain and threatening possibilities are

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6 The variability of these indicators within the relevant time frame (often quite long) may be such that a schedule of performance over time is preferred to summary indication for the entire period.

perceived. In comparing modes for particular tasks, an important (usually subjective) indicator is the extent to which modal options preempt unfavourable outcomes.

Finally, modal comparisons often lack an assessment of the likelihood of success, given the prevailing business environment and the capabilities of available management. To some extent, this factor is already represented in financial indicators (unit costs, etc.). However, even if all objective indicators are balanced, a well-organized and energetic management (where identified with a specific mode), operating within a receptive business environment, is more likely to be favoured than an uncertain (perhaps unproven) management trying to make its way in a hostile environment.

A variety of other factors affect modal selection by operators and government -- environmental impact, energy use, safety, social impacts, and so on. Their relevance will depend on specific circumstances, and therefore should not be evaluated as generalities.

With many indicators in view, the possibility is much greater that 'double-counting' will occur, especially if an attempt is made to resolve all, or subsets of, the indicators into a single figure of merit. The example of energy use has already been provided; energy already appears as a contributor to costs, and its presence as an independent indicator must reflect only the difference between its price and its (social) value.

CONCLUDING COMMENTS

This paper has illustrated many of the difficulties encountered in making valid comparisons of intercity transport systems. The approach that is suggested starts with a specification of the transport product and its market, to ensure that the modes compared are indeed comparable. With this specification in hand, a variety of indicators -- some quantifiable, some not, and some of a subjective nature -- must be considered in the light of the objectives of the comparison (defining priorities for analysis, understanding modal differences, choosing a mode). These indicators should reflect, more closely than they now do, the actual factors in the choice of mode in a government or business setting. In determining the implications for the future historical performance, it is also appropriate to consider the position of the various modes in a longer-term 'life cycle' (development, maturity, then decline).

While the preceding emphasizes the broad conceptual requirements for valid modal comparisons, other technical requirements -- especially consistency and accuracy -- should be met. Cost categories shown for one mode should be comparable, at least in aggregate, with categories represented for other modes. Inaccuracy is, in some degree, inevitable, but acknowledgement of inaccuracy or, better yet, recognition of a range of estimation is likely to discourage over-zealous interpretations.

Clearly, there are limitations on the analyst's

ability to present a conceptually and technically correct comparison. However, the principles of 'good' modal comparison at least provide goals to strive for and reasons for humility in interpreting the results.

WILL MULTIMODAL PASSENGER TERMINALS HELP TO MEET OUR TRANSPORTATION REQUIREMENTS TO THE YEAR 2000?

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ABSTRACT

This paper describes the multimodal passenger terminal research undertaken by Transport Canada since early 1981; outlines recent Canadian activities in that area; and assesses the prospects of these terminals helping to meet our passenger transportation requirements to the Year 2000 and beyond.

INTRODUCTION

Together, the intercity bus carriers and railway companies carry about 42 million passengers each year, and serve 3,400 Canadian communities. This is almost six percent of all person-trips and accounts for about 3 1/2 percent of all passenger-kilometres in Canada. In the last decades the share of the market held by these public carriers has remained constant or declined, in a nation where the overall market continues to grow. This

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small but nonetheless significant market share has lead some to question the current practice of providing separate intercity bus and rail facilities. Many Canadian communities lack adequate bus station facilities; many communities have antiquated, often oversized, railway passenger terminals. In planning and building our public transportation system to the Year 2000, we can continue to make investment and improvements in terminal facilities on a unimodal basis, or passenger terminals can be constructed or renovated to serve more than one mode, i.e., multimodal passenger terminals.

Definition

What is a multimodal passenger terminal?

It is a passenger facility shared by two or more modes, thereby making it easier for travellers to complete their journeys when changing from one intercity mode to another, or from the intercity mode to local-area transit. Multimodal passenger terminals (MPTs) are expected to offer more to carriers than unimodal terminals, through economies of scale and the increased efficiency of a shared facility. An MPT is more than a connection point to the local transit system - it is a focal point for both intercity and local/regional transportation. Carriers using the MPT may be complementary (one mode bringing customers to another) or competitive (each mode competing for the traveller). While

a surface connection may be provided to an airport, a multimodal terminal is unlikely to be located at an airport.

TRANSPORT CANADA STUDY

The Situation in 1981

In 1980-81, VIA Rail began developing plans to revitalize rail travel in Canada. These plans included providing multimodal terminal complexes in: Moncton, Québec City, Trois Rivières, Lévis, Windsor, Toronto, Regina, Edmonton, and Vancouver. Despite VIA's proposals for large capital investments in MPTs (up to $20 million in the Québec City case), the underlying basis for these facilities seemed vague and remarkably undefined. Proponents, including VIA, seemed to start from the assumption that MPTs are a good thing, and built their case from there. The literature relevant to Canadian transportation reflected this same assumption, and concentrated on the locational opportunities and design aspects of MPTs. Another common element in the literature was frequent references to working examples of European centres for Canadians to emulate. MPTs appear to be a logical and rational use of funds and do offer benefits to the traveller and the carriers.

Given the need for quick action in 1981 to revitalize passenger rail, and the need for early decisions on capital improvements to existing rail

stations, we in the Strategic Planning Group of Transport Canada decided to investigate the desirability and feasibility of multimodal passenger terminals as components of the Canadian transportation system. Explicitly excluded from our study were the actual engineering/station design aspects, and extensive research into European designs.

Methodology

A variety of analytical methodologies were initially considered. The lack of practical data on stations (capital cost, operating costs, access for carriers and travellers) prevented the use of cost/benefit analysis or rate-of-return techniques. Other economic analyses were also thought to be too ambiguous and arbitrary, given the many social benefits/costs and the numerous parties affected. It became clear that there were many perspectives to consider when evaluating any MPT proposal; that the real issues were not clearly identified in the literature; and that most of the sophisticated quantitative methodologies were inappropriate given the limited data available or attainable within the study timeframe. "Ranking" approaches were also examined, wherein alternatives could be ranked with respect to defined criteria. But whose criteria would be used - the railways'? the travellers'? the local bus operators'?

The approach eventually selected was the analysis of advantages and disadvantges of MPTs with respect to each of the affected parties. In this approach, both qualitative and quantitative factors were explicitly included in the evaluation. Furthermore, the technique is sufficiently general and flexible that it could include any evaluation criteria. There was no need to engage in a major data gathering exercise or to assign evaluation "weights". An additional major advantage of this approach was that it recognized that any one MPT proposal would affect different groups in different ways, depending on local circumstances. The complex distribution of benefits and costs of any MPT proposal meant that there is no simple decision number or single "best" answer. Therefore, the selected approach summarized and presented information necessary for making trade-offs between criteria and among affected groups. (The actual trade-off exercise is best left to group negotiation in each specific case.)

Our investigation identified and evaluated the relative advantages and disadvantages of multimodal passenger terminals for various affected parties including each of the modes, the travellers, the community, and the various levels of government.

The three carrier groups most involved in MPTs are the intercity bus industry, intercity rail

(usually VIA Rail Canada), and the transit provider in the terminal locality. For each of these there are advantages and disadvantages in multimodalism. These were examined in terms of patronage, terminal facilities, parcel trade, and image and operations.

The potential effects of MPTs on passengers and the general public were also identified and examined. Advantages and disadvantages of multimodalism were identified for other parties involved in MPTs, such as the local business community, the municipal government, provincial government, and federal government.

Results

Our analysis of the advantages and disadvantages for each party suggests that there may not be any significant financial gains accruing to any of the parties. Furthermore, those who invest in the MPT generate benefits that accrue mostly to others.

The current users of public intercity modes could be the biggest "winners" if multimodal terminals are built. Intercity bus and rail travellers would gain better terminal facilities in many cities (a benefit also realizable from constructing or improving unimodal terminals) and will have improved opportunities to transfer to local transit. However, it remains unknown how many

people may actually need or wish to transfer from one intercity mode to another to complete a trip. Since this ability to transfer between intercity modes is often cited as a major traveller benefit from shared terminals, it must be analyzed more closely before being used to justify investment in MPTs.

Rail seems to benefit more than other modes because MPTs are likely to utilize the existing rail stations, which are often expensively oversized for present and foreseeable rail needs. Rail also gains in image, which is important because its future may depend on continued public and political support.

The intercity bus industry is apprehensive about multimodal terminals, even though its potential benefits may be significant. The bus industry now has low terminal costs, and is reluctant to become locked into possibly more expensive terminals that may not generate increased patronage. On the other hand, the bus carriers do recognize that where terminals must be provided, there are certain economies of scale in sharing terminal facilities. The bus carriers also fear being forced (by regulatory agencies or "unfair" pricing by VIA) into a position less competitive than that of passenger rail, or even into a "feeder" role. While the bus carriers' fears of discrimination

may or may not be justified, they currently exceed the lure of potential traffic gains resulting from improved terminals, and the attraction of certain joint economies that may come from sharing terminal facilities.

Local transit providers will be affected by MPTs, but any effect, positive or negative, will be determined by specific local factors. In particular, the location of the MPT will be crucial. If the MPT is at a natural focus of the transit system, then the transit property and its riders will benefit, but if the MPT is off by itself then the transit provider faces various difficult operational trade-offs involving route lengths and scheduling.

The local business community could benefit from the renovating, improving and building of a multimodal terminal; and, after its completion, the purchase of maintenance goods and services. The local real estate and development industries appear to have the major stake in an MPT. These groups may not be interested in the transportation aspects of an MPT, but see it as a lever for promoting development. Also, both railway companies often own large tracts of downtown property suitable for redevelopment.

The general public should benefit from MPTs. Although everyone may contribute through their taxes to help pay for the new terminals, the actual users of public intercity transportation will enjoy better facilities and services. Improved facilities may also attract more customers. General social benefits may also accrue from improvements to the urban architectural environment and from more lively terminal environments. Many travellers currently have a choice of competitive modes for intercity trips, but it is possible that a multi-modal facility may actually reduce the consumer's choice because of modal co-ordination. The effects of any reduced competition have to be traded off against improved connections that may result from modal co-ordination. Finally, the cost of public benefits must be appraised against the benefits that could also be realized by constructing or improving unimodal terminals.

Governments may benefit from MPTs due to improved transportation or urban development opportunities. In general, though, governments must spend real, scarce dollars for MPTs in return for largely intangible "social benefits".

Study Conclusions

Our research project concluded with two observations:

1) Some advocate the MPT concept as the cure for a whole variety of transportation ills. In this view, MPTs are a "solution" seeking an application, rather than a problem or set of problems needing a solution.

   The multimodal terminal concept could be an elegant solution to various problems if the relationship between problems and solution is clear. But multimodal terminals may be an oversimplified, expensive measure ("just put all the terminals physically in one place and everything will be OK") that would have minimal positive effect on the transportation system. It is probably better, therefore, to consider terminal problems as having two levels of solution - level one being individual solutions to individual transportation problems, and level two being a single solution to many problems. Thus, while MPTs remain an "ideal" or model situation to be considered, they may not necessarily be needed in some instances.

2) The potential transportation system benefits of multimodal terminals appear to be significant enough to warrant further research. More investigation is required to properly provide definitive answers to many of the questions

raised in the report, and to respond to the requests to Transport Canada for MPT funding.

To that purpose, we proposed further research in three areas: a) existing terminals, terminal access traffic flow between unimodal stations, and the effectiveness of previous station improvements; b) co-ordination of intercity modes vs competition; and c) various ways of directing federal involvement in MPTs.

While proposing such research, we recommended that Transport Canada adopt an "agnostic" attitude, i.e., maintain an awareness of the apparent benefits, but beware of the costs and value for money. We further concluded that demonstration projects, particularly in smaller cities, may be the best way to conduct the research and gain practical experience.

Dissemination of Report

In the Spring of 1982 we distributed nearly three hundred copies of the report to provincial transportation departments, major municipalities, bus carriers, VIA Rail, transport academics and researchers, libraries, and part of the CTRF membership. We asked readers to tell us if they felt further research was warranted.

The response was less than overwhelming.

VIA Rail, which had urged Transport Canada to do the research, said nothing. The motor coach industry said nothing. Independent researchers on the subject in Canada and the U.S.. were quiet. Alberta was the only province which responded, noting that many of the benefits of a multimodal complex could be attained, with less effort and cost, simply by locating separate bus and rail stations very close to each other.

SUBSEQUENT ACTIVITIES

Undeterred by the general lack of response to our report, Transport Canada promoted the MPT concept in Transpo/82, a quarterly publication of the Department sent to 4,000 external subscribers. The article described, in very positive terms, Canada's first and perhaps only operating MPT, in Kapuskasing, Ontario, and also mentioned the availability of our publication on the subject. Not a single follow-up inquiry was received.

Transport Canada's Transportation Development Centre (TDC) in Montréal investigated, in depth, one demonstration possibility, that of linking the railway stations, airport, bus terminals, city bus, and commuter rail at Dorval to provide convenient and rapid intermodal transfer for intercity travellers. The study sought an improved understanding

of the needs for intermodal transfers and to promote the MPT concept. The study considered using a bus to link the various modal terminals. Despite a potential demand of 20-30,000 passengers a year, and a $1 fare, the service would lose between $8 and $20 per passenger. Thus, it is not expected that Transport Canada will implement this service. The TDC study results illustrate that even where there are a large number of beneficiaries of improved intermodalism, the costs may still be too high for practical implementation.

An evaluation of the major bus terminals was undertaken as part of a current joint federal-provincial examination of transportation in the Maritimes. Opportunities for improved intermodal transfers and multimodal stations were identified. Many Maritime bus stations have been improved in quality over the past few years, in some cases assisted by federal funding, and these improvements have had a positive effect on the image of the industry. While intermodal connections in the Maritimes (including ferries) were found to be not well scheduled, few improvements seem possible. The main opportunity for intermodal coordination occurs at Moncton. Moncton had been suggested as a MPT site in 1980-81, but the intercity bus operator preferred to operate from a unimodal terminal. Federal, Provincial, and carrier discussions are

underway to consider having the bus call at the train station.

What has become of the terminals originally under consideration in 1980-81?

The plans of two communities that came very close to realizing multimodal terminals - Lévis and Trois Rivières - are stalled, owing mainly to issues related to the ownership of station land.

The Regina multimodal station has been deferred by the Province, which was to contribute the $6.2 million in extra funds required for the Saskatchewan Transportation Company to develop its new terminal as part of an MPT rather than as a unimodal terminal. Over $3 million of federal funds were committed to the Regina MPT in 1980.

Other cities did not get much beyond the starting gate: in Moncton, the intercity bus carrier, SMT Eastern, opted to develop a unimodal bus terminal. The Québec City MPT has been delayed due to its high cost and because of delays in the associated urban redevelopment project. In Toronto, uncertainty about land development plans in the rail station area, plus the high cost of downtown land, has delayed MPT planning. In the west, Greyhound has seemed to be reluctant to embrace the MPT concept.

In Vancouver, there was controversy over whether to locate an MPT at the CN False Creek site or the downtown CP site. This was initially resolved in favour of the unattractive industrial-area CN site, which seemed a setback to transport enthusiasts. However, the main entrance to Transpo 86, including a terminal for the Automated Light Rail Transit (ALRT), is near the CN site. The surrounding area is now undergoing urban revitalization. Now the problem revolves around the question of bus carrier and provincial funding. It is still possible that an MPT can be in place in Vancouver in time for Transpo 86.

One province interested in and active with the multimodal terminal complex idea is Ontario. There are various bus/rail initiatives under investigation, including the viability of multimodal terminals, scheduling and ticketing. An interesting aspect of Ontario's research into MPT funding involves the concept of base funding for the MPT, plus additional funding per intramodal/intermodal schedule connection, plus more funding per schedule inter-connection with through ticketing. The Ontario idea promotes the integration of all modes in a fair way - the approach tries to ensure that all carriers benefit and that as many traveller benefits as possible are realized from the MPT investment. In this way, the MPT becomes a means

to an end rather than an end in itself.

THE PROSPECTS FOR MPTs IN CANADA

In trying to assess whether MPTs will help to meet our transportation requirements to the Year 2000, it is helpful to note the factors favouring the development of terminals and the impediments that have, to date, delayed the realization of MPTs in Canada. The barriers to realizing multimodal terminals have been stronger than the incentives, as evidenced by the scarcity of functioning MPTs. The main impediments are:

a) Lack of Carrier Co-operation

Carriers have traditionally competed with each other for clientele, a tradition that is recognized in and encouraged by legislation. Some carriers are uncertain about the multimodal concept because the benefits (and their distribution) are not accurately predictable. Other carriers are suspicious of government and its motives. Some carriers firmly believe that unimodal terminals are an essential part of their industry. Private industry has not built MPTs in this environment because co-operation and mutual trust are prerequisites for a multimodal terminal.

b) Lack of MPT Data

Few carriers have participated in "typical" MPTs and therefore have only non-Canadian examples to go by. They lack data on the financing (capital, operating cost) of the terminals and their effects on patronage.

c) Competition Policies and Practices

Carriers compete both inter-modally and to a limited extent, intra-modally. Various modes are subject to regulation by provincial, federal and municipal bodies. Given this environment that favours independent actions, it has been difficult to generate co-operative group interest in multimodal terminals.

d) Investment in Existing Plant

Each mode locates its terminal to suit its particular operating requirements. Integrating terminals normally means moving the bus depots to the train or ferry depots because these latter modes have the least portable infrastructure. Where carriers own or lease their existing stations and land, it may not be to their immediate apparent advantage to relocate their facilities.

e) Specialized Terminals

Given that bus and rail and local transit terminals are designed specifically to meet the

needs of these modes, a multimodal terminal may represent a less-than-satisfactory arrangement (either operationally or financially) for some carriers. If a carrier is satisfied with its own facilities, it will not necessarily be attracted to a shared facility. Carriers also are concerned that their image or role may be obscurred by moving to another mode's station.

f) Legal Issues

The railways are regulated by the Canadian Transport Commission. For legal reasons, in various pieces of legislation, certain uses of railway lands are required and other non-railway uses prohibited. The use of railway lands for a bus terminal, for example, may not be a permitted use.

g) Dependence on External Funding

Proponents of MPTs often identify governments as sources of funding, usually on the grounds that such terminals fulfill some government interest in "efficiency" or "social benefit". And, governments are the only MPT party that can be expected to accept little or no financial return on investment. While promises of funding have been made, Canadians have not yet seen their governments actually spend the necessary money to bridge the gap between what an MPT costs and what carriers and others are willing to contri-

bute.

Although the barriers to multimodal terminals seem more numerous than the advantages, carriers do reconsider the shared-terminal concept for the following reasons:

a) Potential Carrier Benefits

VIA or a bus carrier may see individual benefits in having an MPT in a certain location. Private-sector firms (e.g., Greyhound, Voyageur) usually judge the benefits in financial investment terms, but public-sector carriers (e.g., Saskatchewan Transportation Company or perhaps VIA) may view multimodal terminals as contributing to certain social or political objectives such as increased visibility or increased demand, which may complement or replace financial benefits. A carrier may consider the MPT alternative when planning to renovate, relocate, or build a new unimodal facility.

b) External Impetus

Many carriers seem to be passively interested in multimodalism and usually respond to multimodal initiatives taken by other parties. In recent times, VIA Rail has been raising the issue. The impetus may come from the municipality seeking either a terminal facility per

se or as part of other municipal objectives; or it may come from a higher level of government's expression of interest. Provincial interest may come from the provincial transport or development agencies. Impetus can also come from special interest groups or the political representative of an area.

c) Increased Awareness

As carriers become more aware of the potential benefits of multimodalism they are likely to be more receptive to the idea. The biggest boost to MPTs will be the successful construction and operation of an MPT that delivers measurable benefits to each involved party.

To return to the central question of this paper and the theme of this conference, will multimodal passenger terminals help to meet our transportation requirements to the Year 2000?

This review has shown that the costs of MPTs are high and the barriers numerous. The potential benefits of an MPT are difficult to quantify. Therefore, it is unlikely that we will see a lot of multimodal passenger terminals springing up in Canadian cities over the next two decades. Those MPTs that are constructed may be built for primarily non-transportation reasons (for example, urban redevelopment, job creation, etc) and may not be

built at locations where transportation specialists wish to see them built. Because of the complex issues involved, it is more likely that the first MPTs will be in smaller cities where the issues are clearer and where there may be fewer involved parties and the costs are much less. It is worth pointing out again that our functioning MPT example in Canada is at Kapuskasing, a city of 20,000. It is also possible that the benefits of multimodal terminals can be enjoyed without any actually being built; this can happen by improving the transit access to and between unimodal terminals, or by improving the communication between already adjacent unimodal terminals.

It is unlikely that we will see multimodal passenger terminals in most of our major cities by the Year 2000. The real MPT opportunities will come in cities where major terminal construction or relocation is otherwise required. In these situations, the MPT concept can be considered along with other alternatives. In places where an MPT is considered but rejected in favour of other terminal arrangements, it is not an "MPT failure" or missed "golden opportunity". Instead, other solutions to a terminal problem were found to be better than a single building or complex. In planning and building our public transportation system to the Year 2000, we should make investments and improvements

in either unimodal or multimodal facilities, according to the needs of the specific location.

THE ELDERLY AND THE HANDICAPPED: TRANSPORTATION REQUIREMENTS TO 2000

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ABSTRACT

This paper examines future transportation requirements of Canada's growing handicapped population by dividing the population into three groups, the elderly, the physically handicapped and the perception and communication-handicapped. The specific transportation needs of each group are considered and transportation solutions for major travel modes are discussed. Canadian and American accessibility goals are contrasted. It is concluded that: a) future transportation needs of the elderly and handicapped will be met by properly applying current-day technology and systems; b) research and development efforts as well as special program costs will increase in order to meet the needs of the E&H; and, c) the needs of the elderly, and the perceptually and cognitively-impaired are shown to be relative unknowns, and therefore should be the targets of R&D. This document will be of special interest to urban and transportation planners.

BASIC DEFINITIONS

Since the early seventies, there has been growing acceptance of the concept of accessible transportation for the handicapped. The notion that the elderly should also receive special transportation in Canada is even newer, as their needs are often considered similar to those of the handicapped, hence the term E&H (elderly & handicapped) for transportation planning purposes. However, it must be recognized that the handicapped population is quite heterogenous, and only 30% of the elderly are handicapped. In order to differentiate the needs of these groups, a discussion on definitions of terms such as the handicapped, the transportation handicapped, and the elderly is in order.

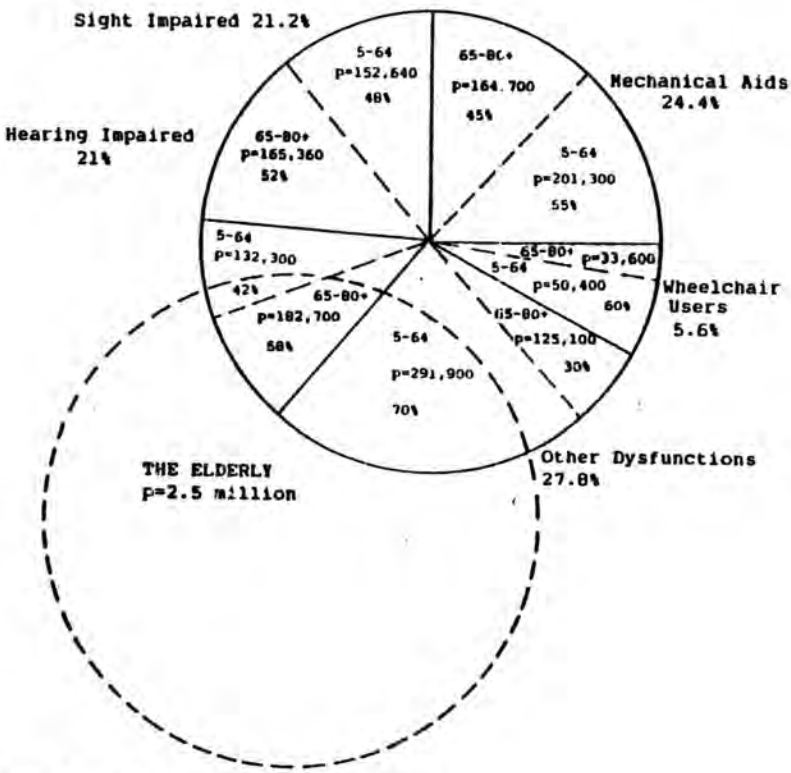
A handicapped person is one who suffers from a physical or mental

impairment that substantially limits his daily activities.[1] At present, the mentally ill (eg. paranoic, schizophrenic) are not included in this definition. There are approximately 1.5 million handicapped persons in Canada (8% of population). Transportation planners coined the term "transportation handicapped" (TH) to include all "persons who, because of specific permanent or temporary problems or incapacity, including aging, experience difficulty in using public transportation and are not homebound".[2] Figure 1 shows the composition of the TH. From the diagram two major groupings are evident: the physically handicapped (PH) and the perception and communication handicapped (PCH). The PH group includes wheelchair users and the ambulant disabled (those using crutches, braces, walkers, artificial limbs). The PCH group includes the sight-impaired, speech-impaired, hearing-impaired, and cognitively-impaired. This last category may be defined as people having difficulty in comprehending or communicating information as the result of brain dysfunctions or mental retardation. It should be noted that data on the above are difficult to obtain due to individuals having multiple dysfunctions and the lack of an appropriate database. The best available estimates on the various TH groups are as follows: 318,000 hearing-impaired TH with 182,700 (58%) over 65 years of age; 84,000 wheelchair-using TH with 33,600 (40%) over the age of 65.

The term "elderly" is used to refer to people over 65 years of age. The majority or 70% of the elderly are not considered transportation handicapped as such. According to Statistics Canada (1981 census),[3] 2.5 million people were 65 years or older in 1981; this number will likely increase to more than 3 million or 11% of the population by the year 2000.[4] The realization that Canada is an aging society takes on new dimensions in the context of transportation planning.

Aging means a slow but steady deterioration of cells, body functions, cognition and psychological processes. Thus, even an able-bodied 65 year old experiences barely perceptible physiological changes that will slow reaction time and decrease predictability, thus making regular transit more difficult to access. In most cases, by a persons's 74th year, memory will be less sharp than it used to be, sight, sound and tactile impressions will grow progressively less distinct, and muscular and skeletal coordination and strength will be more spastic and less reliable. In these aspects, the elderly can be considered as transportation disadvantaged, and their greatest problem

FIGURE 1 COMPOSITION OF THE TRANSPORTATION HANDICAPPED



Note: Population of TH is 1.5 million.

Source: Percentage estimates of group population given by Systems Approach Consultants Ltd., "Data Base Study for the Identification and Quantification of Transportation Handicapped Persons in Canada", TP 2049.

is coping with their deteriorating physical and psychological conditions.[5]

Canadian researchers have only started to study the transportation needs of the elderly in the past few years. Wolfe and Miller[6] proposed a classification system of the elderly which uses transportation requirements, lifestyles, and physical health as major variables. The elderly were classified into the following categories: institutionalized, sheltered and group housing, handicapped, independent-auto ownership; independent-no auto, dependent-access to auto, and dependent-no auto. A mobility continuum that takes into account desire/need for travel, physical condition, dependence on others, geographic location, and financial situation is created. Such a multivariate method contrasted with the two-variable approach noted by Wade.[7] The two-variable approach classifies the elderly into the "young-elderly" and the "old-elderly" based on the person's age and relative health: the young-elderly are between 65 and 75 and are in good health, while the old-elderly are 75 plus and have increasing health problems, thus reduced mobility. Conceptually, the multivariate approach is superior, but in practice difficult to develop because of data requirements. Also, its application to transportation issues remains to be seen. On the other hand, the two-variable approach is easier to apply, but does not take into account the steady decline in body functions which occurs in between the two age parameters.

Because the non-handicapped elderly population is more of an amorphous mass, various government agencies (Health and Welfare Canada, Transport Canada, and Ontario's Ministries of Housing and in particular Transportation and Communications) are studying their travel behaviour in order to derive meaningful solutions to meet their transportation needs. The following sections will attempt to show that the elderly, the PH and the PCH all have problems specific to their own group which should be addressed differently.

PLANNING CONSIDERATIONS

Planning transportation services for the E&H should be approached from the viewpoint of closely matching the needs of the users with the system supply characteristics and cost.

The physical layout of buildings, terminals for intercity modes

and vehicles pose the primary hurdle to the wheelchair-user and the ambulant disabled. In this regard, distances to be covered, horizontal and vertical architectural barriers, access to amenities (e.g., ticket counters, telephones and washrooms), and vehicles are variables to be considered. Barrier-free architectural and vehicle designs, and provision of loading devices, such as ramps and lifts, facilitate independent travel for the handicapped. The ambulant disabled, on the other hand, do not need to rely on lifting or loading devices to any great extent, but may require help when fatigue sets in. Simple operational improvements, such as preferential seating, grab-bars, ramps, buses with low floor heights could alleviate their problems significantly.

Perceptual and communication barriers are more of a problem to the sight, hearing, speech, and cognitively impaired. This group perceives information retrieval and orientation problems as primary obstacles in using transportation systems and physical effort as only a secondary consideration (e.g. a blind person cannot orientate without aid, but is able to walk unhampered).[8] Transportation providers are only beginning to pay attention to improvements such as more legible signs, communication aids for the hearing-and speech-impaired, and tactile or audio cues for the blind. The non-handicapped elderly would also profit from elimination of physical, perceptual and communication barriers in all transportation modes.

Demographics and travel behaviour of the E&H have implications for the type of transit service required. It is known that 70-75% of the PH reside in urban rather than rural areas. The more severely handicapped persons tend to concentrate in urban areas, probably because of accessibility to services. Similarly, the elderly population is concentrated in the most urbanized provinces.[9] According to a 1976 census, 36% of the elderly reside in Ontario and 27% in Quebec. Preference for large cities is illustrated by the fact that 50% of the elderly live in or near cities with population of 100,000 or greater, and another 20% live in small cities, as contrasted with 30% living in rural areas. Corresponding information is not available for the PCH; because physical barriers are not as important to them, one could assume that geographical limitation has less relevance.

It is fair to state that the transportation service most urgently required for the E&H is accessible urban transit due to their large

urban concentration. Table II summarizes the major perceived travel barriers for the E&H. It appears from this table that the most convenient transit modes are taxis and private autos. The preference for autos is borne out in Table III; low usage of taxis can be attributed to the high cost involved.

TABLE II

MAJOR URBAN TRAVEL BARRIERS FOR THE E&H

BARRIERS / MODE	PEDESTRIAN	CAR	TAXI	METRO	TRAIN	BAG	PARALLEL TRANSIT
- Long walk	-	X	X	-	-	-	X
- Physical obstacles (curbs, slopes, stairs)	-	X	X	-	-	-	X
- Information displayed poor	-	X	X	-	-	-	-
- Insufficient seating	-	X	X	-	X	-	-
- Rapid acceleration/declaration	X	X	X	-	X	-	-
- Poor service/schedules	X	X	X	-	-	-	-
- Poor location of stops	X	X	X	-	X	-	X
- Poor driver attitude and assistance	X	X	X	-	-	-	-
- Insufficient shelter	-	X	X	X	X	-	X
- Inflexible routes	X	X	X	-	-	-	X
- Advance booking required	X	X	-	X	X	X	-
- Lack of audio-visual cues	-	X	X	-	-	-	-
- Cost too high	X	-	-	X	X	X	X
- Maintenance required	X	-	X	X	X	X	X

Legend: - barrier exists
X not applicable

TABLE III

TRAVEL MODE OF THE E&H

MODES	TRANSPORTATION HANDICAPPED(1)	ELDERLY(2)
Car		
- as driver	35.0%	47.8%
- as passenger	32.0%	15.8%
Public Transit	10.0%	32.2%
Taxi	3.0%	2.5%
Special Service	2.0%	-
Walking	7.0%	1.4%
Other	6.0%	.3%
Undefined	5.0%	

(1) From "A Review of Urban Transportation Services for Disabled Persons", 1982. By Hickling-Partners Inc.

(2) 1979 Metro Toronto figures based on Wolfe and Miller.

Several studies indicate that the majority of trips undertaken by the elderly are of short distance, generally less than 1 hour travelling time, and have as main destinations social and recreational centers. Also, overall average trip rate has been documented at 1.5 trips per elderly per day, as compared to 2 trips per day for working PH and 3-4 per day for an able-bodied person. Table IV illustrates trip purposes for E&H.

TABLE IV
TRIP PURPOSES OF THE E&H

PURPOSE	TRANSPORTATION HANDICAPPED(1)	ELDERLY(2)
Work	17%	13.8
Shopping/personal business	32%	31.6
Leisure/recreation	27%	37.5
Medical/Therapy	10%	
School/Education	9%	5.6
Other	5%	11.6

Note: Purpose categories were assigned in order to ensure the best comparative grounds.

(1) From "A Review of Urban Transportation Services for Disabled Persons", 1982. By Hickling-Partners Inc.

(2) 1979 Metro Toronto figures based on Wolfe and Miller.

This table demonstrates that the TH person is more work and school orientated than the elderly, but less apt to travel for shopping and leisure purposes. It is believed that a major reason for this discrepancy relates to the elderly's attitude toward the pace of life. The elderly, having been removed from the work environment, learn to take life at a more leisurely pace and need social distraction to occupy time; the physically handicapped, on the other hand, tend to make a minimum of social/recreational trips, in order to avoid physical barriers and discomfort. Bearing in mind the most utilized travel modes for the E&H, one must conclude that the elderly have more flexibility in scheduling trips and are willing to put up with long travel time if level of comfort and certainty of schedule are ensured.

Income of the E&H is a variable that must not be discounted in transportation planning. According to Statistics Canada[10] the single elderly earned less in pension than low-income individuals, $,5092 and $5,957 respectively, and elderly couples earned slightly more than low-income couples, $9,015 as compared to $8,638. (No similar data are available for the TH population, however, general agreement between

transportation and social service agencies indicates that their income would be similar if somewhat higher than that of the elderly.) Such low incomes necessitate inexpensive transportation modes, thus, autos and taxis become highly luxurious items and the bus, despite its many shortcomings, is more affordable. An unfortunate fact to note is even though the E&H would benefit most from a private auto and are statistically safer drivers, banks and other financial institutions rarely give loans to people 65 years of age and over or to the physically handicapped; car ownership, therefore, is often unfeasible.

At this point, it should be noted that the Canadian elderly population capable of gaining access to a car, as driver or passenger, is less than 50%, for the PH this percentage drops to about 35%. It is thought that these percentages represent the total segment of the E&H population who have learned to drive. Since the automobile has always been costly, the low percentages of car ownership and lack of opportunity to learn to drive of the E&H are understandable. Consideration should be given in future time to the "baby-boom" generation, which boasts a driver population greater than 70%. The implications of this will be treated later.

From the providers point of view, the costs associated with making a national transportation system accessible to all citizens after the system is in place quickly reach astronomical levels. The anticipated program cost for the implementation of Regulation 504 in the U.S. is a perfect example, the overall 30-year cost exceeds 6 billion dollars; and yet it is expected that only 7% of that country's handicapped population will benefit from increased access.[11] Perhaps factors such as cost and expected benefit for the target population are responsible for the 1981 ruling that rescinded accessibility plans, an action which seems to show that a more flexible scheme is called for.[12]

In Canada, the socio-economic situation is such that full accessibility for all citizens lies quite a few decades in the future. The impact of the economic situation can be seen by cutbacks in vital transportation services in rural areas and in small and large cities. VIA Rail's elimination of rail services in 1982[13] and the Montreal Urban Community Transit Commission's[14] phasing out of a major bus route and curtailment of 3 others exemplify this cost squeeze.

Despite the increasing costs of transportation services, providers cannot disregard the needs of the E&H for they are a verbal and powerful minority. Consumer movements began in the mid 1970's as disabled citizens banded together in social and political groups to promote equality for the handicapped in employment opportunities, transportation services and facilities, and human rights. The Coalition of Provincial Organizations of the Handicapped (COPOH) is an example of one such consumer group. A more recent movement called "Grey Power", urges the elderly to voice their concerns and lobby for action.

Transportation providers thus get caught between the anvil and the hammer. On the one hand, the costs of making retroactive modifications to vehicles and terminals are prohibitive and the overall efficiency or value of such modifications is dubious. On the other hand, not making terminals accessible could mean a future loss of revenue by not taking into account potential E&H travellers and, in the present, the number of already established clients could decrease if accessibility plans are not continued.

A gradual phasing-in of accessibile facilities would help mitigate the high costs of retrofitting, and vast expenditures such as those estimated for the Calgary Light Rail Transit's plans to make some stations accessible to E&H users.

PRESENT SERVICES FOR THE E&H

Canada, like most other countries in the world, began to recognize that the E&H required adequate transportation to meet their specific needs about a decade ago. With this recognition, private and public research and development agencies concentrated their efforts to develop systems and devices that would aid this population. Two solutions emerged rapidly: special passenger rates and parallel transit systems.

The notion of special transportation services (and considerations) for the E&H population is relatively new, having arisen only with the recent realization that the E&H represent a major portion of the Canadian population. Reduced fares or complimentary passes for the elderly are now offered by most public transit authorities and similar provision for the handicapped is offered by most intercity transporters.[15] Few public transit services, however, offer lower rates to the physically handicapped.

For the PH persons living in an urban environment, reliable and inexpensive transportation which decreases contact with physical/ architectural barriers is of paramount importance. As regular city transit is generally inaccessible, owing to vehicle configuration, fixed routes and distance considerations, two transportation modes are the most popular with this group: the parallel transit system and the taxi.

Both of these systems offer door-to-door service, and can be differentiated mostly on the level of demand responsiveness; the taxi being rapid in responding, whereas the parallel transit vehicle usually requires advance booking, often in excess of 24 hours. The difference in response time can be attributed to the fact that taxis serve exclusive rides while highly specialized parallel transit vehicles must serve a population whose demands greatly exceed vehicle availability and must, therefore, set trip priorities.

Parallel transit is a practicable means of accessible transportation, and for this reason is found in virtually all Canadian cities. Much as regular transit, it is subsidized in most municipalities in order to minimize costs to users. Only three Canadian cities, Toronto, Calgary, and Vancouver,[16] recognize the use of taxis to transport the handicapped, and subsidize such use according to a parallel transit formula.

The communication impaired, although only recently targeted for R&D work, will be better served by transportation providers, owing to rapid scientific advances in communication technology. For the blind, tacticle maps, symbols and texts, and audio-announcement systems are increasing availability of information. For the deaf, information comprehension is increased with the use of the "visual-ear" telephone, telephone adapters for hearing aids and devices which increase a telephone's sound output. The mute or speech-impaired can now communicate information with the "visual-ear", speech synthesizers and the artificial larynx. Many transportation providers are already removing communication barriers by having special communication devices available for their clients.[17] Little work, however, has been undertaken for the cognitively handicapped and for those with multiple communication impairments. It is believed that standardized and easily recognizable signs and information sheets which are simple, yet give comprehensive information, would be of aid to the cognitively

handicapped. They have yet to be proven in tests however. As for persons with multiple communication impairments, little can be done or offered as both transportation and communication R&D components have not, as yet, investigated their requirements fully.

The elderly, apart from those with mobility problems are not eligible to use parallel transit systems. They must use regular transit, because there are no transit services dedicated exclusively to the able-bodied elderly in Canada, with the exception of those provided by service or voluntary organizations.

The removal of architectural barriers and the provision of sensory cues in a transportation environment are also of great benefit to the elderly. However, much as with the communication impaired, the transportation problems of the elderly with cognitive impairments and multiple communication disorders have not been addressed. Such factors as decreasing memory and attention spans, health, tolerance and a host of other problems complicate matters and serve to illustrate just how complex the problem actually is.

Another issue is the provision of transportation services in small towns and farm areas which, as a rule, have little or no public transit. Existing services are usually inadequate because of infrequent schedule, fixed routes, and greater travel distances. While inadequate service poses problems for the able-bodied these problems are intensified for the E&H. As a result, the primary transportation modes in these areas for the E&H are personal vehicles and taxis.

Few empirical studies have been performed in rural/farming environments. A notable exception is the "Mobility-Club" study which Transport Canada launched in 1978.[18] The experimental mobility club enlisted the services of volunteer drivers with private autos and, through centralized coordination, matched driver trips with passengers. Although the 17-month test failed to create a centralized coordination centre, it spawned five activity-specific mobility clubs spontaneously organized by small groups and service organizations. There was, therefore, a perceived need for such a service.

The E&H generally perceive intercity transportation (air, bus, rail) as less problematic than urban transit because fewer vehicle transfers are required. Generally speaking, two problems areas have been identified with intercity transit: information gathering in the terminal and entering the vehicle. A third problem, reaching the

terminal, is not considered proper to intercity transportation modes, but rests mostly on the systems that reach those terminals.

Provisions for dealing with architectural and sensory barriers impeding the E&H and the PCH in terminals have been discussed earlier. In-vehicle provisions for various types of handicaps are considerable, but mostly address the problems of the physically handicapped, both young and elderly. In the air mode, many airlines offer assisted pre-boarding services and narrow transfer chairs for the wheelchair user. A more recent development is the purchase of Boeing 767's by major Canadian airlines; the 767's are considered more accessible than other aircraft, as they have an accessible washroom and some movable aisle arm rests. Many airlines have also implemented policies to ensure that their personnel understand and can aid handicapped passengers.

VIA Rail, the national rail passenger-carrier, also has special personnel training programs. Accessible washrooms, dedicated wheel-chair stations with securement systems, specially designed food trays and eating utensils are all features of the new LRC coach.

The bus mode has undergone the fewest changes, owing to vehicle limitations. Major problems of inaccessibility are the narrow door-ways and the high floors, both of which are difficult to modify. Lowering the bus floor would incur the loss of cargo area in the bus's lower section. Colonial Voyageur recently announced that they plan to offer manual boarding assistance to PH travellers at selected terminals.[19]

For all intercity modes special concessions have been made for the PH and the PCH, enabling attendants, if required, to travel with them at reduced or no costs. However, in-vehicle provisions for the PCH remain relatively few.

The transportation services provided for the handicapped and the elderly in Canada must be comparatively evaluated with those in other countries in order to gauge our relative weaknesses and strong points. Similarities with Canada, on-going cooperative R&D and information-sharing lead to the choice of the U.S. Table 5 compares Canadian and American achievements in service provisions for the elderly, communication and physically handicapped.

As can be seen in this table, both nations have interpreted the transportation problems of the E&H along similar lines. The main differences are that the U.S. stresses integrated service while Canada

has adopted the parallel transit option. This may be explained by the fact that the Urban Mass Transit Administration (an organization for which there is no Canadian equivalent) has the financial ability to lever and assist in the implementation of the U.S. program. Differences between the two countries in type of service (eg. more integrated services in U.S.) and equipment (eg. kneeling buses, lifts in city buses, more accessible terminals in the U.S.) reflect the national differences in problem solving.

TABLE V

Canadian and American Transportation Interventions

(achieved through American and Canadian Literature Search)

Transportation Interventions	CAN. (E)	US. (E)	CAN. (PH)	US. (PH)	CAN. (PCH)	US. (PCH)
- Overall accessibility goal *	Ext.	Ext.	Ext.	Ext.	Ext.	Ext.
- R and D components	Sta.	Mod.	Str.	Str.	Sta.	W.
- Subsidized - paratransit	N.Ex.	Mod.	Str.	Str.	Str.	Str.
- regular transit	Str.	Str.	Mod.	Str.	Mod.	Str.
- taxis	V.W.	Mod.	W.	Mod.	W.	Mod.
- Kneeling buses	V.W.	Str.	V.W.	Str.	V.W.	Str.
- Parallel transit/dedicated	W.	M.Str.	Str.	Str.	Str.	Str.
- Integrated transit	N.Ex.	V.W.	N.Ex.	V.W.	N.Ex.	V.W.
- Modified buses/vans	n/a	n/a	Str.	Str.	n/a	n/a
- Mechanical aids (transport)	Mod.	Mod.	Str.	Str.	n/a	n/a
- Mechanical aids (communications)	Sta.	Sta.	Mod.	Mod.	Sta.	Sta.

Ext.: Extensive
Sta.: Starting
Mod.: Moderate
Str.: Strong

W.: Weak
N.Ex.: Non-Existent
V.W.: Very Weak
M.Str.: Mid-Strong

* NOTE: Both nations have extensive accessibility goals, however these goals are formulated to target on the physically handicapped. The elderly and communication handicapped are included under the general PH category.

In the U.S., as a direct result of food stamp programs for low-income people, transportation subsidies for both the elderly and the handicapped are quite common. The goal of such subsidy programs is to reduce overall transit costs for the user, while ensuring that transportation providers receive the same fare as they would from

regular users. The subsidy methods most preferred are discounted. tickets and vouchers for charge slips. In both instances, the user pays a portion of the fare, while the city (or other agency) pays the remainder. Perhaps the point most worthy of note is that user-side subsidy has been applied not only to mass public and parallel transit, but, in some cities, to taxis as well. Indications are that these programs are successful and will be expanded.[20]

To conclude, the elimination of physical and communication barriers will not only serve the intended target handicapped populations, but it will also be of great importance to the elderly; it can be argued that barrier elimination would also aid able-bodied persons. The transportation restrictions of the physically handicapped are now well-documented and plans of action are underway. The needs of the elderly, the communication and cognition-impaired, however, are not well understood and require study.

It seems that the U.S. is quite a bit ahead of Canada in system and device provisions to aid its E&H population. Regulation 504 was a major factor contributing to the American lead for it defined the problem, set out possible solutions and set a deadline for implementation. This reflects the notion that accessible transportation is the right of all citizens. The Canadian Human Rights Act, a more recent document, also states that accessible transportation is the right of all citizens. However, the actual wording of the document (ie. right of access to all individual citizens or to citizens as a group) is still subject to interpretation.

MEETING THE TRANSPORTATION CHALLENGE

Future advances in medicine will continue to increase life expectancy including that of the E&H. Since the "baby-boom" generation will be senior citizens in the year 2000, transportation providers should anticipate the corresponding increase in transportation needs.

Pedestrian traffic will require attention, as streets are often designed primarily with the flow of vehicular traffic in mind. Two studies, one Canadian[21] and the other British,[22] show that the elderly are involved in three times as many pedestrian accidents as are younger generations. It is estimated that about 18% more elderly persons than

today will be pedestrians by the year 2000;[23] it is likely that the rate of accidents for this group will also increase.

Modifications in overall urban planning will be paramount in pedestrian safety. Examples of these are listed below.

- Reduce inner city speed limits to 30 km/h. This will allow drivers to maintain greater vehicle control and will reduce maximum braking distance, thus giving drivers more reaction time if a pedestrian is caught in the middle of the street.
- Increase the number of controlled intersections, especially on major streets, so that people will not be tempted to jaywalk. Ensure that such pedestrian signals are equipped with audio-visual cues and are timed to allow slow pedestrians to cross safely. An alternative remedy is the installation of pedestrian signs similar to traffic lights which display a "go", "wait" and "stop" sequence, and utilize large and easily recognized symbols. These signs should be highly visible and standardized so that all controlled intersections have the same kind of signal. Audio cues should also be considered for persons with weak vision or colour blindness. Educating the public in the proper and safe operation of these devices is also necessary.
- Time traffic signal phasing to be more consistent with the slower reaction time of elderly pedestrians. At present signals are phased to give a pedestrian only 14 seconds to cross major streets.[24]
- Driver education to increase awareness of the needs of elderly and PCH groups is considered vital to the reduction of accidents.

Approximately 60% of today's adults know how to drive a car; by the year 2000, this will increase to approximately 75%. A further breakdown of the driving population shows that 35-40% of the E&H drive and this number is expected to increase to 50%.[25] In this regard, motor vehicle developments and vehicle regulations are important issues for the E&H. The sight and cognitively-impaired are non-drivers and are excluded from the following discussion.

- Vehicles should be economical to purchase, operate and maintain. Further, the vehicles should be small and easily modified for the wheelchair user.
- Various speed and directional control devices should be developed for

persons with differing types of handicaps. A rear-view mirror that eliminates all blind-spots should be developed. Better and more secure restraint systems should be developed and tested. More comfortable and adaptable interiors should be designed.

Vehicle regulations may also change. At present, the Province of Ontario, which has the most stringent traffic regulations, has few restrictions concerning elderly drivers. Only after the age of 80 does it become necessary to pass written and road tests to renew a driver's licence in Ontario.[26] However, due to E&H population increases it can be expected that pressure will be applied by society upon the provinces to decrease the mandatory testing age to 70 to ensure that elderly drivers do not cause excessive hazards on the road. Additional tests consisting of vision, reaction and psychological measurements will probably be required as well.

For the E&H who have driving ability but cannot afford automobiles, the shared-vehicle fleet concept could be appropriate. Such a concept requires setting up a cooperative car ownership or rental service, which would allow the E&H to go to a depot to rent or book a vehicle. Situated every 4 square kilometres, car depots with fleets of one vehicle for every 4 to 6 drivers would be ideal since most people, including the elderly, find a 2 kilometre walk tolerable.

A similar notion is the car pool as we know it today. E&H drivers would volunteer to drive others to their desired destinations. Some sources of problems in such services are supply of willing chauffers, scheduling of trips and number of passengers.

In rural and farming areas, shared taxis and vehicle fleets would help to make travel less difficult. "Brokerage" systems,[27] which provide for the coordination and management of funding of volunteer van drivers, and mobility clubs are also suggested for the future.

A more cost-efficient device for short-distance travel may be useful. Powered tricycle-like vehicles such as the Happy Wanderer and the Cycle Chair are both versatile and easy to control, as well as fairly inexpensive (approximately $1,000 U.S. per unit).[28] They are ideal inner city transportation vehicles, having travel ranges between 24 and 32 km, speeds between 7 and 23 km/h and the ability to climb curbs. Such devices would certainly serve to decrease dependence on public transit for social and shopping needs, and decrease physical discomfort caused by prolonged walking.

Current bus technology is adequate to meet the present needs of the E&H, although a small, heavy-duty transit vehicle (14-20 passengers) at a reasonable price is not yet available on the market. The future, it is believed, will see a lowering of vehicle costs as the result of greater demand. The use of vehicles such as the kneeling bus and the low floor bus (Steyr City Bus), with the steps either eliminated or reduced in height, is expected to increase. The addition of more strategically placed grab-bars, more comfortably designed seats, reserved seating, and better suspension should be planned for. Other perceived modifications include delaying the closing of vehicle doors and driver education courses stressing the need for gradual acceleration and deceleration, both measures relating to passenger safety.

Transit operational improvements such as timed bus transfers, door-to-door services as now offered widely in parallel transit systems and computerized dispatching can eliminate uncertainty in bus arrival.[29] Also, subsidized bus and taxi fares for the elderly should be seen as a future trend.

Parallel transit devices will assuredly be seen extensively in the future, as the cost of totally integrated transit is prohibitive. Proposed modifications include service and vehicle variables. To reduce pick-up/drop-off time, present computerized booking and dispatch systems should be perfected, drivers should be educated in E&H service requirements and parallel transit operators should be taught how to make effective use of available resources. Suggestions for vehicle modifications would include a seating arrangement accommodating 4-6 wheelchair-users and 8-10 ambulant passengers, better and more rapid lifting/loading devices, lower vehicle floor heights and more spacious interiors with careful attention to higher roofs, thus allowing more "headspace". Transport Canada's Transportation Development Centre recently published a study on the ideal "Transit Vehicle for the Disabled".[30] The study defines vehicle requirements, assesses the market potential and develops specification guidelines.

Commuter trains and subways will require the same vehicle modifications as buses, but the greatest barrier to their use is the terminal proper. For the PH, elevators and escalators, rather than stairs, and moving sidewalks should be installed in order to cut down lengthy walking distances. For the PCH, ease of ticket purchase, avoidance of crowds, clear and visible information boards

and pamphlets, and multi-media announcement systems are stressed.[31]

For all intercity modes, in-vehicle information on itinerary, service disruptions, etc. should be delivered in audio and visual modes to accommodate a large population of PCH travellers. Such communications are now being provided by the Toronto Transit Commission through its "Automatic Station Stop Announcement System"[32] which can be modified for use by other transit modes. This system relies on transponders located in the tracks to communicate with the subway train's on-board computer equipment, thus announcing the name of the next stop. Transportation Development Centre has undertaken a project to develop a similar station-based audio-visual transit information system for the Montreal subway.

Other changes to intercity vehicles and terminals would include adding tactile strips or texts to indicate seat location and evacuation or other procedures, a direct voice channel between passenger and driver/conductor/ pilot, more comfortable seats, removable seating to allow for wheelchair securement stations and more aisle space.

Finally, a totally different approach to alleviate physical exertion in travelling is substitution, which eliminates the need for transportation altogether. Systems such as Telidon, Pay T.V., and Dial-An-Order will enable the E&H to shop at home and have parcels delivered. The service-at-home concept is also gaining greater acceptance and support in the social and health care communities; trips by the E&H for medical care and social support would be drastically reduced if such at-home services were implemented.

This section has proposed transit system and device modifications to aid the E&H of the future. Such modifications are seen as falling into two distinct areas: modifications that facilitate access to vehicles and systems (assistance schemes) and those that minimize the user's need for transportation (substitution). Areas that remain relatively unknown have to do with the PCH, especially those with cognitive difficulties and multiple sensory impairments.

CONCLUSION

The total cost of making transportation services accessible to the E&H and the PCH is staggering, especially if retroactive modifications are required. A sensible approach to be pursued by

transportation providers should be the gradual phasing-in of accessible facilities and services as they become available. In future, terminals and vehicles should be designed for accessibility from inception; in this way, the need for retrofitting may be avoided. Other required measures, such as driver courtesy and preferential seating, are operational improvements that will not incur great costs.

Research and development costs and efforts will certainly also increase to meet the unstudied needs of the PCH and the elderly. Communication and transportation agencies should pay special attention to the problems of cognitively-handicapped and multiple-communication-impaired persons. Cooperative efforts between various public and private agencies would help make R&D costs more manageable and would allow multidisciplinary input, thus allowing for more global planning.

Owing to the predicted increases in E&H drivers, appropriate vehicle licensing regulations should be implemented by all provinces. These regulations should not be restrictive, but should be capable of weeding out drivers (E&H and able-bodied) who may be hazardous due to physical, sensory, or cognitive failings.

Rural transportation should be seen as a concern for all citizens as distance and isolation compound the problem of inaccessible transit. System concepts such as shared fleets and mobility clubs should be made operational in areas where statistics show the elderly population increasing.

Finally, urban transportation should be recognized as the most important transportation component for the E&H. In this regard, urban planning consideration should go hand in hand with transportation planning for the E&H.

REFERENCES

1.(2.25) Database Study for the Identification and Quantification of Transportation Handicapped Persons in Canada. Transport Canada, 1979. TP2049

3.(4.10) Canadian Governmental Report on Aging, Health and Welfare Canada, Catalogue No. H21-89/1982E. Canada, 1982.

5. Revis, J.R. Transportation Problems of the Elderly and Handicapped: An Overview of U.S. Experience. Proceedings of the International Conference on Transport for the Elderly and Handicapped at Cambridge, April 4-7, 1978. Edited by Ashford, N. and Ball, W.G.

6. Wolfe, Robert A. Miller, Eric J., Long-Range Transportation Planning for Seniors in Ontario. Paper submitted for the 62nd meeting of the Transportation Research Board, Washington, D.C., 1982.

7.(23) Wade, P.E., Elderly Transportation Technology. Boston Henry Quinn Associates, Ltd. Toronto, Ontario 1983.

8. Rutenberg, U. and Barber M. Travellers with Special Needs: Facility Design Compendium. Les Designers Douglas Ball Inc., Ste-Anne-de-Bellevue, Quebec, 1982. TP3608E

9. 1976 Census of Canada. Statistics Canada, Catalogue No. 92-823. Ottawa, 1976.

11. Cargill, J. and Fielding, G.J., Mobility for the Handicapped: Case Study in Public Policy. University of California, Institute of Transportation Studies. California, U.S.A. 1980.

12. Status of Special Efforts to Meet Transportation Needs of the Elderly and Handicapped. General Accounting Office, Washington D.C., U.S.A. 1982.

13. Nouvelles coupures possibles à VIA Rail. La Presse, Montreal, newspaper article. October 30, 1981.

14. Bus Cuts Spark West End "Grey Power". The Gazette, Montreal, newspaper article. April 2, 1983.

15. A Review of Urban Transportation Services for Disabled Persons, Hickling-Partners Inc. Ottawa, Ontario, 1982.

16. Urban Transportation Research Branch Directory, Transport Canada. TP2185, 1979.

17. Transportation in Canada: A Guide for Travellers with Special Needs (TP380). Transport Canada, 1982.

18. The Mobility Club Concept in Rural Areas: A Demonstration Project in Huron County. (TP2646). Hickling-Smith Inc. for Transport Canada, 1980.

19. Colonial Voyageur Press Release. April 1983.

20. Sahaj, L. Recent U.S. Experience with Transportation Service Innovations for Elderly and Handicapped Persons: User-side Subsidies, Accessible Transit and Coordinated Services. Proceedings of the International Conference on

Transport for the Elderly and Handicapped at Cambridge, April 4-7, 1978. Edited by Ashford N. and Bell W.G.

21. Canadian Automobile Association, Special Study of Senior Citizen Pedestrian Accidents, Pedestrian Safety Report, 1972.

22. Hopkins, J., Robson, and Town, S. Transport and the Elderly: Requirements, Problems and Possible Solutions. Transport and Road Research Laboratory, Supplementary Report 419, Berkshire, England. ISSN 0305-1315, 1978.

24. Pignatoro, L.J. Traffic Engineer's Theory and Practice. Englewood Cliffs, N.J. Prentice-Hall, 1973. ISBN 0-13-926220-2.

26. From a telephone conversation with an employee of the Ontario Ministry of Transportation and Communication, Licensing Department. April 1983.

27. Transportation Needs of Rural Elderly and Handicapped Persons, Tait, J. Article in Rehabilitation Digest, Volume 14, Number 1, Spring, 1983.

28. Smith, B.A. and Nishizaki, R.S. Compendium of Transportation Equipment for Disabled Persons (TP3618E). Transport Canada, 1981.

29. Computerized dispatching. TDC project, estimated termination date, Fall 1983.

30. Transit Vehicle for the Disabled. DeLeuw Cather Canada Ltd. for Transport Canada.
- Phase I: Definition of Requirements (TP3523). 1982.
- Phase II: Market Assessment (TP3847E). 1982.
- Phase III: Specification Guidelines (TP4195E). 1983.

31. Adam, W. Low Capital Improvements in Access to Public Transport for the Disabled. North Sydney, Australia study. 1979.

32. Toronto Transit Commission, Subway Train Automatic Station Stop Announcement System. Plant Department, 7-105-90. 1982.

RECOMMENDED READING

1. Transportation Requirements for the Handicapped, Elderly and the Economically Disadvantaged. Transportation Research Board, National Research Council. Washington, D.C., 1976.

2. Ulrich, E. and Everett, C. Elderly Mobility and Transportation Services: Some Survey Evidence. The Urban Institute, Washington, D.C. 1981.

3. Metter-Meibon, B. Mobility and Handicapped Persons. Economic Research Centre, Paris, 1980.

4. Hopkins, J. etal. Aspects of Mobility for Old People: Preliminary Results. Transport and Road Research Laboratory. Crowthorne, England. 1976.

5. Innovations in Public Transit. U.S. Department of Transport, Urban Mass Transit Administration. UMTA-MA-06-0086-82-1. 1982.

6. Blethrow, J.G., Garner, J.D., Lowrey, D.L., Busby, D.E., Chandler, R.F., Emergency Escape of Handicapped Air Travellers. Prepared for the Department of Transport, Federal Aviation Administration. Washington, D.C., 1977.

7. Communication Aids for Travellers with Sight/Hearing/Speech Disabilities (TP3941E). IBI Group. Prepared for Transport Canada. 1982.

WESTERN RAIL CAPACITY REQUIREMENTS

THE GRAIN INDUSTRY'S REQUIREMENTS FOR RAIL CAPACITY

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Abstract

This paper describes the development and the inter-relationship of the railway and the grain handling system in Western Canada. It describes some of the distinctive characteristics and needs of the grain industry relative to transportation. It deals with future requirements in terms of volume of products to be moved and suggests some of the areas where change and improvement is needed to achieve an effective and efficient movement of product from the Prairies to export ports.

Introduction

For nearly 100 years the fortunes (and misfortunes) of the grain industry and the railroads have been tied closely together. I want to deal first with some of the historical developments and relationships, and then move on to discuss the present and the future.

Railway Development

Railroad development in the Prairie provinces began with the building of a line from St. Paul and Chicago to Winnipeg in 1878. Five years later, the CPR line was built north of the Great Lakes to connect Winnipeg with Central Canada. In 1882 the construction crews passed through Regina and by 1885, the CPR transcontinental line

was completed to the Pacific coast. Most of the historical records of that period suggest the main purpose for constructing that transcontinental line was to entice British Columbia to join with Upper and Lower Canada and the Atlantic provinces to form a new Canadian nation "stretching from sea to sea". While that was certainly a primary objective, there were other reasons supporting completion of the line. There was a need to generate traffic to cover the costs of constructing and operating a line which ran through the unpopulated rock and bush land north of Lake Superior and then across the empty prairies and through the Rocky Mountains. The intent was to encourage settlement of the western plains as rapidly as possible. This would create in-bound traffic of settlers' effects and supplies. When settlement had been completed, there would be grain and other farm products for the railway to haul, and the hinterland economy would provide a ready-made market for the manufactured products of the infant, tariff-protected industry in Central Canada. A further objective for construction of the transcontinental railway was to cut off any potential northward penetration of U.S.A. railroads into the area west of the Great Lakes. When completed, the CPR main line would provide an effective barrier close to the 49th parallel of latitude. The CPR and the federal government shared in these objectives, and they shared the efforts to attract settlers from Europe, U.S.A. and Ontario.

By the year 1900, the Province of Manitoba and the Northwest Territories had a total of 3716 miles of railroad

line, and total production of wheat in the west amounted to 136,000 tonnes (or about five million bushels).

During the next few years, railway building and immigration on the prairies continued at a rapid pace and by 1914 there were nearly 12,000 miles of railway track in what is now the Prairie Provinces. Between 1900 and the outbreak of World War I, about a million and a quarter immigrants came to the prairies and grain production increased accordingly. The wheat crop in 1915 reached nearly 10 million tonnes.

Railroad construction continued at a slower pace during the next ten years or so, but accelerated again during the period 1926-30. At the end of that time, the total rail network in the prairies had been virtually completed. The table below shows the growth in railway mileage and in rural population in Saskatchewan from the turn of the century to 1936. I think the trends in the provinces of Manitoba and Alberta would be similar.

Year	Railway Mileage	Rural Population
1901*	962	77,013
1906	1,951	209,301
1911	3,121	361,037
1916	5,378	471,538
1921	6,296	538,552
1926	7,267	578,206
1931	8,268	630,880
1936	8,624	650,522

* railway mileage is for 1900, population is for 1901.

At the time when railroad building in Western Canada was most active, the directional emphasis was all toward the east. Supplies and manufactured goods came almost entirely from Central Canada. Markets for Canadian grain were primarily in Europe. The construction activity it-

self moved generally from east to west and spread out in a fan-shape from the main lines of the CPR, the Canadian Northern and the Grand Trunk Pacific railways. For these reasons, it is not surprising that the rail network in the Prairie provinces is shaped somewhat like a funnel with its narrow end at Winnipeg. At the time, this accommodated a natural directional flow for the distribution of goods coming into the prairie area and, in reverse, for the assembly of grains destined for Thunder Bay, or livestock destined for Winnipeg.

Directional Shift

With the passage of time there has been a significant shift in much of that rail traffic. In the last 20-25 years, countries in the Pacific Rim have become very important markets for Canadian grain as well as for coal, potash, sulphur and other products. New handling facilities have been constructed at Vancouver and Prince Rupert to accommodate the increased volume of these commodities. When one considers total movement of grain from the prairies to both export and domestic destinations, approximately 45 per cent now moves through Pacific Coast ports and the remaining 55 per cent through Thunder Bay and Churchill.

Population growth and industrial development in the future are expected to increase still further the importance of Pacific Rim markets for Canadian grain, and a new grain terminal is under construction at Prince Rupert to accommodate this volume. It would be natural for grain

from Alberta and most of Saskatchewan to move westward in future to fill this expanding market but, in some cases, the funnel shape of the rail network does not readily accommodate this directional flow. A number of fairly substantial back-hauls are involved before the grain reaches a main line west-bound.

Elevator System Development

As a result of encouragement by the railroads, construction of primary elevators and flat warehouses for grain took place at a rapid rate prior to the turn of the century. By 1901 there were about 400 elevators and nearly 100 flat warehouses on the prairies, with total capacity for about 325,000 tonnes (13 million bushels).

Even more rapid growth occurred in the ensuing period and by 1924 the number of elevators had reached 4,203. Because grain delivery was made by team and wagon, elevators were located at intervals of only a few miles on track, and were quite small in terms of today's standards. About 1933, the number of elevators reached its peak at 5,746. Elevator numbers have declined very substantially since that time, but total storage capacity has increased until fairly recently. The table below shows changes in numbers of elevators and in total capacity to the present time.

Number and Capacity of Country Grain Elevators - Western Canada

Year	Number of Elevators	Total Capacity (million tonnes)
1914	2,746	2.2
1924	4,203	3.5

Year	Number of Elevators	Total Capacity (million tonnes)
1933	5,746	4.8
1943	5,537	4.8
1953	5,324	8.0
1963	5,178	9.1
1973	4,383	9.2
1982	2,934	8.1

Elevator System Consolidation

There is a widespread misconception in some parts of Canada that the primary grain handling system has not changed since the days of the horse-drawn wagon, that the elevator system is inefficient and ready to collapse. This is not borne out by the facts.

The most rapid consolidation of the elevator system has taken place since about 1971. Older and low-volume elevators are being closed. New elevators are less numerous but they are larger, have faster handling equipment and space to spot larger numbers of rail cars. Some recent experimentation has produced entirely new designs which have the potential for even faster loading operation.

The following tables show the extent of change which has occurred in the elevator system in Western Canada in the last ten years.

There is every indication that numbers of elevators will continue to decline in an evolutionary fashion. A major study carried out in 1978-79 by Booz-Allen, Hamilton and the IBI Group, estimated there would be about 2,600 elevators in use by 1985. It is expected that grain volume will continue to increase, so total storage capacity may remain constant or may increase. The study concluded the primary elevator system was not a limiting factor with

Company	August 1/73	April 1/83	Decrease	Percentage Decrease
		Number of Elevators		
Saskatchewan Wheat Pool	1,528	932	596	39.0
Alberta Wheat Pool	856	566	290	33.9
United Grain Growers	759	495	264	34.8
Pioneer Grain	449	353	96	21.4
Manitoba Pool Elevators	323	192	131	40.6
Cargill	289	155	134	46.4
Patterson	92	77	15	16.3
Parrish & Heimbecker	56	51	5	8.9
Others	31	24	7	22.6
All Companies	4,383	2,845	1,538	35.1
		Number of Operating Units*		
Saskatchewan Wheat Pool	1,026	603	423	41.2
Alberta Wheat Pool	558	336	222	40.0
United Grain Growers	533	346	187	35.1
Pioneer Grain	339	238	101	29.8
Manitoba Pool Elevators	239	166	73	30.5
Cargill	222	137	85	38.3
Patterson	79	60	19	24.1
Parrish & Heimbecker	51	47	4	7.8
Others	26	22	4	15.4
All Companies	3,073	1,955	1,118	36.4

* At many shipping points, several elevators are managed by one man. As a rule, the best elevator is used regularly while the others are used only when necessary. An operating unit is one or more elevators managed by one person.

Licensed Storage Capacity

Company	August 1/73	April 1/83	Decrease	Percentage Decrease
	(---------- 000 tonnes ----------)			
Saskatchewan Wheat Pool	3,225	2,271	954	30.0
Alberta Wheat Pool	2,158	1,742	416	19.3
United Grain Growers	1,804	1,407	397	22.0
Pioneer Grain	1,160	1,002	158	13.7
Manitoba Pool Elevators	760	608	152	20.0
Cargill	637	463	174	27.2
Patterson	247	234	13	5.2
Parrish & Heimbecker	218	244	(26)	(11.9)
Others	94	112	(18)	(18.9)
All Companies	10,303	8,083	2,220	21.6
Total Grain Handled	21,300 (1973-74)	28,556 (1981-82)		

It will be noted that the amount of grain handled has increased markedly, at the same time that numbers and capacity of elevators have declined. Since a large proportion of elevator costs are fixed costs, the result is a substantial improvement in efficiency.

regard to volume.

Rail System Consolidation

At the peak of railway development there were about 19,000 miles of railway lines in Western Canada, including both main and branch lines. Shortly after World War II, the railways began to argue that they were losing money on the operation of light density rail lines whose traffic consisted mostly of grain. The MacPherson Commission, which reported in 1961, introduced the idea of a subsidy to the railway companies for continued operation of lines which did not cover their costs from freight revenues. The subsidy began later as a general lump sum payment but was then changed to specific reimbursement for costs on each line that was determined by the Canadian Transport Commission to be uneconomic, but whose continued operation was considered to be in the public interest. In late 1973, the government created a "basic network" of lines, guaranteed to 2000, consisting of 12,414 miles of prairie lines.

The Hall Commission was established in 1974, to examine prairie branch lines and make recommendations about their continued existence into the future. Hall and his colleagues recommended to the Government of Canada that a further 1,813 miles of line be placed in the basic network. They recommended that an additional 2,166 miles be abandoned over a scheduled period, and that further study be given to an intermediate group of lines totalling 2,344 miles.

The government, not satisfied to leave uncertain the

intermediate group of lines, appointed the Prairie Rail Action Committee which, in turn, recommended abandonment of a further 1,402 miles of line.

Final decision on the fate of any particular branch line depends on the decision of the Canadian Transport Commission which typically holds a public hearing to assess the views of all interested parties.

As a result of the activities of the Hall Commission, the Prairie Rail Action Committee and the Canadian Transport Commission, authorization has been given to date to abandon a total of 2,435 miles of rail line in Western Canada. This is approximately 13 per cent of the basic network mileage of main and branch lines in the area. At this date, a small number of hearings are still to be held and decisions are pending on a few additional lines (843 miles).

Projected Volume of Rail Traffic

A great deal of attention has been focused, in recent years, on the projected volume of movement of bulk products from this area of Canada to the Pacific Coast. Various individuals and agencies have produced varying numbers for different lengths of time into the future. For the purposes of this paper, I will use a set of volume figures produced by the Western Transportation Advisory Council, based on consultations with a variety of council members who are shippers of bulk products. The table below sets out actual volumes for the calendar year 1982, and WESTAC projections for 1990.

Westbound Bulk Export Tonnage

	Actual - 1982		Projected - 1990	
	Million Tonnes	%	Million Tonnes	%
Coal	15.7	46	53.3	60
Grain	11.2	32	19.0	22
Sulphur	5.0	14	6.8	8
Potash	2.6	8	9.0	10
Total	34.5	100	88.1	100

I should note in passing that these estimates were made in 1981, before the recession. Some of the figures look high in light of today's conditions, but may still be appropriate for 1990.

It will be noted that the 1990 projected volume for all products combined is about two and a half times the actual volume moved in 1982. While the last couple of years have adequately demonstrated the hazard of making long-term projections, I don't think many would quarrel with the general conclusion that we are looking forward to substantially larger volumes of total movement. Coal is expected to become even more dominant, accounting for 60 per cent of the four-commodity total in 1990, compared with 42 per cent in 1980 and 31 per cent in 1970. WESTAC anticipates that grain will increase in actual volume but decrease in relative terms, to 22 per cent in 1990, compared with 30 per cent in 1980 and 44 per cent in 1970.

In recent years, the railways have indicated it will be impossible for them to handle these projected volumes of traffic without very substantial expenditures for capital improvements, equipment and rolling stock. It is natural that shippers of all the major bulk products are

concerned that their export opportunities should not be hampered by inadequate rail capacity.

Grain Shippers Requirements

I want to discuss briefly today the requirements of grain shippers for rail capacity in the years ahead. These requirements must include two distinct geographic areas, the prairie area on the one hand and the mountains and ports on the other.

There are certain basic "facts of life" about the movement of grain by rail. The first of these is that grain is grown and marketed by about 150,000 producers occupying some 130 million acres of land in four provinces. Grain is not a homogenous product like sulphur, potash or coal.

Grain includes wheat, barley, canola, oats, flax, rye. Some types of grain are used for human foods and some for livestock feeds. The flour miller in Japan will not accept durum wheat for bread making and he will not accept just any grade of bread wheat. Thus, we must have a system which segregates parcels of grain into grades which indicate their quality for the intended end use.

Grain must be protected from the weather and from insect infestation to preserve its quality. Most of our customers have seasonal requirements for grain and are not able to take uniform and regular shipments from Canada over the course of the year.

These "facts of life" must be taken into account by anyone who is considering the future transportation re-

quirements of the grain industry. Too often in the past, they have been ignored by some of the technicians who have proposed drastically different systems modelled on the movement of coal or potash.

System Costs vs. Component Costs

When we are considering the interface between various participants in grain handling and transportation, it is important to keep in mind the cost of the total movement, from the farm gate to the hold of the ship. It is unfortunate, but quite understandable, that each participant in the system tends to be concerned primarily with the activities and costs which affect him most directly. For example, some people believe that grain should be moved in unit trains, from a few origin points, to achieve maximum railway efficiency. They are less concerned with the costs involved in getting the grain from farms to those few collection points. The federal government is concerned with the escalating cost of its subsidy and rail rehabilitation programs, and anxious to place a ceiling on its financial input to the system. Elevator companies are concerned that a drastic consolidation will make obsolete a great deal of their large investment in facilities, and will require huge amounts of new capital to build new and centralized primary elevator facilities. Farmers, and those elevator firms that are owned by farmers, want to avoid the higher costs and greater involvement of time required if they had to haul greatly increased distances to large centralized collection points.

They tend to be less concerned about the magnitude of government expenditure required for branch line rehabilitation, or the balance sheets of the railways.

What is needed is to establish, in some way, a mechanism which will encourage all system participants to work toward a common purpose of system improvement. At present, it is too often the case that a system improvement costs money, but the benefit of the improvement does not accrue to the party which incurred the expenditure. For example, a couple of years ago, there was discussion of pooling of shipments of canola arriving at Vancouver. An explanation may be in order for those unfamiliar with grain marketing. Ordinarily, when a carload of canola is shipped from a primary elevator on the prairies, it is consigned to a specific port terminal elevator, usually one owned by the same company. This involves switching by the railway to take that specific car to that specific terminal. Under a system of pooling, any car of canola, regardless of origin, may be delivered to any terminal which has space, regardless of ownership. An exchange of documents is used to balance the ownership and the stocks. There is an obvious gain to the railroads in reduced switching, but an expense to the grain terminals in extra accounting costs.

Branch line rehabilitation presents another example. The federal government has a policy of paying for the rehabilitation of branch lines which are in the so-called "permanent network". The cost of this rehabilitation varies, but is in the order of about $300,000 per mile of

track. Thus, a 50 mile line could require rehabilitation expenditure of $15 million, or an annual cost (based on ten per cent interest rate) of $1.5 million. If the amount of grain delivered to that line is equivalent to 30,000 bushels per mile of track, then the interest cost alone of the rehabilitation program is equivalent to $1.00 per bushel. The federal government finds this level of cost unacceptable, but farmers and elevator companies tend to be less concerned since the funding comes from the federal government. The alternative to rehabilitation is abandonment, which would reduce government expenditure but increase costs to farmers.

Most system improvements and changes which have been contemplated involve similar problems of expense accruing to one participant while gains accrue to others. There is an urgent need for some mechanism which will make possible an impartial and realistic assessment of costs and gains, and then some formula for sharing both the costs and the system benefits.

Future Requirements

Now I want to turn to a discussion of the transportation requirements of grain shippers in the years ahead to the end of this century. Because of the uncertainty involved in a time frame of that length, I think it wise to avoid specific numbers and to concentrate on trends.

1. Volume

Most analysts are agreed that we can expect further increases in volume in the years ahead. Canadian grain

exports in the last crop year were 27 million tonnes, an increase of 34 per cent from five years ago. The Canadian Wheat Board estimates that there is market potential for exports of 30 million tonnes by 1985 and 36 million by 1990. The growth in world population, if it is accompanied by real purchasing power, should assure further substantial increases in the 1990s. The geographic distribution of our grain markets would suggest a further increase in the proportion of shipments going through Pacific ports, and a considerable reduction, if not total disappearance, of our feed grain markets in central Canada and the Maritime provinces.

2. Assembly points

As I mentioned earlier, we have seen in the last ten years or so, a reduction of 36 per cent in the number of prairie operating units at which grain is assembled. It is clear that this downward trend will continue, but the rate of decline and the eventual number of points depends greatly on the new transportation legislation which, at the time of writing, is anticipated momentarily. One section of that legislation would permit the railways, with the approval of the Canadian Transport Commission, to offer reduced freight rates at individual points, or for certain conditions. A similar type of rate adjustment freedom has existed in the United States for several years. The result in the northern plains states has been a clustering of large elevators at a few widely scattered locations, the disappearance of many branch line elevators, and a very substantial increase in hauling distance

for many farmers. If the legislation is passed in its present form, I expect we will see a similar development in Canada.

3. Elevator car spots

The term "car spot" means the number of rail cars that can be placed on the loading track which adjoins a primary elevator. Traditionally, elevators were built side by side along the track, on sites leased from the railway. In the days of frequent scheduled train service, there was no need to accommodate more than two or three cars at an elevator at any one time. Today, trains are less frequent and the railways would prefer to spot larger numbers of cars to reduce their switching activity. The disappearance of some elevators through consolidation has improved the situation in some cases. Elevator companies now pay more attention to obtaining larger sites, even to the extent of purchasing their own land for a private spur. In certain instances, it seems there is a conflict of interest within the railway, between the operations people who want to spot more cars at a time, and the real estate department which is interested in having as many leases as possible for any given length of track. Maybe this will change in the new environment of compensatory rates for grain.

4. Branch line network

Grain shippers are concerned that a reasonable network of main and branch lines will remain in place in Western Canada, and that the lines will be adequately

maintained for year-round operation. This does not mean that every mile of branch line which now exists must remain forever. It does mean, however, that farmers should be able to deliver grain in their own trucks, to a point on rail, without undue hardship because of distance. An average distance for the prairies of about 15 miles one way, with a maximum of about 25 miles, would be reasonably acceptable. The Canadian Transport Commission, in its examination of abandonment applications, takes into account the alternate delivery distance which would be involved if the line were abandoned.

5. Main line capacity

Shippers of grain, like those of other products, are anxious that main line capacity for both railroads will be expanded to accommodate the expected increase in traffic volumes. It seems evident that the east-bound main lines already have sufficient capacity to handle future volumes, without major capital expenditure. However, the capacity of main lines west-bound from Calgary and Edmonton is another matter. I do not intend to discuss this area in detail since I expect Mr. Pike of CP Rail to do so in his presentation. Grade reductions, tunnels, double tracking, improved signals, and sidings all have a contribution to make to capacity expansion. Many of these projects are already under construction and others are in the planning phase. If there is an early turn-around in the Canadian economy, it will require diligent effort to complete the required projects

by the time they are needed.

6. Car cycle

A car cycle is the time required for a car to be loaded, moved to destination, unloaded and returned to an origin point ready for the next load. Consultants Booz-Allen, Hamilton and the IBI Group, in a study completed in 1979, made a careful examination of car cycles and the potential for improvement. They calculated the average car cycle, over-all, for grain cars on the two railways at that time to be 16-18 days. There were, of course, variations for different port locations and various origins. They calculated that if the average car cycle could be reduced by one day, it would be equivalent to an additional 633 hopper cars. The consultants recommended that concerted efforts be made to accomplish at least part of the apparent potential for time saving. I think it should be possible to make very significant gains in efficiency in this area, but it will require willingness and attention from a number of participants in the industry.

7. Port capacity

Anyone who has studied the rail system in and around Vancouver tends to become pessimistic about the future. There are five railway companies moving a large variety of products in a heavily populated area with many geographic and topographic barriers. In the case of grain, some terminals are located on the North Shore and some on the South Shore of the Second Narrows.

There are single track bridges, a tunnel, main yards, secondary yards and interchange yards. Some terminals are equipped to specialize in certain types of grain, while others handle all types. Problems seem to occur with disconcerting frequency. Despite the best efforts of the resident Grain Co-ordinator, it is often difficult to pin-point the causes for delay. Railway officials have been known to complain about terminal operators, citing the number of loaded cars which were in Vancouver at any one time. Terminal operators retort that they can unload only those cars which are on-site at their terminals. It seems that each party is referring to a different set of numbers or to numbers of cars in different locations, and therefore drawing different conclusions about the real nature of the problem. Complications such as snow slides, storms or delayed ship arrivals arise from time to time, but are beyond the control of either party. As in some other areas of grain transportation and handling, the problem has been studied to death, but little has been accomplished. It seems the various parties would rather shout accusations at each other from a distance than to search together for solutions.

Several years ago the grain industry, at the urging of the Canadian Wheat Board and the Government of Alberta, concluded that expansion was required elsewhere than at Vancouver, to accommodate future volume of exports to Pacific Rim markets. The grain industry, through a consortium, purchased a small government

terminal elevator at Prince Rupert, and immediately began planning for further growth. Construction is now under way on a large new terminal at Ridley Island just south of Prince Rupert. It will be completed in late 1984 and will handle large volumes of grain from northern Alberta and Saskatchewan. It is important that some inter-change arrangement be made, so the terminal can handle grain originating at points on Canadian Pacific as well as Canadian National lines.

Need for Understanding and Co-operation

I think it will be clear from the preceding section that there are a number of areas in which grain shippers would like to see improvements in efficiency, and expansion in the overall handling and transportation capacity of the system for grain. Some of this increased capacity will come about through general projects (such as main line improvements and tunnels), in which shippers of all products will share the benefits. In other cases there are improvements which require the attention and co-operation of the railroads and the grain handling firms which load and unload the cars.

There is need for some mechanism to facilitate serious examination of alternatives and to push forward those proposals which would bring about true system improvements. The ideal mechanism would be one set up within the industry itself, representing shippers, carriers and the marketing agencies. It would need a mandate to examine all facets of the system. The group

would need to be small enough to be effective and would need the confidence of all participants in the industry. It could be modelled on the Grain Transportation Technical Group which was formed in 1968, with representation from grain firms, the railways, Wheat Board, Canadian Grain Commission. The Technical Group functioned successfully for several years and was able to develop the block shipping system and several other improvements. It depended on persuasion rather than coersion to bring about change. It was able to submerge the individual rivalries of the participants and to develop a feeling of effective teamwork for the mutual benefit of the entire industry.

In the intervening years, a number of other mechanisms have been tried. Some have been large and unwieldy, meeting only briefly and infrequently to deal with specific problems of an immediate nature. Others have been set up and imposed by government on the industry. There has been a tendency for each participant in the industry to look out for its own interests first. The environment has resembled that among the individuals in a poker game rather than the members of a football team with a common objective.

Unfortunately, the situation relative to transportation in the last few years has tended to foster antagonism and divergence of views, rather than the search for common ground on which improvements could be constructed. Such an environment is likely to continue as long as there is uncertainty about the legislative

framework for grain transportation and freight rates. Time alone will tell whether the new legislation, in whatever form it may take, will result in a continuation of the present antagonisms and divergence. It is to be hoped that the various participants in the industry will find it possible to work constructively toward the introduction of system changes and improvements which will benefit the total system, without imposing undue burdens and costs on any one segment of the industry.

SOME PERSPECTIVES ON THE CROW'S NEST PASS RATE

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INTRODUCTION

On February 1, 1983, the Honourable Jean-Luc Pepin announced the Western Transportation Initiative. This would end the virtual freeze on grain freight rates, known as the Crow's Nest Pass Rate, which commenced in 1897. The decision to make legislative changes which will end the Crow regime followed an intensive period of consultations between members of the grain industry, the railways and government. The basic principles were negotiated by Dr. J.C. Gilson while many of the details were worked out by a series of task forces. The authors of this paper served on the task force that was established to examine the current Crow Rate structure, identify the anomalies and recommend a new base rate structure upon which all rate increases may be based. As part of this work it was found necessary to delve into history to explain some of the apparent anomalies that exist in the current rate structure. We did this on the grounds that most actions carried out in the past have a logical basis and if we could only find out the reason

it would help us to develop a better solution. Unfortunately the phrase "Lost in antiquity" kept cropping up in our discussions but we were able to uncover some useful information. This has been used in the report of the Rates Task Force but it was felt desirable to expand on certain aspects in greater detail hence the genesis of this paper.

The authors would like to acknowledge the works of J.C.R. Hanley who for many years was the Executive Director of the Commission's Traffic and Tariffs Branch. A good part of the source material was traced by referring to the work of Mr. Hanley, some of which remains to be published.

While the authors were all members of the Rates Task Force the opinions expressed herein are those of the authors and do not necessarily represent those either of the Rates Task Force, United Grain Growers, Transport Canada or the Canadian Transport Commission.

BACKGROUND

The 1890's were an interesting period in the economic development of western Canada. The Great Depression, a worldwide depression lasting 23 years from 1873 to 1896, was coming to an end. By 1895 there were signs of recovery particularly in the mineral developments of the Kootenay region close to the US-Canada border. The Canadian Pacific main line to the west coast had been completed in 1885 but the

railway was faced with severe competition in the Kootenay region. J.J. Hill's Great Northern was pushing northwards from the U.S.A. and was not averse to skirmishing, if not outright war, with Canadian Pacific. (On one occasion Hill's men attacked and tore down the CPR station at Sandon.)

In order to secure the Kootenays for the Canadian Pacific and, incidentally, to ensure Canadian sovereignty in the area, a line was needed from Lethbridge through the Crow's Nest Pass and the Kootenays to Nelson, B.C. CP recognized the strategic importance of this southern route but the effects of the depression compounded the problems of near bankruptcy following the completion of the main line. The railway announced its intention to build the Crow's Nest line although lacking the necessary capital.

But where to find the money? The Dominion Government had traditionally been a source of funding for railway projects and the company was able to persuade the government of the day that such a railway would be worthwhile. Negotiations commenced in 1896 on a subsidy to assist the railway to build into the Kootenays. In order to avoid delays Canadian Pacific purchased the provincial charter of the British Columbia Southern Railway and surveys were carried out during the winter of 1896-97.

Negotiations with the government dragged on into 1897. To speed the process the railway offered to reduce its rates throughout the west in return for a subsidy. CPR rates in western Canada had been a sore point since the opening of the railway and the offer was quickly accepted. Parliamentary sanction was obtained on 29 June 1897 and the Crow's Nest Pass Agreement was entered into on 6 September 1897.

A subsidy of $11,000 per mile to build a railway from Lethbridge through the Crow's Nest Pass to Nelson (maximum $3,630,000) was granted the railway. In return the railway agreed to reduce rates on thirteen categories of essential settlers' supplies shipped into western Canada from the Lakehead and on export shipments of grain and flour via the Lakehead. The government also obtained 50,000 acres of coal bearing lands (Dominion Coal Blocks) being part of the land grant obtained by the railway from the provincial government through the charter of the B.C. Southern Railway. This incidentally is the only occasion in North American history where a railway made a land grant to a government rather than vice versa.

At this point it is worthwhile emphasizing a number of important factors relating to the Crow's Next Pass Agreement:

- The Agreement was entered into in order to facilitate railway construction in British Columbia and to strengthen the Dominion presence in the area.

- Subsidies given in exchange for rate reductions were common at the time and were a substitute for the inadequacies of regulatory control.
- The rate reductions on inbound goods were just as important as were the reductions on export grain and flour. The Agreement was seen as a means of assisting settlement.
- The only land involved was that given to the Dominion Government. Canadian Pacific had obtained a land grant in B.C. through the B.C. Southern charter but no land whatsoever was obtained in the three prairie provinces.

THE OPERATION OF THE AGREEMENT UP UNTIL THE GENERAL FREIGHT RATES INVESTIGATION OF 1925

The Crow reduction took effect in two parts on August 1, 1898 and September 1, 1899. All grains and flour should have been reduced by 1½ cents per 100 pounds on each occasion. For reasons that are not now clear, flaxseed did not take the second 1½ cent reduction. A theory for this is that flaxseed, which will flow like a liquid, is more susceptible to leakage from a boxcar. This may not be the real reason because potatoes, hay and oilcake were also excluded from the second reduction. The differential on flaxseed varied between 1 and 2 cents until July 6, 1922, when a uniform 1½ cents was applied. Rapeseed was added to the statutory list on August 1, 1961 at

the flaxseed level. The differential between flax and rapeseed and the other statutory grains will be removed in the new legislation.

The rate reductions did not satisfy the people of Manitoba who felt that lower rates should be applied. The provincial government encouraged the construction of a line in competition with Canadian Pacific to the Lakehead. This new railway, the Canadian Northern, agreed to reduce the Winnipeg grain rate by 4 cents per 100 pounds and to reduce all its other rates by 15%. Canadian Pacific subsequently reduced its rates after reaching agreement with the Manitoba Government. In making these concessions to Manitoba, Canadian Pacific was of the opinion that this would result in the insolvency of the Canadian Northern. This did, of course, happen and the Canadian Northern was incorporated into Canadian National. This rate reduction led to the demise of a competitor but ironically saw the establishment of a much more powerful competition.

In the 1920's there were persistent complaints from all parts of the country about the freight rate practices of the railways. It was a time of great turmoil. The Government of Canada had created the Canadian National Railways from lines already owned by it and from lines that had recently become bankrupt such as the Canadian Northern and the

National Transcontinental. The Maritime provinces were clamouring to have their "claims" addressed and there was a great deal of dissatisfaction with the way in which the railways priced the transportation of grain. The Crow's Nest Pass Agreement was suspended during World War I by the proclamation of the War Measures Act and the railways were allowed to increase the rates for the movement of "Crow" grain during this period. Furthermore, the low rates on grain and grain products only applied on eastbound movements from the prairies to Thunder Bay (and Armstrong) not westbound to Vancouver. During the 1920's there was continued development of west coast ports and increasing pressure to have at least some grain traffic routed that way. A major deterrent to development at that time was the difference in rates eastbound vs westbound. In order to set the stage for a consideration of the General Freights Investigation, we are listing below, in chronological sequence, the major events of a regulatory or statutory nature that preceded it and may be considered (for Crow purposes) to have led up to it.

1. July 7, 1919. Railway Act revised to remove for three years the limitations of the Crow's Nest Pass Agreement on the B.R.C.'s powers over rates.

2. May 5, 1922. Parliament appointed a Select Special Committee to "...make enquiry into the question of railway transportation costs and the effect upon Canadian National Railways and other lines, as well as upon agricultural development and Canadian industry generally of the expiration of the suspension of the Crow's Nest Pass Agreement of July 6 next". The committee reported on June 24, 1922. Its recommendations were accepted and the Railway Act was amended to reflect the Crow's Nest Pass level only on grain and flour for a period of one year from July 6, 1922.
3. July 3, 1923. The Governor-in-Council extended the exemption of the rates on settlers' effects until July 6, 1924.
4. General Order 384, October 10, 1923. The Board of Railway Commissioners ordered a reduction of 10% on the rates on grain and grain products to Pacific Coast ports for export (underlining added).
5. July 6, 1924. Suspension ended and the railways filed tariffs (July 7) restricting the Crow's Nest Pass basis to those points on Canadian Pacific lines in 1897. There was an immediate flood of complaints.

6. B.R.C. Decision of October 14, 1924. "The Board found that the rates in the restrictive tariff would not exceed 35% to 60% of what would be adequate, fair and reasonable rates under existing conditions; that the rates in effect prior to July 7, 1924 were equitable, fair and reasonable; and that the rates in effect prior to July 7, 1924 should be restored, notwithstanding the fact that they were not in accordance with the terms of the Crow's Nest Pass Agreement."(1)

7. Order-in-Council P.C. 2220; December 5, 1924, suspended the Board's decision of October 14, 1924 pending the decision of the Supreme Court.

8. Supreme Court Decision, February 26, 1925. Overturned the Board's decision but found that the Agreement only applied to those points and lines of Canadian Pacific in 1897.

9. Order-in-Council 886, June 5, 1925, created the General Freight Rates Investigation with particular reference to:

   a) The claims of the Maritime provinces that they were entitled to the restoration of the rate basis which they enjoyed in 1919.

(1) J.C.R. Hanley Railway Freight Rates in Canada: A History 1836-1930, OTTAWA: Canadian Transport Commission, (unpublished) 1981, P. 161

b) The encouragement of the movement of traffic through Canadian ports.

c) The increased traffic westward and eastward through Pacific Coast ports owing to the expansion of trade with the Orient and to the transportation of products through the Panama Canal.

10. June 27, 1925. Amendment to Railway Act given Royal assent which enshrined the Crow's Nest Pass level of rates on grain and flour on "...traffic moving from all points on all lines of railway west of Fort William or Port Arthur over all lines now or hereafter constructed by any company subject to the jurisdiction of Parliament." (15-16 George V, Chapter 52).

11. General Order 419, July 8, 1925. Ordered the restoration of westbound rates on 13 commodities to the level in existence at July 6, 1924. These rates were now subject only to the normal Railway Act provisions.

12. General Order 420, July 8, 1925. Railways were given 15 days in which to give effect to the Railway Act amendment on rates on grain and flour to Fort William and Port Arthur.

13. Board of Railway Commissioners Order No. 36769, September 2, 1925. Ordered the "Crow" level of rates to be filed within 15 days for export movements of grain and flour via Pacific coast ports in Canada.

THE GENERAL FREIGHT RATES INVESTIGATION

In line with the directions contained in Order-in-Council 886 the Board held hearings all across the country. At these hearings evidence was adduced concerning most major freight rate issues of the day. In order to be as brief as possible, we shall only consider, in this paper, those issues related to the rates on the movements of statutory grain. It is interesting to note, that this activity occupied the time of six Commissioners and that each one wrote his own report contained in the judgment. It is obvious from reading the report that the Commissioners held widely differing views on a number of issues, not the least of which was the movement of grain and flour for export.

Mountain Differential

The Board was of divided opinions as to the justification for the existence of the Mountain Differential. However, they pointed out in their report that the differential did not apply to approximately 85% of the traffic moving through the mountains and that one type of traffic to which it did not apply was grain and flour moving for export.

Branch and Main Line Rates

The Board found that all rates on grain and flour both on branch lines and main lines should be adjusted to the main line basis of rates then in existence on the CPR. Commissioner Oliver dissented from this view. The Board further held that rates on domestic grain from the Prairies to Vancouver could be higher than the statutory basis since the grain moving domestically was not in competition with the grain moving for export. Commissioner Oliver dissented from this decision. The Board decided that Canadian Pacific could continue to use the higher constructed mileage from Calgary to Vancouver, which mileage is based on the CNR mileage from Edmonton to Vancouver. They held that, were the actual CPR mileage used, the CNR would have to adjust its rates down to meet the CPR level and the CNR would then be carrying the traffic at a lower mileage cost than for similar shipments to Fort William, thus defeating the equalization of rates on a mileage basis to Fort William and Vancouver. Commissioner Oliver dissented.

In addition to the items decided by the Board, there were some interesting comments and some interesting dialogues that occured during the investigation. For instance, it was pointed out by Canadian Pacific, that the Crow's Nest rates on grain to Fort William were put in on an arbitrary basis.

They were not on a uniform distance basis. This argument has been borne out by the work of the Task Force in which we found that the rates, when grouped on miles, had uneven distributions and tended to break around major shipping points. It was further contended by the Canadian Pacific that, in Manitoba and eastern Saskatchewan, there were competitive conditions arising from railways paralleling each other with the effect that farmers were able to haul by wagon to a point on either railway and this factor had a bearing on the rates charged. This is obviously the genesis of what are referred to in the Task Force Report as contiguous points.

On August 26, 1927, the Board of Railway Commissioners issued General Order 448 which, in effect, set the ground rules for the rates on grain and flour that have existed since then. It is interesting to note that the directive contained in Order-in-Council 886, concerning the use of Canadian ports, largely fell by the wayside. General Order 448 was virtually silent on the subject, and, in fact, with the question of eligibility of traffic moving via U.S. ports for the Crow basis within Canada, this problem is still with us. For example, see the decision in the case concerning Prairie Malt versus Canadian National Railways, 1983.

There is also a nebulous relationship between the Crow Rates and the so-called "At and East rates" which apply on export movements of grain and flour through Eastern Canadian ports.

It may be recalled, that during the McPherson Royal Commission hearings, allegations as to the non-compensatory nature of the Crow Rates were raised. It was pointed out to the railways that At and East rates were currently in effect at extremely low levels and that the carriers had chosen to maintain such levels despite the absence of statutory requirement.

These rates were subsequently costed, by the carriers, and found to be below variable cost. The attempt to replace the existing rates by a remunerative scale led to appeals to the Board of Transport Commissioners and subsequently the Governor-in-Council. As a result, the existing scales were frozen by a series of orders-in-council and later enshrined in section 272 of the Railway Act.

We will not go into detail on considerations and machinations which led to this determination as such an exercise would deserve a paper in its own right.

EVENTS SINCE 1927

Not very much has happened since 1927! The Crow Rate was extended to cover export movements through Churchill and Prince Rupert when those ports commenced to ship grain while rapeseed was included in the list of eligible grains in 1961.

The original rate groupings are shown in Table 1. This is far from consistent, particularly when one bears in mind that the CN scale was forced to fit the already inconsistent CP scale. The scale resembles two straight lines meeting at 1,275 miles. Rates over 1,275 miles were determined by the Morley, Alberta rate of 28 cents for 1,284 miles or .436 cents per ton mile. This gives shipments over 1,275 miles a slightly higher rate per ton mile than those below the break point. Morley does not now exist!

Northern Alberta Railways

The reasons for the Northern Alberta Railways scale are somewhat obscure. It appears that the N.A.R. scale was originally constructed as a two line, or joint line, scale to take in account the added cost of interchanging grain cars between the N.A.R. and either CN or CP at Edmonton. For example, the mileage from Alcomdale to Vancouver is 790.6 miles. The published rate is 22 cents, whereas it should be 20 cents according to the Crow scale. Until recent years, reductions from the N.A.R. scale were

made from time-to-time in response to political pressure or local requests for rate reduction. The N.A.R. has now been acquired by Canadian National which has agreed under the new regime to establish rates off former N.A.R. points at the single line rate scale.

CP Rates between Calgary and Red Deer, Alberta

Rates to Thunder Bay from CP points between Calgary and Red Deer are 2 cents per 100 lbs. below scale rates. It was claimed that this came about in 1906 in response to a BRC Order. When CN built into the area the CN rates were set at the CP level. The reasons for the anomaly remain unknown to this day.

Competition from U.S. Railways

The best example is Boissevain, Manitoba which has a 16 cent rate - 2 cents below the scale. An early tariff shows Boissevain as a competitive point presumably from the U.S. Great Northern Railway whose line through Boissevain to Brandon was abandoned in 1936. Even in 1927 it is doubtful if the American road could have competed with the Crow Rate yet this anomalous situation has remained to this day.

Freedom of Railways to Make Changes

While General Order No. 448 provided the basis for grain rates, it left considerable freedom for the railways to make changes. There are a number of instances or anomalies where the actual or

published rate differs from the rate developed from the Crow scale. Where the published rate differs from the rate developed from the Crow scale, the railways are generally free to alter the rate back to the scale. There are two notable exceptions:

(1) CP Vancouver-Calgary constructed mileage. General Order 448 specified that the rates on grain and flour from prairie points to Vancouver and Prince Rupert for export shall be on the same basis as the rates to Fort William, but in computing such rates, the distance Calgary to Vancouver via the Canadian Pacific Railway shall be assumed to be the same as Edmonton to Vancouver via the Canadian National Railways. Namely 766 miles, or a difference of 124 miles.

(2) Until 1966 CN could adjust the rates to Churchill, but with the passage of the National Transportation Act and revisions to the Railway Act, CN must maintain the rates at the level applying on December 31st, 1966, by reason of Section 271 (3) of the Act.

There are only a few instances, and none since the early 1960's, where the railways chose to increase rates. One example was due to rail line abandonment in the area of the south Saskatchewan River Dam or the Diefenbaker Dam, the mileages from certain points south of Moose Jaw were altered. As a result, C.N.R. increased the rates to meet the mileage to Vancouver via Regina.

THE RATES TASK FORCE

The work of the Rates Task Force is documented in detail in its report of November 1982.

In developing a new rate scale the following parameters were established:

- in order to minimize the impact of change upon shippers and shipping points the new scale should be as close a fit as possible to the existing scale;
- there should be a combined CN and CP scale;
- canola and flaxseed and their products should take the same rate as other statutory grains;
- the new scale should produce approximately the same revenue yield as the existing rates. This would not alter any of the principles of the Gilson recommendations;
- there should be regular mileage blocks. Eventually 25 mile increments were chosen as producing a smoother scale.

Linear regression was used to develop the new scale shown in Table 2. This produced revenue approximately ½% less than that obtained from the existing scale while no shipping point experienced a change in revenue greater than plus 5 cents from the existing scale. A number of anomalies were retained in order to avoid undesirable distortions in shipping

patterns. All existing competitive and contiguous points were retained initially as was the principle of west coast port parity.

The new scale is the base from which all future rates will be derived. Each year the Canadian Transport Commission will develop a multiplier which will be applied to the base rate scale to produce the rate scale for that particular crop year.

The recommendations of the Task Force regarding the rate structure have been accepted by Transport Canada and are incorporated into the draft bill on Western Grain Transportation.

Although the work of the Task Force was completed in November 1982, the members have been meeting frequently to carry out work preparatory to publishing the new tariff. This has required a great deal of patient, meticulous work. One may agree to maintain existing competitive and contiguous relationships but with abandonments, new points and re-routings these are not always evident. In some cases contiguous relationships have been completely reversed. In such cases, the test of reasonableness was used. This has been greatly helped by the Task Force members who, although exhibiting a wide range of partisan views, were able to function together to produce a workable result. We may not always have reached full agreement, but differences were honoured in the spirit of co-operation.

Freight rates are usually dynamic. They change over time not only to reflect inflation but to respect the dictates of changing traffic patterns, technology, methods of operation and competition. The Crow Rates have remained virtually static for 55 years. The report of the Task Force on Rates (November 1982) proposes some first steps towards a more dynamic system that may better serve the needs of railway and shipper. Whether or not we embark on the road to normalization depends upon that most unpredictable body - the Parliament of Canada.

TABLE I

RATES TO FORT WILLIAM, PORT ARTHUR AND VANCOUVER EFFECTIVE SEPTEMBER 12, 1927 IN COMPLIANCE WITH BOARD OF RAILWAY COMMISSIONERS GENERAL ORDER NO. 448 - AUGUST 26, 1927.

C.P.R. SCALE			C.N.R. SCALE		
MILEAGE	RATE		MILEAGE	RATE	
210.5	12	Dryden	226.2	12	Fort Frances
232.5	12	Gunna	280.7	12	Rainy River
293.4	13½	Kenora	393.7	14	La Broquerie
296.5	13½	Keewatin			
365.5	14	Whitemouth	417.3	14	Vivian
419.1	14	Winnipeg			
474.7	15	Portage la Prairie	474.7	15	Portage la Prairie (CP)
552.2	16	Brandon	552.2	16	Brandon (CP)
577.0	17	Griswold	577.0	17	Griswold (CP)
683.1	18	Broadview	680.0	18	Deepdale*
742.5	19	Qu'appelle	735.0	19	Canora
817.1	20	Moose Jaw	790.6	20	Quinton
851.8	21	Parkbeg	819.2	21	Nokomis
927.5	22	Swift Current	926.6	22	Dalmeny
1,012.0	23	Maple Creek	1,003.1	23	Scott
1,119.1	24	Kininvie	1,095.7	24	Greenshields
1,191.0	25	Gleichen	1,156.9	25	Bruce
1,251.8	26	Cosway	1,238.1	26	South Edmonton (Strathcona)
1,275.4	27	Radnor	1,275.4	27	Radnor (CP)
1,300.0	28		1,291.7	28	Evansburg
1,350.0	29		1,344.3	29	Wolf Creek
1,375.0	30		1,375.0	30	
1,425.0	31		1,425.0	31	
1,475.0	32		1,475.0	32	
1,525.0	33		1,525.0	33	
1,575.0	34		1,575.0	34	
1,600.0	35		1,600.0	35	
1,625.0	35		1,625.0	35	
1,650.0	36		1,650.0	36	
1,700.0	37		1,700.0	37	
1,750.0	38		1,750.0	38	
1,800.0	39		1,800.0	39	
1,850.0	40		1,850.0	40	
1,900.0	41		1,900.0	41	
1,925.0	42		1,925.0	42	
1,975.0	43		1,975.0	43	
2,025.0	44		2,025.0	44	
2,075.0	45		2,075.0	45	
2,100.0	46		2,100.0	46	
2,150.0	47		2,150.0	47	
2,200.0	48		2,200.0	48	

* This is the station closest to the mileage indicated in the table using current tariff miles from 1924.

TABLE 2

NEW BASE RATE SCALE
IN CENTS PER CWT

MILEAGE	RATE	MILEAGE	RATE
325	13.27	1275	27.56
350	13.63	1300	28.12
375	14.00	1325	28.68
400	14.36	1350	29.24
425	14.72	1375	29.80
450	15.09	1400	30.36
475	15.45	1425	30.91
500	15.82	1450	31.47
525	16.18	1475	32.03
550	16.54	1500	32.59
575	16.91	1525	33.15
600	17.27	1550	33.71
625	17.63	1575	34.27
650	18.00	1600	34.83
675	18.36	1625	35.39
700	18.73	1650	35.95
725	19.09	1675	36.51
750	19.45	1700	37.06
775	19.82	1725	37.62
800	20.18	1750	38.18
825	20.55	1775	38.74
850	20.91	1800	39.30
875	21.27	1825	39.86
900	21.64	1850	40.42
925	22.00	1875	40.98
950	22.37	1900	41.54
975	22.73	1925	42.10
1000	23.09	1950	42.66
1025	23.46	1975	43.22
1050	23.82	2000	43.77
1075	24.19	2025	44.33
1100	24.55	2050	44.89
1125	24.91	2075	45.45
1150	25.28	2100	46.01
1175	25.64	2125	46.57
1200	26.01	2150	47.13
1225	26.44	2175	47.69
1250	27.00	2200	48.25

NOTE: This table may be subject to minor adjustments.

UNITED STATES FREIGHT RATE STRUCTURE FOR GRAIN: POTENTIAL RELEVANCE TO CANADA

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ABSTRACT

This study found that grain freight rates in the U.S. are largely determined by distance, shipment size, frequency of shipments, inter-modal competition, and geographical characteristics of route origins and destinations. Freight rates, therefore, vary depending upon routes. Rates for domestic movements compared to export movements are generally more influenced by hauling distance. When Canada's statutory rate was compared with U.S. rates for export routes in 1979, it was found that the U.S. rate level was about 5.4 and 2.7 times higher for hauling distances of 200 and 1,000 miles respectively in the lowest rate route; while it was about 11.0 and 7.1 times higher for the same mileage in the highest rate route.

INTRODUCTION

In a decision to replace the centry-old statutory export grain freight rates with a new rate structure,[1] the government of Canada announced on February 1, 1983 a multi-billion dollar program to improve and expand Canada's

western rail system. The new policy will mean that the freight rates producers pay for shipping western grains will be brought more in line with costs of moving it. Under a new rate formula rates grain producers and the government will share cost increases, the new freight rates will be increased to almost about double their current level by 1985-86. The government will compensate the rail carriers' losses if the carriers meet performance and investment commitments.[2]

In light of this development, the way of determining the freight rate level and structure for grain has received attention from many interest groups in Canada including grain producers, elevators, railways, grain using industries, and federal and provincial governments. This is not surprising since the new rate scheme will have significant economic implications in many segments of Canada's economy. Literature on this subject is almost nonexistent because of the fixed level of freight rate under the statutory rate regime.

The objective of this study, therefore, is threefold: (i) to examine the U.S. grain freight rate structure in order to quantify the determinants of that rate structure; (ii) to compare U.S. and Canadian experiences under the current rate regimes; and (iii) to shed some light on the potential Canadian freight rate structure in the long-run under commercial freedom. Specifically, this study will identify and quantify factors which contribute to rail freight variations for U.S. grain movements to both domestic and export destinations.

Before examining U.S. grain rail freight rate structure, the theory of rail freight rate making will be briefly reviewed in Section II. Based on the theory, a model will be formulated to examine the U.S. rate structure in Section III and an empirical estimation of the model will be given in Section IV. The U.S. and Canadian experiences will be compared in Section V. Policy implications and concluding remarks will be discussed in Section VI.

REVIEW OF THE THEORY OF RAIL FREIGHT RATE STRUCTURE

The theory of freight rate making is one of the most controversial and unsettled issues in transport economics. Railways are characterized as having high excess capacity, a high proportion of fixed costs (about 40%), problems of allocating common cost and producing a nonstorable heterogeneous output. Furthermore, there may be certain extra costs involved in shipping different commodities, a problem not generally encountered in the theory of the firm.

Nevertheless, there are many competing theories of freight rate making in the literature. None of it encompass them all. Widely known pricing principles are: cost based pricing (e.g., average cost and marginal cost); value-of-service pricing; peak/off-peak pricing; density based pricing; pricing under different market states; etc. (e.g., 2, 3, 7, and 12).

In reviewing the theory of freight rate structure, some of the well known pricing principles are examined in the origin-destination context. First consider cost-of-service pricing vis-a-vis the cost structure of railways. Railways have a relatively high proportion of fixed costs

to variable costs. In variable costs, transportation services are composed of two major cost components: (i) terminal costs associated with handling and loading; (ii) line-haul costs associated with moving commodities. Terminal costs of handling and loading depend upon the commodity weight and bulk. They increase in total as both weight and bulk increase. However, costs rise less than in proportion to the increase in weight and/or bulk. While distance does not impact on terminal costs, it is one of the most important factors on line haul costs. Since terminal costs are divided into the mileage when average cost is calculated, the average variable cost will be higher per mile for short distances than that for long distances. In addition, since the typical railway companies' cost structure is such that fixed costs are high relative to other industries, the more units of output produced the less will be the proportion of fixed costs on each unit. This is known as the short-run increasing returns. Firms subject to such increasing returns due to high fixed costs and having excess capacity (such as the railways), usually have a strong incentive to expand the volume of output to improve capacity utilization and revenue earned.

In Figure 1, a hypothetical average total cost curve (fully allocated cost) is constructed for a railway according to distance between origin i and destination j. Let RR' be a simplified average total cost curve for a representative origin-destination (O-D) pair. Assume that RR' reflects the cost structure of railways, given the volume of movement, commodity characteristics, and

geographical nature of the route. If the railways charge shippers on the basis of their costs of service, RR' represents the cost recovery freight rate. RR' also reflects the concept of "rate taper"; that is those rates increase at a decreasing rate as distance increases. The freight rate level RR', however, does not apply universally for all O-D pairs since costs can be changed depending upon other factors including volume, frequency of service, nature of terrain (uphill, downhill, or degree of curvature), route density, commodity characteristics, etc. In other words, the intercept of the RR' curve and its shape depends on the cost factors stated above and these factors contribute to vary freight rate given distance from one O-D pair to another.

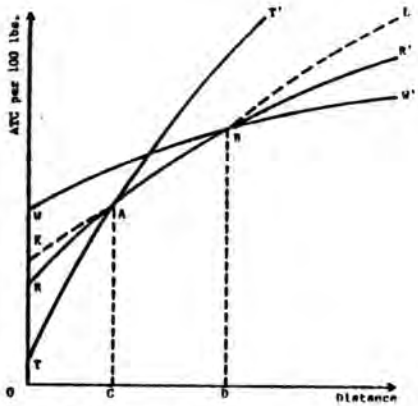


Figure 1. Hypothetical Average Total Cost Curves for Rail (RR'), Truck (TT'), and Water (WW') Modes of Transportation for a Given Origin/Destination

Now suppose that between the chosen O-D pair, other modes of transport such as truck and water also operate.

The cost structure of the trucking industry is quite different from the railway industry since fixed costs constitute only about 10% of total costs and there are only insignificant terminal cost components. Thus, there is less need for an arbitrary allocation of fixed costs. The hypotherical average total cost of trucking is also shown in Figure 1, depicted TT'. Similarly considering cost structure of water mode, assume that the average total cost curve can be shown as WW' in Figure 1 since water is known as cheapest mode of transportation for bulk commodities over long distances.

If the freight rate is solely determined by the cost of providing service, the transport market i to j will be divided by between modes according to hauling distance. The trucking industry will have natural advantage in the OC market, railways in the CD market, and water from D to the final destination.

Railways by nature, however, have an incentive to compete with other modes by engaging in discriminatory pricing to penetrate markets where other modes of transport have a competitive advantage. Railways may lower rates below the average total cost where intermodal competition exists, ceteris paribus, while charging relatively higher rates where competition does not exist. The loss suffered in the competitive pricing situation is recovered by engaging in value-of-service pricing. This means that rail service is priced at least in part according to the value of the product, i.e., high-valued products tend to be accorded high rates for their movements, while low-valued

commodities tend to be accorded low rates, regardless of costs.

Other types of discriminatory pricing are second- and third-degree discimination (i.e., Pigouvian price discrimination). Second-degree discrimination among shippers is based on the volume, season (peak vs. off-peak), and regularity of patronage whereas the third-degree discrimination is based on the elasticity of demand for transport services. Railways possess perhaps to a unique extent both the incentive and ability to engage in discriminatory pricing to maximize revenue subject to an acceptable level of profit. Authors of this paper perceive railways as revenue maximizers rather than profit maximizers. In engaging in discriminatory pricing, marginal cost may be used as a "floor" for rates while "fully allocated cost plus some margin" may be a "ceiling".

As a result, the relevant boundaries of freight rate in terms of "floor" will be TABW' in Figure 1 which is the rate for the route, where inter-modal competition from truck and water is strong. On the routes where inter-modal competition is weak, the rate-distance curve will be somewhere in-between RA and TA for distances less than OC and between BR' and BW' for hauling distances greater than D. On routes where inter-modal competition does not exist at all, the rate will follow the general shape of RR' plus some mark-up. The extent of mark-up may vary by distance and by route. Therefore, it is expected that may different shapes of rate-distance curve may exist-e.g., convex (i.e.,

KABL) or concave (i.e., TABW') from origin, or seemingly straight line (i.e., KABR', RABR', KABW', etc.).

THE MODEL

Based on the theory of the rail freight rate making, discussed in the earlier section, a generalized model of freight rate for U.S. grain movement is formulated as follows:

$$FR_{ijk} = f(DT_{ij}, DTS_{ij}, OD, DD \text{ or } ED, CSD, V_{ij}, FQ_{ij}, e_{ij}) \quad (1)$$

where $i = 1, 2, \ldots n$ origin points,

$j = 1, 2, \ldots m$ destination points,

$k = 1, 2, \ldots r$ commodity types,

FR = freight rate in cents per hundredweight (lbs.) between ith origin and jth destination,

DT = rail distance in miles between origin-destination pairs,

DTS = distance squared,

BC = a dummy variable representing water (large) competition between origin-destination pair,

OD = a dummy variable representing domestic route destination (i.e., used only for domestic rate equation),

ED = a dummy variable representing export route destination (i.e., used only for export rate equation),

CSD = a dummy variable indicating the rate corresponding to a corn and soybean shipment,

V = shipment volume in tons,

FQ = shipment frequency, or a number of shipment moves per year required to qualify for the rate specified, and

e = a random error term.

A Priori ground, rail freight rate model specification for domestic movement is differentiated from the export

rate model. The most significant difference between the domestic and export rate structure in the U.S. is the availability of multiple-car shipment rates. In developing domestic rate, it is based upon single-car rail shipment alone, while the export rate is based on both single- and multiple-car shipments. Therefore, shipment volume and shipment frequency were dropped from the domestic model.

The description of both the domestic and export origin-destination regions is stated in Table 1. All regions serve as origin-destination except region six, which serves as only destination.

TABLE 1. DEFINITION OF ORIGIN-DESTINATION PAIRS IN THE U.S.

Region	States
Domestic Regions	
1	ME, VT, NH, MA, CT, RI, NY, PA, MD, DE, MI, OH, IN, IL
2	VA, WV, NC, SC, TN, GA, AL, MS, FL
3	WI, MN, IA
4	MO, AR, LA, NE, KS, OK, TX, CO, NM
5	ND, SD, MT, WY
6	WA, OR, ID, UT, AZ, NV, CA
Export Regions	
East	Philadelphia, PA; Norforlk, VA
Gulf	Mobile, AL; New Orleans, LA; Houston, TX
West	Seattle, WA; Portland, OR
Great Lakes	Duluth, MN; Minneapolis, MN

It is hypothesized, therefore, that rail freight rate per hundredweight (CWT) is positively related to distance (DT), negatively related to barge competition (BC), volume to be hauled (V), and frequency of shipment (FQ), all other things being equal. Freight rates are expected to increase

with hauling distance but as a decreasing or an increasing rate depending on the sign of distance squared variable (DTS), if the coefficient is zero, the rates increase at a constant rate. However, if value of service or other factors are involved in rate making for a given route, it is expected that distance squared (DTS) will have a positive sign. Since geographic region influences rate determination because of differing degree of inter-modal competition, rail density, track conditions, and the nature of the terrain, route origins and destinations dummy variables are explicitly included in the model. Such dummy variables are multiplied to other independent variables to derive information to on the level of origin-destination specific intercepts and slope coefficients.

THE DATA AND EMPIRICAL RESULTS

U.S. rail freight rate data were collected from industry sources including the Minneapolis Grain Exchange, the Kansas City Board of Trade, and various grain merchandising firms. U.S. rates used for this analysis are the Ex-Porte' 368-A level, October 15, 1979.[3] Most rail mileage figures were obtained from the Princeton University Railroad Network Model.[4] Domestic grain rail rate equation is estimated on the basis of 523 origin-destination routes on which grain flows are heavy. The data consist of 200 observations for wheat and 323 observations for corn and soybeans movement. The total observations used to estimate export grain rail rate equations are 432 origin-destination routes, 187 observations for wheat, and 245 observations for corn and soybeans movements.

The assignment of barge competition dummy variables is based on the truck distance to water access points from the route origin to the route destination. For domestic movements of grain, a route is assumed to have barge competition if the ratio of the distance to a water access point to the total travel distance is less than 10% of the total distance. The ratios of less than 5 and 10% are used to determine strong and weak barge competition for movements of grain for export markets. In addition to this criterion the "likelihood" of a competing barge route is considered.

For empirical estimation of the model (1), freight rate for domestic movement is estimated separately from the export rate as the behaviour of rate making for the two movements are different from each other due to the fact that different shipping practices are applied.

The estimated parameters for wheat, corn, and soybeans (from now on corn refers to corn and soybeans), and for the aggregate equation (i.e., combined wheat, corn, and soybeans) for domestic and export movements are presented in Tables 2 and 3, respectively. The reader should note that the variables included in the equations estimated do not exactly correspond across equations.[5] For all domestic regressions, origin and destination regions 3, which include Minnesota, Iowa, and Wisconsin, are used as the base region for comparison. All intercept and slope shifters estimated add to the estimated domestic rate from origin region 3 to destination region 3. For all three regressions, origin 1 (the East) did not enter significantly, nor did its related variables. Hence, origin

region 2 and origin region 3 can be considered comparable in terms of domestic rate determination.

TABLE 2. EMPIRICAL RESULTS OF THE U.S. DOMESTIC FREIGHT RATE: WHEAT, CORN, AND AGGREGATE GRAIN

Variable	Wheat Coefficient	(t-Value)	Aggregate Coefficient	(t-Value)	Corn Coefficient	(t-Value)
DT	.207	13.41	.276	17.09	.267	11.84
DTS	$-.828\times10^{-4}$	-4.83	$-.208\times10^{-3}$	-7.63	$-.216\times10^{-3}$	-6.42
OD2	--		190.12	3.80	83.67	3.67
OD5	-24.24	-3.35	-11.41	-3.26	-16.44	-2.20
OD4	6,054.1	2.75	19.35	5.07	20.04	4.46
OD2xDT	--		-.694	-4.06	-.335	-4.55
OD5xDT	$.919\times10^{-4}$	6.29	--		$.665\times10^{-1}$	3.61
OD4xDT	-18.17	-2.76	-.163	-8.06	-.139	-5.26
OD2xDTS	--		$.501\times10^{-3}$	3.51	$.212\times10^{-3}$	3.46
OD5xDTS	--		$.140\times10^{-3}$	7.46	--	
OD4xDTS	$.135\times10^{-1}$	2.77	$.248\times10^{-3}$	8.39	$.185\times10^{-3}$	5.02
DD1	--		29.78	5.79	28.60	5.59
DD2	--		-184.04	-3.78	-79.70	-5.51
DD5	-4,740.50	-2.73	--		43.42	2.75
DD4	-6,047.3	-2.75	--		--	
DD1xDT	--		-.189	6.44	-.191	-5.86
DD2xDT	--		.498	3.05	.142	5.18
DD5xDT	90.28	2.73	--		--	
DD4xDT	18.16	2.76	$.488\times10^{-1}$	4.45	$.160\times10^{-1}$	2.47
DD1xDTS	--		$.264\times10^{-3}$	6.47	$.282\times10^{-3}$	6.23
DD2xDTS	--		$-.295\times10^{-3}$	-2.18	--	
DD5xDTS	-4.25×10^{-1}	-2.74	$-.368\times10^{-4}$	-5.96	--	
DD4xDTS	$-.135\times10^{-1}$	-2.77	$-.824\times10^{-4}$	-5.45	--	
CSDxDT	--		$-.718\times10^{-2}$	-3.00	--	
BDxDT	--		$-.151\times10^{-1}$	-5.19	$-.157\times10^{-1}$	6.47
Intercept	17.37	4.56	10.71	4.54	12.15	3.92
R^2	.9477		.9433		.9210	
Standard Error	11.82		10.04		8.08	

Domestic rail rates appear to be very sensitive to the travel distance and dummy variables associated with origin and destination characteristics. Estimated coefficients for distance (DT) and distance squared terms (DTS) are consistent for wheat corn, and aggregate. Estimated parameters are all significant from zero at 10% probability level.

The estimated domestic wheat equation as it is presented in Table 2, most of the slope and intercept shifters

are extremely large in absolute value. The coefficient and the intercept on distance (DT) are comparable to those estimated for the aggregate equation. While the coefficient on distance squared (DTS) is negative, it is considerably less than the aggregate equation coefficient. Barge competition (BC) does not enter significantly into the domestic wheat equation. This is reasonable given that few wheat producing areas are close to inland waterways.

The domestic corn rate regression strongly indicates that the domestic corn rate structure is not consistent throughout the United States. The intercept and coefficients on distance (DT) and distance squared (DTS) are close to those of the aggregate equation. Barge competition (BC) interacting with distance (DT) enters similarly also. Hence, domestic corn rates decrease with the presence of barge competition (BC).

The aggregate domestic results strongly suggest that the domestic rate structure is not consistent throughout the United States. Domestic rates are significantly determined by the origin and destination characteristics of the rail route in addition to trip distance. Cron and soybeans are, in general, lower than wheat on a per mile basis due to the frequency of rail shipments or other factors which vary between regions. Barge competition (BC) also results in a lower rate per mile.

Regarding estimated export rate equation for wheat, corn, and aggregate again variables included in the three export equations do not exactly correspond across equations for the same reason as stated for the domestic equation.

For all export regressions, origin 3 is also used as the base origin. The lake region is used as the base destination.

Export grain rail rates appear to be very sensitive to competition with barge (BC), volume shipped (V) and frequency of shipments (FQ) in addition to hauling distance (DT) and dummy variables associated with origin (OD) and destination characteristics (ED). This indicates that the rate structure for export movements of grain is different from that for domestic movements of grain. Estimated coefficients for distance (DT) and distance miles squared (DTS) are not consistent for wheat, corn, and all grains. Most estimated parameters are statistically significant at the 10% level.[6]

Barge competition (BC) enters in general more significantly in the export equation than in the domestic equation and has a strong decreasing effect on rate per mile. Both weak (BC) and strong barge competition (BCS) lower rail rates. Strong barge competition, however, does not lower rail rates for trip distances less than 826 miles. Barge transportation competes more strongly with railroads for grain shipments over greater distances. Shorter distances usually do not merit incurring the higher trucking and transfer costs associated with moving grain to water access points.

In the estimated wheat rate equation, the coefficient on distance (DT) is negative; the coefficient on distance squared (DTS) is positive. These results suggest that export wheat rates decrease at a decreasing rate with

TABLE 3. EMPIRICAL RESULTS OF THE U.S. EXPORT FREIGHT RATES: WHEAT, CORN, AND AGGREGATE GRAIN

Variable	Wheat		Aggregate		Corn	
	Coefficient	(t-Value)	Coefficient	(t-Value)	Coefficient	(t-Value)
DT	-.341	-5.55	.122	11.36	$.795 \times 10^{-1}$	8.16
DTS	$.317 \times 10^{-3}$	7.44	$-.539 \times 10^{-4}$	-5.79	$.192 \times 10^{-4}$	3.57
OD1	-358.47	-4.50	21.35	6.48	--	
OD2	--		-8.97	-2.18	-7.67	-1.76
OD3	88.64	9.88	11.70	1.80	15.97	2.84
OD4	--		-26.30	-2.49	--	
OD1xDT	.533	3.40	$-.357 \times 10^{-1}$	-6.57	$.417 \times 10^{-1}$	4.74
OD4xDT	.144	6.81	.115	4.38	$.466 \times 10^{-1}$	6.59
OD1xDTS	$-.237 \times 10^{-3}$	-2.61	--		$-.595 \times 10^{-4}$	-6.57
OD5xDTS	--		--		$.355 \times 10^{-4}$	6.15
OD4xDTS	$-.971 \times 10^{-4}$	-6.52	$-.747 \times 10^{-4}$	-4.32	$-.295 \times 10^{-4}$	-5.38
DDE	260.31	5.80	--		--	
DDG	-43.65	-1.87	20.93	2.32	--	
DDW	-100.15	-4.45	--		49.11	6.05
DDExDT	--		--		$.127 \times 10^{-1}$	5.11
DDGxDT	.269	4.10	$-.704 \times 10^{-1}$	-3.44	--	
DDWxDT	.378	5.94	$-.985 \times 10^{-4}$	-5.28	$-.489 \times 10^{-1}$	-7.11
DDExDTS	$-.156 \times 10^{-3}$	-6.00	$.196 \times 10^{-4}$	4.36	--	
DDGxDTS	$-.209 \times 10^{-3}$	-4.91	$.563 \times 10^{-4}$	4.33	--	
DDWxDTS	$-.263 \times 10^{-3}$	-6.39	$.893 \times 10^{-4}$	5.09	--	
BCS	--		19.02	3.18	32.36	5.32
BCxDT	--		$-.653 \times 10^{-2}$	-2.22	$-.486 \times 10^{-2}$	-2.35
BCSxDT	--		$-.218 \times 10^{-1}$	-2.95	$-.392 \times 10^{-2}$	-6.38
V	--		$-.300 \times 10^{-2}$	-16.71	$-.183 \times 10^{-2}$	-3.31
VxDT	$-.429 \times 10^{-5}$	-7.45	--		$-.169 \times 10^{-5}$	-3.20
FQxDT	--		$-.322 \times 10^{-3}$	-6.18	$-.259 \times 10^{-3}$	-3.95
CSD	--		--		27.95	8.13
CSDxDT	--		--		$-.382 \times 10^{-1}$	-11.98
Intercept	19.45	6.52	30.04	10.06	19.79	4.72
R^2	.9580		.9333		.9525	
Standard Error	10.98		6.39		9.91	

mileage (up to 542 miles), then increase. In other words, the basic export wheat rate with respect to mileage is negative up to 542 miles, but increases thereafter. The slope and intercept shifters, however, in many cases do change the coefficients on miles and miles squared; yet, the rates usually increases at an increasing rate. However, barge comeptition (BC) does not enter significantly, nor does shipment frequency (FQ) for the wheat export rate equation.

The basic structure of the export corn rate equation is different from those of wheat and aggregate grain equations. The coefficient on distance (DT) is postive; the coefficient on distance squared (DTS) is negative. This suggests that rates increase at a decreasing rate with hauling distance. The presence of barge competition (BC) and the use of multiple-car shipment systems strongly moderate corn export rates to the Gulf. For hauling distances greater than 2,246 miles, strong barge competition has a stronger negative effect on rates than does weak barge competition. For distances less than 872 miles, strong barge competiiton has a positive effect on rail rates. However, as stated previously, these may be reasonable results since barge compete with railways primarily for long distance grain movements. Therefore, export rate for corn is a function of route origin (OD) and destination (ED), degree of barge competition (BC), and volume of frequency (FQ) of shipments as well as hauling distance (DT).

The aggregate export equation also strongly indicates that the export rail rate structure is not consistent throughout the United States. The corn rate differs from the wheat rate; it has a higher intercept and increases at a slower rate than wheat. Corn export rates have a higher intercept but lower rate per mile increase than do wheat rates. Beyond a hauling distance of 732 miles corn export rates are lower than wheat rates.

The effect of multiple car shipments on export rates is also strongly evidenced in the aggregate export rate function. The coefficients on volume (V), volume

interacting with mileage, and frequency (FQ) interacting with mileage are all negative. This is to say, increasing frequency also shifts rate per mile downward. Hence, as volume (V) and shipment frequency (FQ) increase, the effect of multiple car shipment systems on export rates is greater.

COMPARATIVE ANALYSIS OF U.S. AND CANADIAN EXPERIENCES

Based on the empirical results for both domestic and export equations shown on Tables 2 and 3, region specific rate equations (truncated) by route are derived by adjusting origin and destination dummy variables. These equations will be now called "route equations" (i.e., equivalent to rate-distance curve in Figure 1) and are presented in Table 4 for domestic routes and in Table 5 for export routes. These route equations represent regional characteristics associated with the corresponding route. Since coefficients for the distance variable are all positive as expected, freight rate increase as hauling distance (DT) increases. However, whether the rate of increase is at an increasing rate, a decreasing rate, or a constant rate depends entirely on the sign and magnitude of coefficients of distance squared (DTS).

Although, there are some differences between the wheat and corn route equations in terms of the magnitude of the coefficients and the signs for distance squared, they exhibit generally similar patterns for each route. Therefore, aggregate equations for domestic and export movements will be used for further analysis. Most route equations have negative coefficients on distance squared term; except

TABLE 4. TRUNCATED FREIGHT RATE EQUATIONS FOR U.S. DOMESTIC ROUTES AND WESTERN CANADA'S ROUTE

Equation No.	Routes: Origin	Routes: Destination	Intercept	Mile	Mile Squared
Wheat					
1	1	1	17.37	0.207	-0.0000828
2	3	3	17.37	0.207	-0.0000823
3	4	4	24.17	0.197	-0.0000828
4	5	3 or 6	-6.87	0.299	-0.0000828
Corn and Soybeans					
5	1	1	40.75	0.076	0.000066
6	2	2	16.12	0.074	-0.000004
7	3	3	12.15	0.267	-0.000216
8	3	4	12.15	0.283	-0.000216
9	4	4	32.19	0.144	-0.000031
10	5	3 or 6	-4.30	0.1335	-0.000216
Aggregate					
11	1	1	40.49	0.087	+0.000056
12	2	2	16.79	0.080	-0.000002
13	3	3	10.71	0.276	-0.000208
14	3	4	10.71	0.325	-0.00029
15	5	3 or 6	-0.70	0.276	-0.000068
16	4	4	30.06	0.162	-0.0000424
17	5	5	-0.70	0.276	-0.000105
Canada					
18	CN[a]		32.7*	0.196*	--
19	CP[b]		32.7*	0.196*	--

[a]Canadian National Railway's special commodity rates for grain, flaxseed, and rapeseed within Western Canada, effective April 1, 1982. R^2 for CN equation is 0.99.

[b]Canadian Pacific Railway's commodity rates for grain, flaxseed, and rapeseed within Western Canada, effective June 10, 1982. R^2 for CP equation is 0.99.

*T-Values are significant at the 99 percent level.

SOURCE for Canadian Route Equations: Western Grain Transportation: Report of the Task Force on Routes, November 1982, p. 3-4.

TABLE 5. TRUNCATED FREIGHT RATE EQUATIONS FOR U.S. EXPORT ROUTES AND WESTERN CANADA'S ROUTE

Equation No.	Routes: Origin	Routes: Destination	Intercept	Mile	Mile Squared
Wheat					
1	1	East	-6.71	0.192	-0.000076
2	3	Gulf	47.80	-0.072	0.000109
3	4	Gulf	47.80	-0.072	0.0000109
4	5	Lake	180.09	-0.341	0.000317
5	5	West	79.94	0.037	0.000054
Corn and Soybeans					
6	1	East	51.39	0.0863	-0.0000343
7	1	Gulf	72.32	0.0159	0.0000024
8	2	East	21.07	0.0863	-0.0000343
9	2	Gulf	21.07	0.0516	0.0000024
10	3	Lake	30.04	0.122	-0.0000539
11	3	Gulf	50.97	0.0516	0.0000024
12	4	Gulf	24.67	0.1666	-0.0000723
13	5	Lake	41.74	0.122	-0.0000539
Aggregate					
14	1	East	19.79	0.1339	-0.0000403
15	1	Gulf	19.79	0.0922	-0.0000403
16	2	East	12.12	0.0922	-0.0000192
17	2	Gulf	44.48	0.0403	-0.0000192
18	3	Lake	19.79	0.0795	0.0000192
19	3	Gulf	52.15	0.0311	0.0000192
20	4	Gulf	52.15	0.0969	-0.0000191
21	5	West	84.87	0.0106	0.0000547
22	5	Lake	35.74	0.0795	0.0000547
Canada					
23	Statutory Grain Moved by CN		5.7*	0.018*	--
24	Statutory Grain Moved by CP		6.0*	0.018*	--

*T-Values are statistically significant at the 99 percent level. R^2 for both CN and CP equations are 0.99, respectively.

SOURCE for Canadian Route Equations: Western Grain Transportation: Report of the Task Force on Routes, November 1982, p. 3-4.

equation 11 representing the route between origin and destination Region 1 (Table 4). The postive coefficients on the distance squared term in equation 11 indicate that rail rates increase at an increasing rate with hauling distance. This is mainly due to rail operating costs associated with high rail line density and poor track condition in the region. High rail line density has dual effects on grain rate determination; increases in rail rates because of an increasing number of switches and reduction of rail rates because of strong intra-modal competition. Rail rates are influenced more by switches than intra-modal competition since intra-modal competition is limited under Interstate Commerce Commission jurisdiction. Route equations 12 through 17 are concave from origin indicating that rates increase at a decreasing rate with respect to hauling distance (Figure 2). However, the degree of concavity is different for each route equation. Equations 15 and 17 are particularly noticeable. They represent freight rates within Region 5 and from Region 5 to the west and east. For hauling distances greater than 400 miles, the two route equations show the highest freight rates in the U.S. This implies that states such as Montana and South Dakota have transportation cost disadvantages in marketing their grain. The route with the lowest rail rates is within Region 2. For the most common hauling distance for domestic grain movements (400 miles), the rail rate in Region 2 is about $.48 per 100 pounds, which is about $.40 lower than the rate in Region 5.

Regarding route equations for export shipments for all grains, equations 18, 19, 21, and 22 are convex from the origin indicating rail rates represented by the equations increase at an increasing rate as hauling distance increases (Figure 3). Other equations are concave from the origin. The convexity in route equations is largely due to insufficient inter-modal competition and characteristics associated with route origins and distance. For instance, most shipping points in Regions 3 and 5 do not have sufficient inter-modal competition in shipping grain to the West Coast. However, western Montana and Idaho ship grain to the Snake River and barge to the West Coast. Also, the West Coast and Lake Region ports require a relatively small amount of grain for export shipment-a comparative disadvantage for multiple-car shipments over the Gulf ports. Equations 18 and 22 have negligible effects with miles squared for most common hauling distances (300-500 miles) in the corresponding routes, and give lower rates than those representing the western states. Rates for the routes originating from Region 2 are lower than rates from other regions mainly beacuse of track condition and barge competition. For example, export rates are about $.74 per 100 pounds in Equation 17 (from Region 2 to the Gulf) for the hauling distance of 1,000 miles, $.85 per 100 pounds in Equation 16 (from Region 2 to the East), and $1.70 per 100 pounds in Equations 21 and 22 from Region 5 to the West and Lake ports).

In Canada, about 90 percent of six major grains (wheat, oats, barley, rye, flaxseed, and rapeseed) are

produced in the three prairie provinces and the large proportion of them are exported through the Canadian Wheat Board. The rail freight rate for export movement of grain is subject to the statutory rail freight rate, widely known as the Crows Nest Pass Agreement of 1897. This insures that rates on grain and flour traffic moving from the Prairies to export ports such as Thunder Bay in Ontario, Vancouver, and Prince Rupert in British Columbia, Churchill in Manitoba are held to be 1897 level of 0.5 cents per ton-mile. For example, for a haul of 1,000 miles the rate per 100 pounds is about $.23. Domestic movements, however, are generally subject to compensatory rates with an exception of the movement under the Feed Freight Assistance Act.[7]

For comparison with the U.S. situation, two representative grain movements in Canada (i.e., domestic movements in the Western Canada; export shipments originated from the Western Canada) have been selected and their linear regression equations for rates as a function of distance are also presented in Tables 4 and 5. These equations are obtained from the recent publication entitled "Western Grain Transportation: Report of the Task Force on Rates".[8]

The Canadian rate equations for domestic movements are based on April 1, 1982 while the export movement rate is based on the statutory rate, i.e., 1897 level. They are also depicted and shown in Figures 2 and 3. The Canadian domestic rate-distance curve in Figure 2 has been adjusted to 1979 levels for inflation by using Industry Selling Price Index (1971 = 100) in Canada. The rate structure

for flaxseed, rapeseed, and grain movements in the Western Canada is shown similar pattern that of U.S. domestic freight rate equation between Region 5 to Region 3 or 6 (Figure 2) although U.S. rate level is somewhat higher.

To visualize statutory rate in comparison with U.S. export freight rate structure and compensatory rate in Western Canada, the following three situations were selected (Figure 4): (i) the U.S. export route, from Region 2 to the Gulf, which has a similar slope of the statutory rate-distance scale; (ii) the most expensive export routes in U.S., i.e., from Region 5 to the West, and from Region 5 to the Lakes; and (iii) the compensatory rate in Canada i.e, domestic shipments for grain, flaxseed, and rapeseed.

The statutory rate in Canada is compared with the U.S. Southern route (i.e., origin 2 to Gulf), note that the shapes of the curve are similar although U.S. rate level is about 5.4 times higher for a distance of 200 miles and about 2.7 times higher for 1,000 miles. When compared with the statutory rates the most expensive export route in U.S., from origin 5 to Lake, the U.S. rate is about 5.6 times higher for 200 miles and 7.1 times higher for 1,000 miles. From the same origin to West Coast in the U.S., the American freight rate is about 11 times higher for 200 miles and 7.1 times higher for 1,000 miles. Finally, compared with compensatroy rate for grain, flaxseed, and rapeseed shipments in the Western Canada the compensatory rate is higher about 5.5 times for 200 miles and about 7 times higher for 1,000 miles.

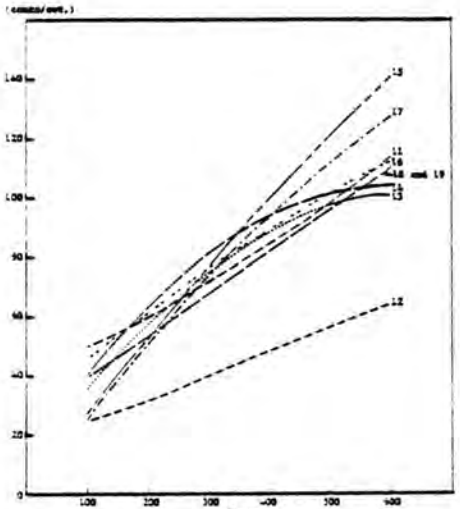


Figure 2. Freight Rate Level for Grain (Aggregate) by Domestic Income Obtained from Route Equations (Table 4)

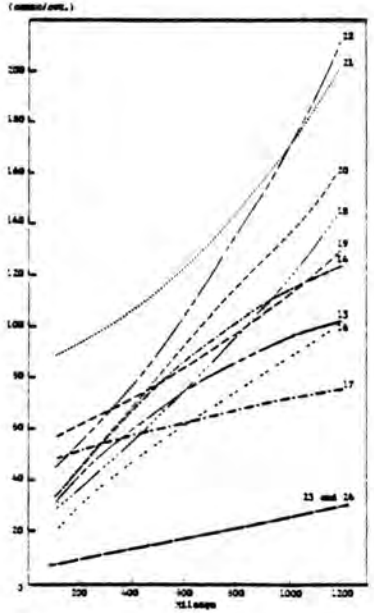


Figure 3. Freight Rate Level for Grain (Aggregate) by Export Income Obtained from Route Equations (Table 3)

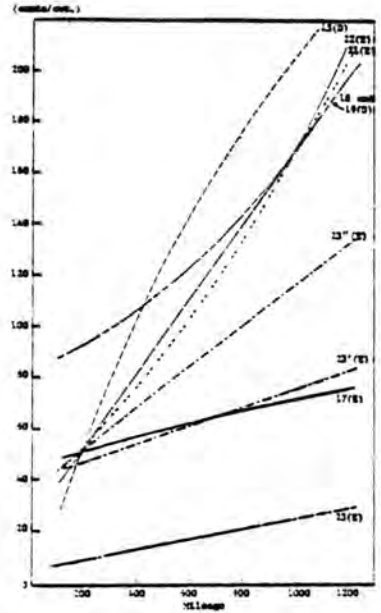


Figure 4. Freight Rate Structure for Selected U.S. and Canadian Routes

POLICY IMPLICATIONS AND CONCLUDING REMARKS

Because of the recent deregulation of the rail rate making process in the U.S., the American process has begun to converge with that of the Canada's which, for freight movements not subject to statutory rates, operates under commercial freedom allowed by the National Transportation Act (1967).

Recent legislation in the U.S. such as the Railroad Revitalization and Regulatory Reform Act of 1976 (4R Act) and the Staggers Rail Act has encouraged more temporal flexibility in rail pricing. The flexible rail pricing through both Acts may result in localized rail rate structures in the U.S. Two major changes in the U.S. may occur in the post deregulation era. They are: (i) geographical rate variations may be widened; (ii) seasonal and demand sensitive rate variations may also occur.

Regarding the first point, rate deregulation might tend to lower rail rates in the Corn Belt, and eastern and southern states if deregulation stimulates competition between rail and other modes of transportation, and among railroads. In contrast, the flexible pricing under the rate deregulation could raise rail rates in the Northern Plains. Railways in this region have limited competition with barge and truck. Rail rates in this area have been increased and are highest in the United States. More freedom for pricing through further deregulation of grain rail rates could aggravate the current localized rate structure leading to a higher price for rail services in areas where competition is limited.

The second, rail rate deregulation could bring in seasaonal rail rate variation. Railways might charge higher rates during the winter months in which river transportation is highly limited and charge lower rates during the rest of the year to maximize their revenue. The seasonal rail rates are only beneficial to both producers and consumers if seasonal rates can moderate seasonal demand. Demand for grain is not seasonal in domestic or export markets and consequently, can be controlled by seasonal rail rates. Hence, seasonal rail rates might be beneficial for only the rail industry.

The extent to which U.S. experiences in 1979 are relevant to the Western Canada depend largely on the manner in which the statutory rate is revised. If the present statutory rate scale is protected while adjusting level of freight rate (i.e., statutory rate multiply 5), it means that the statutory freight rate curve shown in Figure 4 will be shifted upward not only intercept term but also slope of the curve (see curve depicted 23 "(ED)", "statutory rate multiply 5"). Then, the revised rate structure will have much steeper slope than that of current statutory rate scale (see Figure 4). Canadian grain shippers in the Prairies will still have marketing cost advantage compare with the grain producers in the North Western route (i.e., from region 5 to West Coast or Lake). If the statutory rate revision accommodates all relevant factors of transportation, slope of the curve might be changed even further by taking into account factors such as geographical characteristics, competition

from other modes, demand, etc. This possibility is shown in the present compensatory domestic rate for grain, flaxseed, and rapeseed in the Western Canada.

In the long-run, if both countries' railways operate under commercial freedom for grain traffic, the freight rate structure for Western Canada and the North Western states (Northern Plains) may more resemble each other to the extent that they have similar transportation characteristics.

REFERENCES

1. Board of Trade of Kansas City, Missouri. Kansas City Board of Trade, Grain Rate Book. No. 42, March 1980.

2. Friedlaender, Ann F. and Richard H. Spady. Freight Transport Regulation, The MIT Press, Cambridge, Massachusetts, 1981.

3. Heaver, T. D. and J. C. Nelson. Railway Pricing Under Commercial Freedom: The Canadian Experience, The Center for Transportation Studies, University of British Columbia, 1976.

4. Johnson, J. Econometric Methods. New York: McGraw-Hill Book Co., 1972.

5. Kornhauser, Alain L., Mark Hornung, and Reggie J. Caudill. "Theory for Estimating Traffic Diversions on a Vastly Restructured U.S. Railroad System." Transportation Program Paper 79-TR-11. Princeton University, 1979.

6. Kornhauser, Alain L., Mark Hornung, Yehonathan Hazony, and Jerome M. Lutin. "The Princeton Railroad Network Model: Application of Computer Graphics in the Analysis of a Changing Railroad Industry." Transportation Program Paper 79-TR-16. Presented at the Harvard Graphics Conference, Cambridge, Massachusetts, July 1979.

7. Locklin, D. P. "The Literature on Railway Rate Theory," The Quarterly Journal of Economics, Vol. XLVII, February 1933, pp. 167-230.

8. State of Iowa, Traffic Department. Rates for Grain, October 1979.

9. Theil, Henri. Principles of Econometrics, New York, John Wiley and Sons, 1971.

10. Transportation Department, Minneapolis Grain Exchange. Grain Rate Book, No. 15, October 1979.

11. Western Grain Transportation. Report of the Task Force on Rates, November 1982.

12. Wilson, G. W. Economic Analysis of Intercity Freight Transportation, Indiana Univeristy Press, Bloomington, 1980.

FOOTNOTES

[1]The history of statutory freight for grain goes back to 1897. An agreement was reached between the federal government and Canadian Pacific Railway. Parts of this agreement specified that the government would provide a subsidy of $11,000 per mile ($3.4 million total) to assist the railway in building a line from Alberta into South-eastern British Columbia through the Crows Nest Pass; and the railway would reduce its then current grain freight rates from the prairies to Fort William/Port Arthur by $.03 per hundred pounds and would not charge higher rates in the future. In 1925 the federal government enacted legislation which applied that rate structure (to Fort William/Port Arthur) from all points in the West over all rail lines, present and future, constructed by any company subject to the jurisdiction of Parliament (e.g., included Canadian National Railway). For details see Section 271 of the National Transportation Act.

[2]Government of Canada News Release, February 1, 1983.

[3]Transportation Department, Minneapolis Grain Exchange, Grain Rate Book, No. 15, October 1979; Board of Trade of Kansas City, Grain Rate Book, No. 42, 1980; and Traffic Department, State of Iowa, Rates for Grain, October 1979.

[4]Kornhauser, Alain L., Mark Hornung, Yehonathan Hazony, and Jerome M. Lutin, "The Princeton Railroad Network Model: Application of Computer Graphics in the Analysis of a Changing Railroad Industry," Transportation Program Paper 79-TR-16, presented at the Harvard Graphics Conference, Cambridge, Massachusetts, July 1979. Kornhauser, Alain L., Mark Hornung, and Reggie J. Caudill, "Theory for Estimating Traffic Diversions on a Vastly Restructured U.S. Railroad System," Transportation Program Paper 79-TR-11, Princeton University, 1979. The rail routes chosen and associated rail mileages obtained from the Princeton Model are based on traffic density, number of interchanges or switches between railroads, condition of the railroads travelled, and travel speed feasible along possible routes. Routes chosen minimize traffic density and interchanges as well as maximize travel speed and railroad condition. Rail mileages for those routes not included in the Princeton model were calculated on the basis of the criteria used in the Princeton model.

[5]It was decided that because of the degree of collinearity among certain variables in the separate estimations and because of the large number of variables considered, presenting the same models for all six estimations would not yield meaningful results. Therefore, only variables that enter significantly into each regression are kept as explanatory variables.

[6]Estimation was carefully evaluated to detect possible multicollinearity among independent variables. Multicollinearity was not found to be a problem in the estimated equation.

[7]The transportation subsidy under Feed Freight Assistance Act contributes in varying amounts to equalizing the cost of Prairie feed grains used for livestock and poultry feeding in the Eastern Canada (Quebec and Maritimes) and B.C.

[8]See Western Grain Transportation: Report of the Task Force on Rates, November 1982, Table 1.

SOUTH IDAHO RURAL GRAIN MOVEMENTS: TECHNICAL CHANGES IMPACT ON RURAL AREAS

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ABSTRACT

Continuing change in grain handling technology and markets is bringing about adjustments in rural areas. These adjustments affect producers, truckers, grain buyers, railroads and government. Policy changes influencing the situation include the development of on-farm grain storage, sub-terminal elevators, unit trains, and multi-car freight rates. Each of these factors help to revolutionize grain handling in rural areas. Hopper cars and unit trains have necessitated investment in high speed grain handling and loading equipment. Local grain sheds are being redefined as unit train loading facilities compete for the limited amount of grain in a geographic area. Producers through on-farm storage have more marketing options.

Benefits include higher grain prices paid to producers as the advantage of lower freight rates is divided among producers and grain buyers. However, there are also costs resulting from adaptation of this new grain handling technology. Producers are hauling grain greater distances in their trucks. This increased mileage is generally on local /county and state/federal highways. Therefore, governmental units bear the cost of upgrading roads and bridges to accomodate the new traffic flow patterns. Taxes to support this upgraded road and bridge system are generally paid by all members of the community, thus receivers of the benefits

from new grain handling technology (producers, grain merchants, and grain users) are not necessarily the same people as payers of the taxes supporting the system. This paper describes the shipping patterns and discusses the changes in transportation resulting from the introduction of unit train loading (25 car) in southern Idaho by the Union Pacific Railroad.

GENERAL DESCRIPTION OF THE AREA

Idaho, a state located in the Pacific Northwest of the United States, is bordered by British Columbia and Montana to the north, Washington and Oregon to the west, Nevada and Utah to the south, and Wyoming and Montana to the east. The central part of the state contains rugged mountains which are a nationally protected river and wilderness. The main agricultural areas are, in the south, the Snake River Plain stretching from the Wyoming to Oregon borders, the Bear River Basin in the Southeast and the Camas Prairie/Palouse Hills area of north central Idaho. In addition there are numerous mountain valleys where grain and seed are produced. Generally the portions of the Snake Plain nearest the river are irrigated while the foothills are predominantly dryland production areas.

Idaho's most important grain crops are soft white wheat, hard red wheat, malting barley, and feed barley. In 1981 Idaho produced almost 90 million bushels of wheat and slightly over 63 million bushels (1,515,120 tons) of barley as shown in Table 1, Figs. 1, 2. Soft white is the majority of the wheat comprising about 80 percent of all wheat produced. Almost all the remaining wheat is red. Soft white is

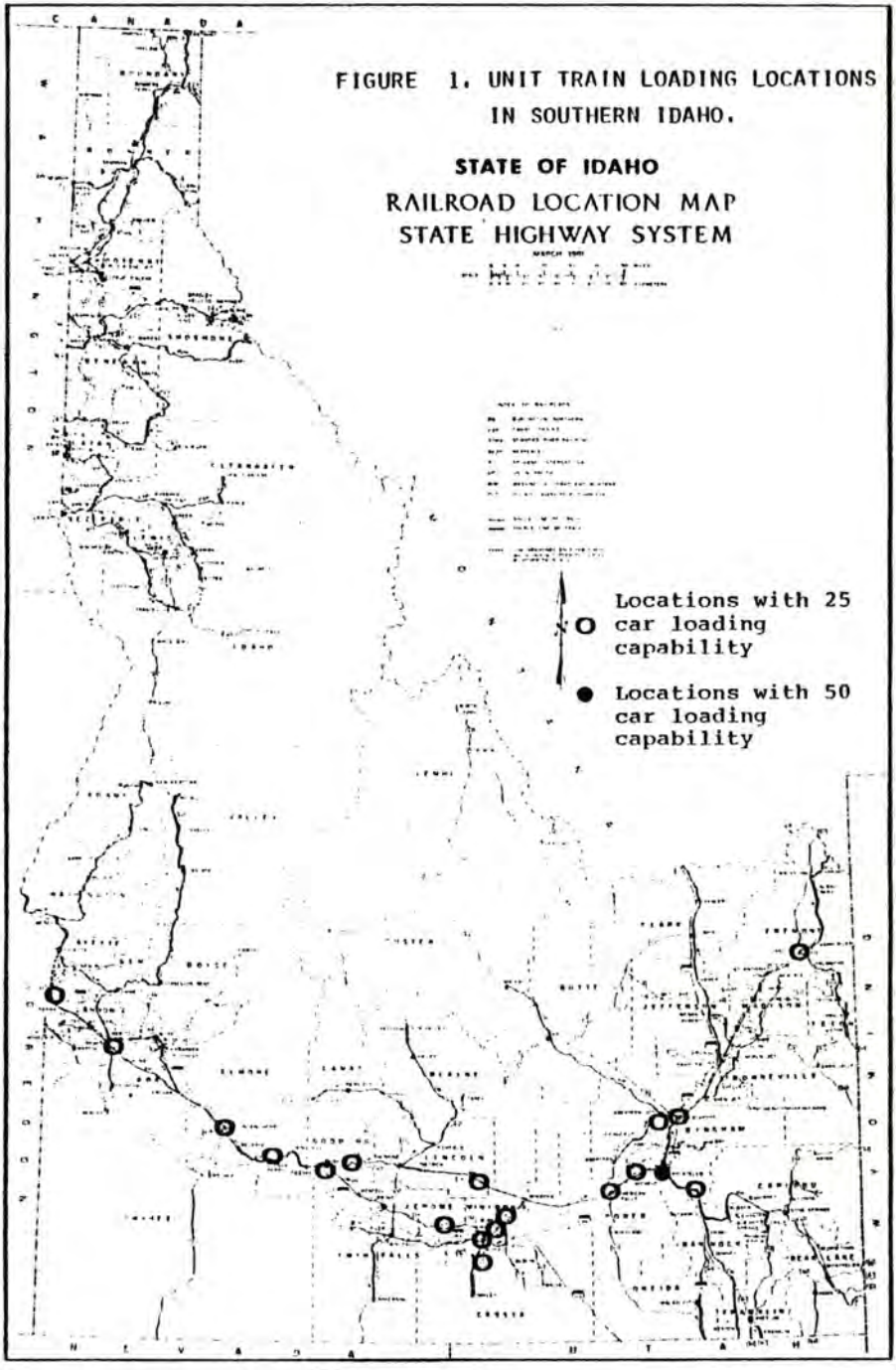
Table 1. Idaho 1981 Acreages and Bushels.

	Barley		Wheat	
	Acres Harvested	Bushels[1/]	Acres Harvested	Bushels
North				
Benewah	12,600	441,000	26,900	1,432,000
Bonner	800	25,800	500	23,100
Boundary	15,300	963,900	14,300	892,000
Clearwater	7,700	354,200	8,900	467,600
Idaho	45,600	2,062,500	67,600	3,487,400
Kootenai	10,600	407,000	21,200	1,088,700
Latah	48,300	2,167,500	96,500	6,459,200
Lewis	47,600	2,142,000	61,900	3,529,700
Nez Perce	36,500	1,755,700	97,700	6,660,900
Shoshone	---	---	---	---
District Total	225,000	10,319,600	391,500	24,040,600
Southwest				
Ada	17,800	1,451,400	12,800	977,400
Adams	1,200	70,800	800	38,300
Boise	200	9,700	100	3,500
Canyon	25,500	2,239,800	36,300	3,195,100
Elmore	5,700	375,900	27,900	2,074,500
Gem	2,800	201,500	3,500	284,900
Owyhee	7,100	568,000	12,900	1,046,600
Payette	7,500	592,500	8,600	719,300
Valley	700	37,500	100	2,000
Washington	7,500	439,800	20,500	1,234,400
District Total	76,000	5,986,900	123,500	9,576,000

1/For conversion to tons, a bushel of barley weighs 48 pounds, therefore 41.7 bushels equals 1 ton.

South Central				
Blaine	16,600	1,044,200	4,500	228,000
Camas	19,300	788,200	8,100	202,500
Cassia	37,400	2,913,600	102,300	6,508,300
Gooding	4,900	396,900	13,700	1,167,800
Jerome	16,000	1,280,000	39,900	3,281,100
Lincoln	12,200	866,200	13,000	906,900
Minidoka	34,600	2,871,800	47,100	3,774,800
Twin Falls	25,000	2,066,400	39,900	3,361,600
District Total	166,000	12,227,300	268,500	19,431,000
Southeast				
Bannock	29,000	1,397,200	59,200	2,475,200
Bear Lake	14,200	565,700	19,100	387,600
Bingham	40,800	2,966,800	134,000	9,465,100
Bonneville	58,100	3,720,800	86,000	4,494,300
Butte	19,600	1,332,000	5,200	280,000
Caribou	95,100	4,987,200	45,000	1,780,900
Clark	10,000	673,000	12,200	574,100
Custer	8,400	562,800	500	31,600
Franklin	26,800	1,419,700	30,800	1,301,600
Fremont	90,100	4,653,800	24,000	1,145,600
Jefferson	51,000	3,731,800	32,900	2,310,300
Lemhi	3,000	186,000	200	11,800
Madison	60,500	3,666,900	39,800	2,212,500
Oneida	36,400	1,681,200	69,000	1,964,600
Power	10,700	573,600	159,000	7,883,700
Teton	49,300	2,477,700	9,600	413,500
District Total	603,000	34,596,200	726,500	36,732,400
State Total	1,070,000	63,130,000	1,510,000	89,780,000

FIGURE 1. UNIT TRAIN LOADING LOCATIONS IN SOUTHERN IDAHO.



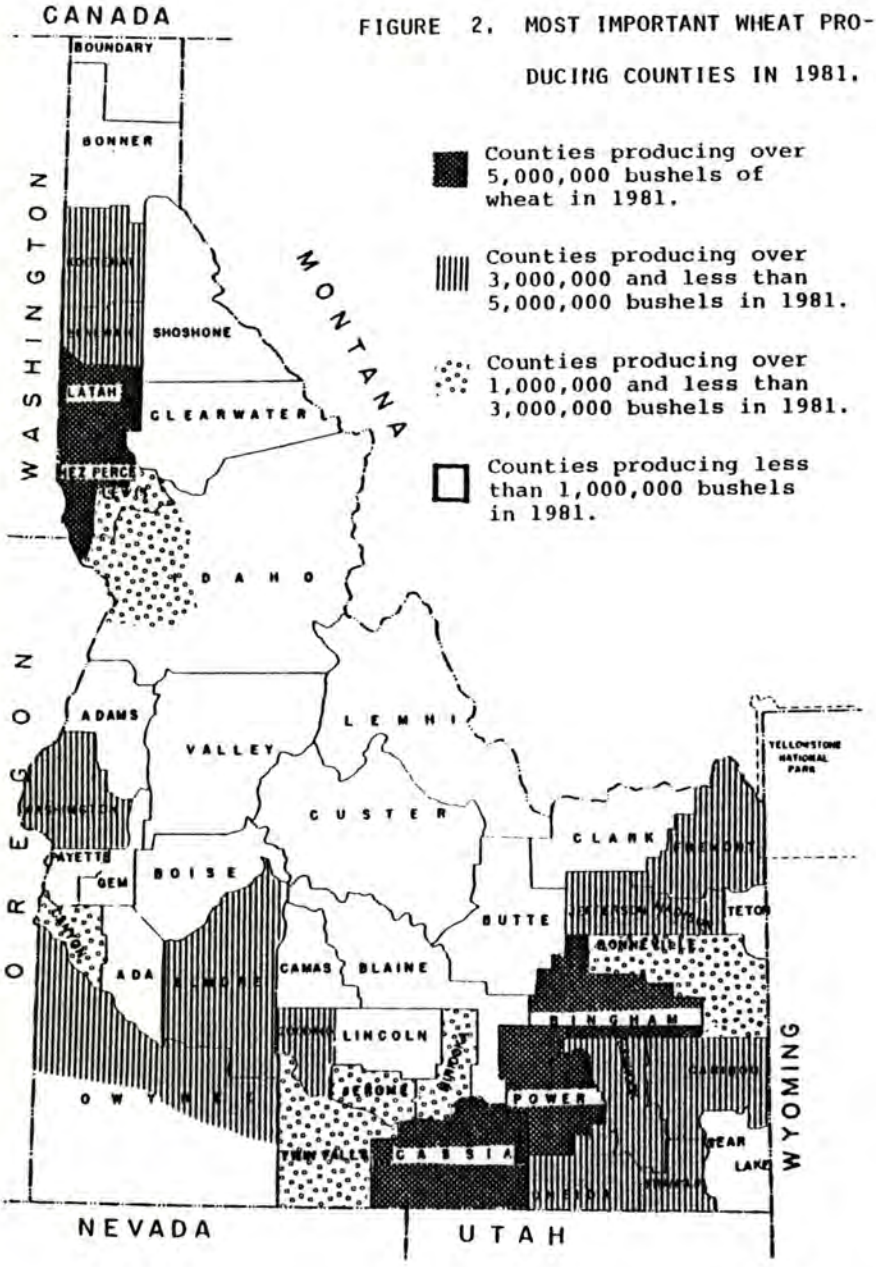


FIGURE 2. MOST IMPORTANT WHEAT PRODUCING COUNTIES IN 1981.

mainly for export whereas the hard red is for domestic consumption in the southwestern United States and for export. Barley, the second most important grain is an alternate crop and often a part of the crop rotation system. The majority of the South Idaho malting barley is produced in southeastern Idaho. It is shipped to Washington, Colorado, and the Midwest for processing into malt. Feed barley produced in southern Idaho is consumed by cattle in feedlots on the Snake River Plain and shipped to feedlots in California.

DATA DESCRIPTION

Primary data for this study come from two sources. During early summer 1982, Idaho grain merchandizers were interviewed concerning how they transported agricultural commodities. In addition, through a mail survey, during Fall 1982, wheat and barley producers were quized concerning their grain transportation and handling patterns.

All large grain dealers and a random sample of smaller grain dealers willing to cooperate were interviewed. Dealer questions centered on grain delivery to their plant and how grain was shipped to the user or exporter. In total 37 grain merchants were interviewed.

In September 1982 mail survey forms were sent to 1,321 grain producers in Idaho. Nine hundred and sixty-four persons returned useable questionnaires. Using the Dillman "Total Design Method," a 78 percent response rate was achieved (Dillman, p. 50).

IDAHO GRAIN TRANSPORTATION FACILITIES

South Idaho has traditionally shipped grain by rail with smaller amounts moving by truck. Introduction of 25

car rates by Union Pacific Railroad in 1980 and 3-5 car rates in 1982 for shipments to a common destination opened new opportunities for freight cost savings. This new technology of 25 car loadings required investments in hopper cars, grain handling equipment and railroad sidings. Paying for this new investment requires handling large grain volumes. Locations in Idaho presently capable of loading 25 car trains are shown in Figure 1. At present there are 19 locations (1 at Nyssa, OR) capable of loading 25 car trains. Each railroad hopper car is capable of carrying about 3,200 bushels, wheat or 3,500 bushels of barley, therefore each 25 car unit train is capable of carrying approximately 80,000 bushels of wheat or 87,500 bushels of barley. Assuming a 5-axle semi-truck carries 800 bushels wheat, and one 25 car train is equivalent to 100 truck loads. At present, March 1983, the freight cost reduction for moving grain by unit train from eastern Idaho to Columbia River ports is as much as 45 cents per bushel (Casavant, Dooley, and Meyer) under the single car rate.

Trucks handle virtually all on-farm grain movements. On-farm truck movements are almost entirely on private and local roads. For farm to market grain transport local state/federal roads provide the route. For long distance transport state/federal roads dominate the routing.

STUDY OBJECTIVES

This study describes the farm to market grain shipment patterns in south Idaho and analyzes the effect new technology has on rural Idaho grain transportation. The specific objectives include:

(1) Describing the wheat and barley shipping patterns from field to central collection point or the user/exporter.

(2) Describing the relative contributions of private, local, and state/federal roads used to transport wheat.

(3) Identifying the types of trucks used to move grain.

(4) Analyzing the impact that introduction of unit train loading facilities has had on local grain shipping patterns.

WHEAT SHIPPING PATTERNS

Grain shipping distances from producer fields or on-farm storage to market are expected to increase as grain buyers adapt the technology necessary to load 25 car trains in 24 hour periods. Because almost all of the soft white wheat is irrigated, it is grown closer to the Snake River and nearer established communities (market centers) making expected transport distances shorter than for red wheat. However, as new technology is introduced, the distance grain is hauled is expected to increase as producers choose to capture the benefits of higher prices at unit train loading locations. Considering all of south Idaho, the mean one-way distance from field to market for all wheat is 16.5 miles with white wheat haul distance being 15.4 miles and the red wheat haul distance being 18.6 miles. The respective haul distances for all wheat, white wheat and red wheat from producer fields to commerical storage were 13.0, 11.9, and 15.1 miles. Owned storage to market showed a similar order of transport distance of 17.9 miles for all wheat,

17.1 miles for white wheat and 19.6 miles for red wheat.[1/]

With the introduction of 25 car unit grain trains on the Union Pacific Railroad in 1980 the price paid to producers for grain would be expected to rise. This is because part of the benefit (reduced shipping cost) gained by using unit trains would need to be shared with producers to bid wheat away from other buyers. Producer grain shipment distances to unit train loading sites are greater than to other marketing destinations in south Idaho. White wheat's mean field to market transport distance is 15.5 miles to unit train loading sites compared with 10.1 to non-unit train loading destinations (Table 2). For all wheat, the mean field to market distance was 16.9 miles at unit train loading destinations versus 12.6 miles at non-unit train loading destinations. Analysis of distances from producer owned storage to market showed similar relationships. The mean miles from white wheat producers owned storage to market was 15.4 miles to unit train loading sites compared with 12.0 miles to non-unit train loading sites. For all wheat producers in south Idaho, the mean distance wheat is shipped to unit train loading sites from owned storages is 15.8 miles compared to 13.7 miles to non-unit train loading sites. Introduction of unit trains increased the wheat shed or the mean miles wheat is hauled in each case.

Destination distances were greater for red wheat than for white wheat. Because the majority of the red wheat is grown on dryland at upper elevations, the haul distance to

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[1/] Our survey data showed 78% of the grain producers had on-farm storage with a mean volume of 43,312 bushels for grain.

Table 2. Distance Wheat is Hauled to Unit Train Loading Destinations and Non-Unit Train Loading Destinations.

	Unit Train Destinations			Non-Unit Train Destinations		
	Mean Miles	Max. Miles	No. Obs.	Mean Miles	Max. Miles	No. Obs.
White Wheat						
Field to Commercial Storage	15.0	135	97	7.1	60	61
Field to Market	15.5	60	81	15.1 [10.1][a]	250	48 [47]
Own Storage to Market	15.4	60	49	19.7 [12.0][a]	250	31 [30]
All Wheat Producers						
Field to Commercial Storage	16.8 [15.8][b]	135	124	8.6	40	106
Field to Market	16.9	80	102	15.9 [12.6][a]	250	72 [71]
Own Storage to Market	17.4 [15.8][c]	120	66 [65]	18.8 [13.7][a]	250	47 [46]

a/ Maximum of 250 omitted, mean was then recalculated without this high outlier.

b/ Maximum of 135 omitted, mean was then recalculated without this high outlier.

c/ Maximum of 120 omitted, mean was then recalculated without this high outlier.

market is greater. Comparing the mean transport distance for red wheat (Table 3) with white wheat's the mean field to market distance is 3.2 miles greater and the mean owned storage to market distance is 2.5 miles further.

In summary, for locations with unit train loading facilities, the mean distance wheat is hauled to market from producer's fields is 16.9 miles. This compares with 12.6 miles from producer's fields to non-unit train loading market sites. This is a difference of 4.3 miles one-way or a 34 percent greater wheat haul distance to a unit train loading site.

BARLEY SHIPPING PATTERNS

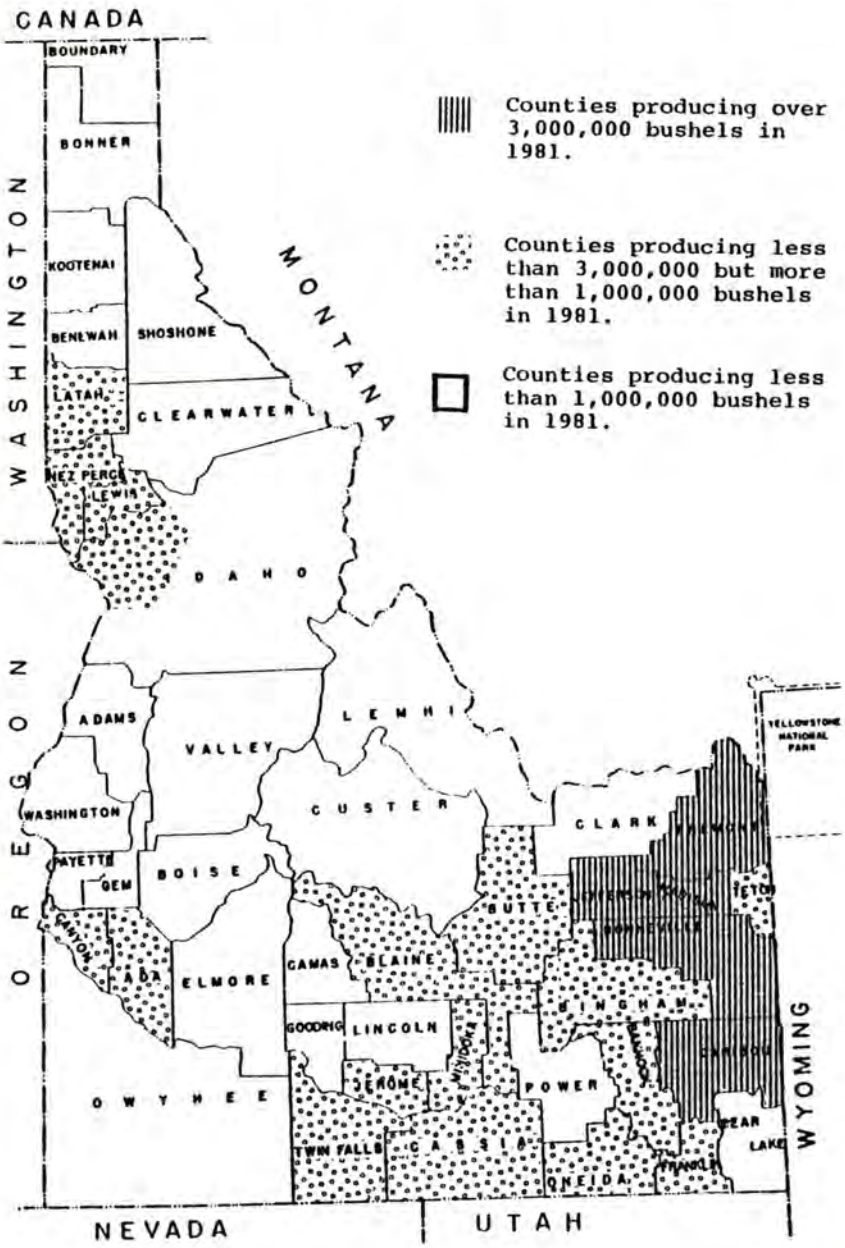
Barley, which is mainly a domestic crop, is expected to have a slightly different shipping pattern. A considerable volume of feed barley moves directly from the producer to the user. Malting barley is often shipped directly from the farmer to the malter. Barley production for Idaho in 1981 was 63,130,000 bushels (Table 1). Figure 3 shows the barley production is in the eastern part of Idaho. Because barley is part of the crop rotation pattern with wheat, it is grown in many of the same areas. In certain higher elevation counties such as Caribóu, Fremont and Teton, it is the main crop. Introducing unit trains was expected to have an effect on barley movements similar to wheat. However, because special rates for domestic barley movement were introduced later, the impact is not shown in the available data.

Considering all of south Idaho, the mean one-way field to market distance for feed barley was 19.3 miles and

Table 3. Distances in Miles South Idaho Wheat is Hauled.

Destinations All South Idaho	Mean Distance	Minimum Distance	Maximum Distance	Number of Observations	Standard Error
White Wheat					
Field to Commercial Storage	11.9	1	135	158	1.515
Field to Market	15.4	2	250	128	3.152
Own Storage to Market	17.1	2	250	80	3.279
Red Wheat					
Field to Commercial Storage	15.1	2	120	101	1.104
Field to Market	18.6	2	200	71	2.129
Own Storage to Market	19.6	3	120	50	3.251
All Wheat					
Field to Commercial Storage	13.0	1	135	229	0.965
Field to Market	16.5	2	250	172	1.997
Own Storage to Market	17.9	2	250	112	2.669

FIGURE 3. IDAHO BARLEY PRODUCING COUNTIES IN 1981.



18.5 miles for malting barley (Table 4). Respective haul distances from producer fields to commerical storage were 11.9 miles for feed barley and 13.8 miles for malting barley. Owned storage to market showed a similar order of mean transport distances with 22.6 miles for feed barley and 13.8 miles for malting barley.

Union Pacific's introducing 25 car unit grain trains in 1980 provided the opportunity for prices paid to producers to rise at locations capable of loading unit trains as the benefit of lower freight rates are shared among producers and grain handlers. Barley transport distances are expected to be greater to unit train loading sites as producers bear the extra expense of shipping greater distances to secure higher prices. Feed barley's mean field to market distance to unit train loading sites was 16.0 miles compared to 20.9 miles to other marketing destinations (Table 5). For hauls of feed barley from producer owned storage to market the distance was greater for non-unit train loading sites. This may also be because the domestic destination rates for barley had not yet been implemented or this may be because considerable feed barley moves directly to feedlots. Malting barley's mean field to market transport distance to unit train loading site was 17.8 compared to 9.8 miles to other marketing destinations. Producers hauled malting barley further to unit train loading sites but the sample size was very small implying limited reliability.

Destination distances were greater for feed barley than for malting barley. (Barley was considered to be at

Table 4. Mean Distance in Miles Barley is Transported to Market Destination.

	Malt Barley			Feed Barley		
	Mean Miles	Max.	Obs.	Mean Miles	Max.	Obs.
Field to Commercial Storage	13.8	135	44	11.9	60	158
Field to Market	18.5	110	40	21.4[19.3][a]	250	110 [109]
Own Storage to Market	13.8	90	25	25.8[22.6][a]	250	72 [71]

[a] Outlier of 250 omitted from mean.

Table 5. Mean Distance Barley is Hauled to Unit Train Loading Destinations and Non-Unit Train Loading Destinations in South Idaho.

	Unit Train Destinations			Destinations Excluding Unit Train Destinations		
	Mean Miles	Max.	#Obs.	Mean Miles	Max.	#Obs.
Feed Barley						
Field to Commercial Storage	14.3	60	75	9.7	40	83
Field to Market	17.4 [16.0][c]	90	54 [53]	25.0 [20.9][a]	250	56 [55]
Own Storage to Market	19.2 [16.6][c]	90	28 [27]	30.1 [24.9][a]	250	43
Malting Barley						
Field to Commercial Storage	15.0 [10.4][d]	135	27 [26]	11.9	40	17
Field to Market	22.2 [17.8][e]	110	25 [24]	12.5 [9.8][b]	50	15 [14]
Own Storage to Market	13.2 [8.4][f]	90	17 [16]	15.0 [10.0][b]	50	8 [7]

a/Maximum of 250 omitted, mean was then recalculated without this high outlier.
b/Maximum of 50 omitted, mean was then recalcualted without this high outlier.
c/Maximum of 90 omitted, mean was then recalculated without this high outlier.
d/Maximum of 135 omitted, mean was then recalculated without this high outlier.
e/Maximum of 110 omitted, mean was then recalculated without this high outlier.
f/Maximum of 90 omitted, mean was then recalculated without this high outlier.

its destination when title changed.) The mean field to market distance for feed barley was only .8 mile greater than malting barley while the mean owned storage to market distance for feed barley was 8.8 miles greater than malting barley. This implies that once harvest is over and grain is in owned storage, people are much more willing to haul it greater distances in the marketing process.

PRIVATE, LOCAL/COUNTY, AND STATE/FEDERAL ROADS

Moving grain from the field to market involves using private roads, local highway district or county roads, plus state and federal roads. As grain handling facilities are updated, trucks tend to travel farther to deliver grain. Trip length is increased as producers transport grain greater distances to take advantage of higher prices. Table 6 shows the percentage of mileage on each type road for trips to alternative destinations. Transport from the producer's field to producer owned storage has the greatest proportion on private roads. Private road proportions for all wheat, red wheat, white wheat, malting barley and feed barley are respectively 31.1, 31.0, 32.5, 29.5, and 33.8 percent. All are slightly over 30 percent for this first leg of the field to consumer trip. For grain moving directly to market the mean percentages are smaller for private roads and local/county roads as shown in Table 6. Actual mean distances are usually less than a mile for the private road proportion (Table 7). With the exception of malting barley, owned storage to market transport distances were greater than field to market transport distances and this additional distance used state/federal highways.

Table 6. Percent of Transport Mileage on Private, Local/ County, and State/Federal Roads for Each Trip.

Mean	Field to Commercial Storage*	Field to Market*	Owned Storage to Market*	Field to Owned Storage*
All Wheat				
% Private Road	5.6	4.1	2.4	31.1
% Local/County Rd.	50.9	42.2	37.2	55.1
% State/Fed. Hwy.	42.8	52.7	59.6	13.5
Red Wheat				
% Private Road	6.1	5.2	2.3	31.0
% Local/County Rd.	50.2	39.2	35.2	54.1
% State/Fed. Hwy.	43.5	54.8	62.0	14.5
White Wheat				
% Private Road	5.7	4.3	3.2	32.5
% Local/County Rd.	49.0	43.9	36.7	54.9
% State/Fed. Hwy.	44.0	50.9	58.7	12.3
Malting Barley				
% Private Road	7.9	5.0	3.6	29.5
% Local/County Rd.	50.9	39.6	35.0	55.0
% State/Fed. Hwy.	40.2	54.5	59.4	15.6
Feed Barley				
% Private Road	5.8	4.2	1.6	33.8
% Local/County Rd.	53.1	44.3	39.7	53.6
% State/Fed. Hwy.	40.3	50.1	57.7	12.0

*Numbers do not total to 100% due to rounding.

Table 7. Mean Mileage for Grain Transport in South Idaho.

	Field to Commercial Storage	Field to Market	Owned Storage to Market
White Wheat			
Private road	.7	.7	.6
Local/county road	5.9	6.8	6.3
State/federal highway	5.3	7.9	10.2
Mean trip (one-way)	11.9	15.4	17.1
Red Wheat			
Private road	.9	1.0	.5
Local/county road	7.6	7.3	6.9
State/federal highway	6.6	10.3	12.2
Mean trip (one-way)	15.1	18.6	19.6
All Wheat			
Private road	.7	.7	.4
Local/county road	6.6	7.0	6.6
State/federal highway	5.7	8.8	10.7
Mean trip (one-way)	13.0	16.5	17.9
Malting Barley			
Private road	1.1	1.0	.6
Local/county road	7.1	7.4	4.9
State/federal highway	5.6	10.1	8.3
Mean trip (one-way)	13.8	18.5	13.8
Feed Barley			
Private road	.7	.9	.4
Local/county road	6.4	8.6	9.0
State/federal highway	4.8	9.8	13.2
Mean trip (one-way)	11.9	19.3	22.6

As new grain handling technology is adopted and new freight or contract rates are utilized, the distance producers transport grain to market increases because not all market points can afford the new investment and have the volume necessary to pay for new investment. This results in grain being transported greater distances to fewer buying points. Often the new grain shed transportation routes will use roads designed for lower volume and weights as some market points are phased out.[2/] The direct truck operating costs are paid by producers or those hiring the transport service.[3/] Indirect costs of road maintenance, bridge and grade improvement, and new construction must also be paid. Particularly for local and county roads, local taxes are the financial base. This means non-truckers are paying part of the cost. The distribution of benefits and cost from these newly designed grain sheds is an area needing further research.

TRUCK TYPES

Trucks are required to move grain from producer fields to on-farm storage, local commercial storage, and local or regional markets. Among survey participants 92 percent owned at least 1 truck and 68 percent owned more than 1

[2/] Closing market points reduces retail volume for the community in two ways. First, reducing grain traffic to a community reduces retail receipts and second, as producers make more efficient use of higher transport cost, by purchasing goods in the marketing center to avoid empty haul back (Maloney p. 98-99).

[3/] Most Idaho farm trucks are registered as 0-16,000 or 16-26,000 pound gross weights and can be registered for a minimum of 3 months. In addition, the state fuel tax for farm trucks is 14.5¢ per gallon and the federal tax is 9¢ per gallon for a total of 23.5¢ per gallon.

truck. Of the trucks owned by producers surveyed (Table 8), 64 percent were straight two-axle while three axle tandoms comprised 30 percent. Semi-trailers comprised the remaining 6 percent of the trucks owned by producers. Gasoline powered 89 percent of the trucks with the remaining farm trucks being diesel powered.[4/] Larger trucks are more likely to be diesel powered. Nineteen percent of the three-axle and seventy three percent of the semi's were diesel powered (Table 8).

Trucks owned by producers were used 44 percent of the time to transport wheat and 62 percent of the time to transport barley (Table 9). In thirty-eight percent of the cases commercial truckers moved wheat to market but only 19 percent of the barley shippers used commercial trucks. Buyers owned about the same proportion of trucks transporting wheat and barley. Together the seller and commerical trucker were responsible for transporting barley 81 percent of the time and wheat 82 percent of the time.

UNIT TRAIN LOADING'S IMPACT ON GRAIN TRANSPORTATION IN SOUTH IDAHO.

Introducing unit train (25 car) shipping rates to south Idaho created a spread in rail rates between single car shipments and multi-car shipments to a common point. This spread was as much as 45 cents per bushel under the single car rate to Columbia River ports from eastern Idaho. These rates encouraged new investment in 25 car grain handling capacity by 18 south Idaho and 1 eastern Oregon shipping points (March, 1983). In 1981, 65,700,000 bushels of

[4/] LP gas is used in less than 1/10 of 1 percent of farm trucks (Henry, p. 8).

Table 8. Number of Axles and Engine Type for Farm Trucks in South Idaho.

	Engine Power Source				Row Total	
	Gas		Diesel			
Truck Type	Number	Percent	Number	Percent	Number	Percent
2-axle	932	63	11	1	943	64
3-axle	361	25	82	6	443	30
3-axle semi	7	a/	16	1	23	2
4-axle semi	5	a/	7	a/	12	1
5-axle semi	5	a/	42	3	47	3
Column Total	1310	89	158	11	1468	100

a/ Less than 1 percent.

Table 9. Ownership of Trucks Used for Transporting Grain.

	Barley		Wheat	
	Frequency	Percentage	Frequency	Percentage
Buyer	31	19	28	18
Seller	101	62	68	44
Commercial Trucker	30	19	59	38
Column Total	162	100	155	100

wheat and 52,810,000 bushels of barley were produced in south Idaho. Subtracting 1.5 million bushels of wheat seed and 2 million bushels of barley seed, 64,200,000 bushels of wheat and 50,810,000 bushels of barley were available for other uses. Almost all non-seed wheat 64,200,000 bushels, produced in Idaho is exported from the state. For barley, 46 percent of the acreage was planted in malting varieties. The amount of malting barley going for feed depends on quality considerations. For years with good quality, all of the malting barley and 34 percent of the feed barley are exported from the state. The remaining 66 percent of the feed barley is used within the state. This means out of state transportation could be needed for 34 percent of the feed barley (54 percent of the planted acreage) and for all of the malting barley, a total of about 34,000,000 bushels. Ninety-eight percent of south Idaho's white wheat is shipped to Columbia River ports for export while the remaining 2 percent moves to southern California. Destinations for red wheat are similar, 88 percent to the Columbia River ports, 7 percent to southern California and 5 percent to Ogden Utah.

Of the 34 percent feed barley, exported from Idaho, 30 percent goes to Columbia River port area and the remaining 4 percent to northern California. All of the south Idaho malting barley is exported from the state with 25 percent going to Colorado, 6 percent to southern California, 38 percent to Vancouver WA, and 31 percent to the midwest.

Introducing unit trains increased the distances wheat and malting barley traveled by truck in south Idaho

to market/loading points. After adjustment for outlying data points, the difference in hauling distance for all wheat from field to market or unit train loading sites was respectively 4.3 miles or 34 percent greater, and for malting barley 8 miles or 82 percent greater. Producers were hauling their grain greater distances to unit train loading sites. This change in grain shed has implications for total communities as mentioned earlier. Total business volumes can be expected to increase in the marketing centers for the new grain shed as producers economize trips and make retail on input purchases for back-haul to their farm.

SUMMARY

Union Pacific's introduction of multi-car shipping to south Idaho is bringing about a change in how grain is transported to markets outside of Idaho. Along with the traditional marketing points there are now 19 locations capable of loading unit trains serving grain shippers in south Idaho and likely to be several more built in the near future. Producers willing to pay the extra costs of hauling greater distances are receiving higher prices made possible by reduced rail transport costs and competition among buyers for the available supply of grain. As routes to these new grain shed market points are revised, a portion of road maintenance and improvement is paid by user fees through truck registrations and fuel taxes. However, in many cases, the local/county road system gets a major share of its revenue from the general taxes. These taxes are paid by all members of the community. What proportion is paid by which group is important to understanding the

complete benefits and costs of 25 car unit trains in south Idaho. At present, producers and certain grain merchants are definitely using the new transportation arrangements. The benefits and costs to the general taxpayers have not yet been documented.

REFERENCES

1. Casavant, K., F. Dooley, and N.L. Meyer. Railroad Transportation Issues Affecting Idaho Wheat, CIS 681, College of Agriculture, University of Idaho, Moscow, 1983.

2. Dillman, Don A. Mail and Telephone Surveys - The Total Design Method. John Wiley and Sons, New York, 1978.

3. Fuller, Stephen, Larry Makus, and Merritt Taylor. "Effect of Railroad Deregulation on Export-Grain Rates," North Central Journal of Agricultural Economics, Vol. V, No. 1, Jan. 1983.

4. Henry, R.L. Idaho Agricultural Truck Use Survey, 1982. Food Producers of Idaho, Inc., Boise, Sept. 20, 1982.

5. Idaho Agricultural Statistics. Idaho Crop and Livestock Reporting Service, P.O. Box 1699, Boise, Idaho, 1982.

6. Maloney, Patricia A. "Impacts of Rail Abandonment on Rural Communities: An Alberta Example," Proceedings-Twenty-third Annual Meeting of Transportation Research Forum, Volume XXIII, No. 1, 1982.

COASTAL AND MARINE SHIPPING

THE ECONOMICS OF A CANADIAN MERCHANT MARINE WITHIN A QUASI-COMPETITIVE INTERNATIONAL ENVIRONMENT

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ABSTRACT

This paper presents a discussion of some of the factors which have an impact on the economics of a Canadian merchant marine within an international context. Assessment is made within the context of the changing structure in shipping with greater participation by governments, and the likelihood of a significant percentage of the overall capacity in shipping being influenced by non-market forces. With the realignment of market shares and increased capacity provided by the low cost or new national flag fleets, for traditional maritime nations to maintain a significant share of the shipping industry, paradoxically this may require greater government involvement in these countries.

INTRODUCTION

As a major trading nation it should not be surprising that the question of a Canadian deep sea flag fleet should be raised at varying times by different groups; and even more so in recent years with the developments in international trade and shipping.

For the most part over the last couple of centuries shipping has emerged as a specialized area in the world economy, and especially over the period 1900 to the mid-1960's. Furthermore, one can discern the development of

a dualistic nature in international shipping where both government and the private sectors became intertwined.

The international nature of the industry meant to the private sector that given the capital investment required, they would attempt to provide the trade and service in areas in which they were most efficient. Theoretically, this policy should provide the cheapest possible rates for a given level of service as required by shippers. Conjointly, it necessitated that there be a multilateral pattern of shipping, that is cross-trading.

From the viewpoints of governments, major maritime nations became established to secure both political and economic goals, although the benefit most often referred to was in terms of the potential impact on a country's balance of payments.

CANADIAN CONDITIONS

Although significant attention has been given to the developmental and promotional role of government in the Canadian transport sector, greater emphasis has been placed on rail and highway transportation. Notwithstanding, ocean transportation is of great concern to Canada as it relates to the promotion of economic development arising from foreign trade.

While recognizing the difficulties in effecting a comparison of shipping activities over the last few years, due to changes in data coverage, nonetheless certain trends and estimates are possible. Between 1975 and 1979, the total volume of Canadian oceanborne cargo, excluding the United States, grew from 84.2 million short tons to 135.6 million

short tons or an increase of 61 percent. A breakdown of the total volume in 1979 reveals that bulk accounted for 86.7% and liner traffic 13.3%. Liner traffic over the period 1975 to 1979 increased its share of the total volume; but maintained its composition of two-thirds and one-third for the exports and imports segments respectively. The significance of liner cargoes is, however, based not only on tonnage but more so on values; the latter increasing by 68 percent over this period.

By 1980 Canada's oceanborne trade represented approximately $48.5 billion. Estimates to determine what proportion international transportation costs represents in terms of the value of commodities have generally been set at a figure of approximately 10 percent, which for 1980 would represent $4.8 billion, though this figure may vary depending upon the commodities and their values. The significance of transportation costs can be inferred from a recent study pertaining to Australian and Canadian manufacturing in which it was estimated that the average nominal tariff represented only approximately two-thirds of transport costs.[1]

It is now appropriate to indicate that Canada does have a merchant fleet. Estimates of the tonnage have been made at over 3 million d.w.t. in the Lloyd's Registry of Shipping and represents slightly over 1 percent of the world's tonnage. However, over 80 percent of the Canadian merchant fleet is registered in foreign countries (see Table 1) which has led one author to assert that our deep sea fleet is hidden offshore.[2]

Table 1

Composition of the Canadian Deep Sea Fleet 1981

By Flag of Registry	Number of Vessels	Tonnage ('000's of short tonnes)	Percent
British	64 (38)	4259 (1445)	58 (55)
Liberian	22 (14)	1175 (575)	16 (22)
Canadian	85 (60)	1171 (478)	16 (18)
Belgian	8 (3)	272 (67)	4 (3)
Singapore	3	221	3
Greek	3	165	2
New Zealand	3	83	1
Panamanian	2 (2)	15 (43)	- (2)
Norwegian	1	10	-
Cayman	1	6	

Note: 1973 figures are in brackets.

Source: K. C. Griffen, "The Canadian Deep Sea Fleet 1981; Rule Britannica," Seaports and the Shipping World, April, 1982, 26-36.
_____, "Canada's Deep Sea Fleet is Hidden Offshore," Seaports and the Shipping World, February, 1979, 23-31.

The reasons for the demise of a Canadian deep sea flag fleet in the early 1950's were (a) the second highest operating costs next to the U.S., (b) poor labour conditions, (c) fleet rebuilding and deployment by European subsidies, (d) no tax incentives or subsidies from the government, and (e) the focus on the promotion of a fleet pertaining to domestic cargo movements with the opening of the St. Lawrence Seaway.

However, it cannot be inferred that Canada does not pursue an explicit shipping policy. Reliance on international shipping services has been an explicit policy, based on the concept that in the long run a freely competitive shipping environment is more beneficial as it facilitates an adequate level of service at competitive rates, minimal allocation of resources and the avoidance

of subsidies. This policy was reiterated in 1979[3]; and it has proven economically sound over the past 30 years.

Since the early 1970's, however, a number of developments have taken place with the potential to affect the underlying assumptions of Canadian international shipping policy; which has been based on the concept of free circulation of shipping in international trade and 'fair' competition as administered by the traditional major shipowning countries.

This has led to a number of reports such as that by Darling, Transport Canada and Alcan Shipping Services which have examined various facets of the potential and economics of a Canadian flag fleet. Nonetheless one of the difficulties in comparing these studies is the fact that different underlying methodologies were adhered to in each.

Within the context of a given public policy the arguments for a Canadian flag fleet can be appraised from either: (a) the benefits to be secured in terms of macro variables--balance of payments, employment potential, changing international environment--taking into account varied levels of subsidization, or (b) on a purely commercial basis, operating within an appropriate fiscal environment.

Under (a) in terms of the balance of payments arguments these have generally been expressed explicitly on the basis of foreign exchange which could be earned and thus improve the net balance on the freight account. Nevertheless, the magnitude of improvement to the balance of payments by using one's own national ships has been questioned by many authors and as indicated by R. O. Goss,

such a policy may not necessarily provide an easy or significant improvement in the balance of payments, when account is taken of potential alternative uses to which the same resources may be directed.[4]

The potential for increased employment centers in two spheres--shipbuilding and staffing. Although there has been the tendency to identify the benefits which would accrue to the Canadian shipbuilding industry with the re-emergence of a deep sea merchant fleet, shipbuilding really falls within the manufacturing sector and thus it would appear appropriate to exclude this facet from an assessment of the economics of a Canadian merchant marine. Regarding staffing there are serious doubts as to whether significant benefits can be gained in terms of employment, except in marginal regions such as the Atlantic areas, due to the increased capital intensiveness of vessels, the shortage of qualified personnel and the element of uncertainty.

Studies conducted under category (b) have generally concentrated on the aspect of efficiency based upon costs and demand factors. The analysis is generally of a static nature in which a particular route is examined within the context of vessel operating costs, with the main components being classified as wages and subsistence, stores, maintenance and repair, supplies and equipment, insurance and bunker fuel.[5] It has been further contended that there are only minor differences in operating costs[6]: though variations may occur in insurance costs; being a function of whether the vessel belongs to a developing or flag of

convenience country versus an established traditional maritime nation.[7] Maintenance and repair costs may also be higher in those countries where there is a lack of expertise and experience in manpower.[8]

In Canada, the recent impetus under this category has been to initiate changes in specific tax and financial measures rather than seeking outright subsidization (see Table 2). Canadian shipowners have enunciated the view that tax provisions are much less favourable than those in the majority of traditional maritime European countries, and desire to see in place measures which would be equivalent.

Table 2

Alternate Fiscal Measure Favourable to the Employment of Canadian-Flag Ships in Deep-Sea Trades

1.	Allow accelerated capital cost allowances on deep-sea ships to protect deep-sea earnings from tax.
2.	Allow accelerated capital cost allowances on deep-sea ships to protect any shipping earnings from tax.
3.	Allow accelerated capital cost allowances on deep-sea ships to protect earnings of the owner/operator from tax.
4.	Allow accelerated capital cost allowances on deep-sea ships to protect the earnings of any company through the leveraged lease.
5.	Allow tax-free reserves for vessel replacement.
6.	Make tax concessions for seamen.
7.	Reduce rates of interest on loans through credit support comparable to Export Development Corporation loans.
8.	Establish a loan guarantee programme.

Source: Trevor D. Heaver, "A Canadian Merchant Marine: How, Why and When?," Canadian Transport Commission, Research Seminar Series, Spring 1981, p. 33.

It is recognized that the diverse interests of the different groups such as shipowners, unions, users, shipbuilders and taxpayers have not been addressed, but it avoids one difficulty--namely the tendency for various groups to equate their goals to that of national interests. Dosman examined this problem and concluded that it may be better resolved if viewed not in terms of 'interest' but 'advantages or disadvantages'[9]; with the Canadian interest in international marine policy being narrowly defined in terms of 'advantage' situations.

While a national merchant marine has often been identified as a policy instrument, its significance will be determined by how the national interest is perceived. However, many authors have often equated the terms 'national interest' and 'national security', thus rendering economic analysis more difficult.

THEORETICAL MODEL

It was earlier indicated that the shipping industry internationally operated on a fairly competitive basis until the mid-1960's. Whether this condition did in fact prevail is, however, dependent upon how competition is defined. This can be viewed at two levels: (a) within the industry or between firms as reflected in terms of structure and costs, and (b) between countries.

Although various models have been used in the application of economic analysis to the shipping industry, a great amount of the research has been based on the ideal allocation which results from a perfectly competitive structure and the non-optimality of the monopoly model. However, the

actual markets are much more complex and do not approximate the two models often referred to.[10]

Recent attempts have been made to develop a model which identifies the feature of potential or actual competition which could restrain profits in the traditional imperfect markets yet produce the desired results as in perfect competition. This approach has been termed the doctrine of contestable markets,[11] with the main characteristic being freedom of exit and entry and the vulnerability of hit and run entry.[12]

A great proportion of the analysis of the shipping industry has generally followed the traditional marginalist modelling with the underlying assumption of a competitive industry structure. Furthermore, this approach has been used predominantly in studies of the liner segment of the shipping industry with special accent on the pros and cons of freight conferences. One of the weaknesses of the theoretical model has been that it does not reflect the shipping industry, and this had led to poor predictions of the behaviour of firms in the industry.

While a number of studies have pursued directly an analysis of overall vessel operating costs, it is clear that the degree and level of competition will be constrained by specific government policies. This can best be portrayed in a modified version of a model as suggested by Dicer and Sentall,[13] and is depicted in Figure 1.

THEORETICAL MODEL OF SUPPLY IN SHIPPING--SHORT TERM

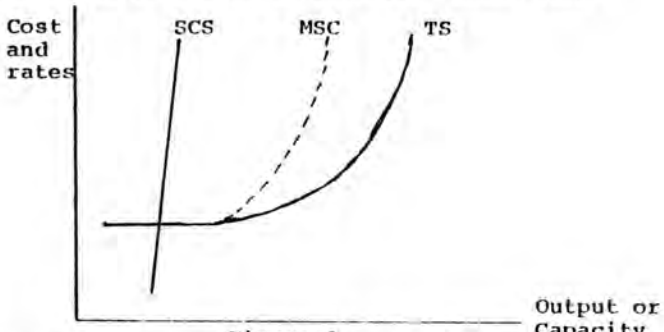


Figure 1

Prior to discussing the model, certain definitions must be made regarding time periods. The short term is regarded as a period too short to facilitate scheduling of new vessel construction, or conversion from one type of vessel to another; medium term as a period which facilitates conversion and refitting but no large scale fleet expansion by new ship construction; and long term the period which permits major expansion through building of new ships.

The SCS is a social cost based supply curve. Underlying this curve are the assumptions that governments and their agencies may not place profitability as the number one priority, or showing the flag is given greater credence, which may ultimately be reflected in operating losses. It can be observed that the SCS curve is very inelastic with minimal changes in supply as rates are increased substantially.

The MSC curve is a supply curve which is market or cost determined. In contrast to the SCS curve, capacity expands with increased rates but also it is not available below a minimal rate as reflected by the elastic section of the curve. It should be pointed out that a pure MSC

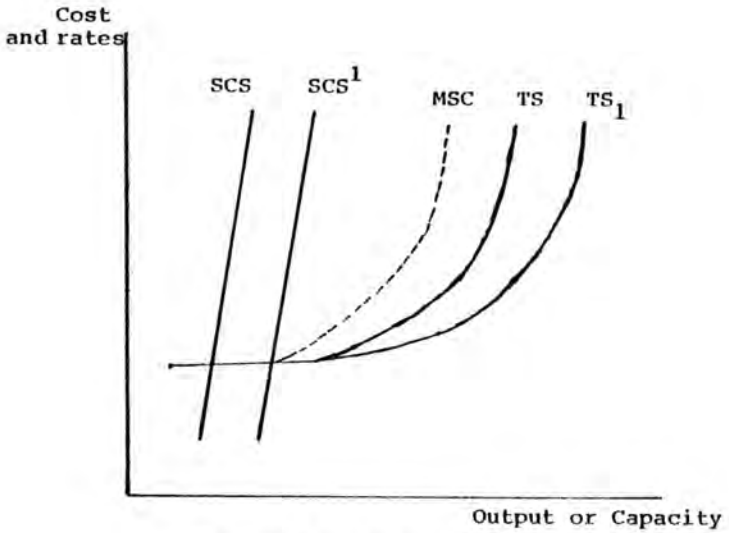
curve does not prevail in practice due to varying degrees of government involvement.

In the short and medium term, the available capacity will be a combination of both the SCS and MSC sources, yielding an overall supply function--TS. It should also be discerned that the breakdown of the total Supply function between SCS and MSC can alter over time with far reaching effects.

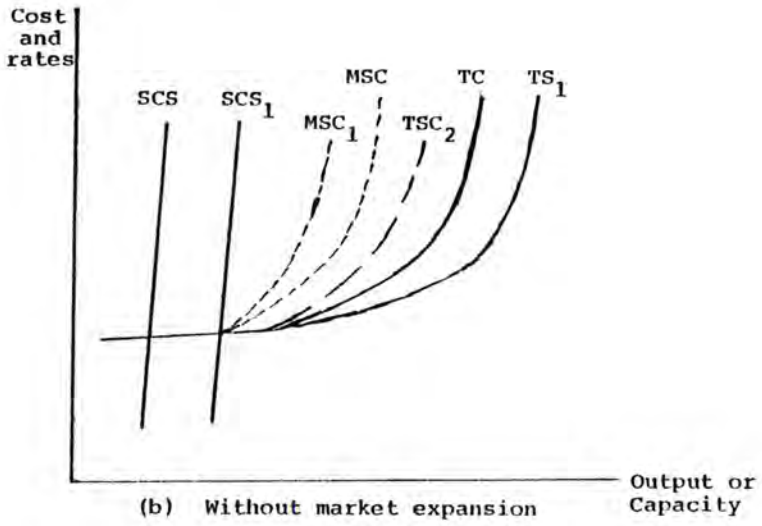
Although it would be easy to assert that the SCS curve reflects state controlled or developing countries' new thrust for merchant fleets, the MSC curve is however a theoretical condition and not representative of the conditions as prevailing in most traditional maritime nations. It is thus within these two theoretical limits that the economics of a Canadian merchant marine must be assessed.

In Figure 1, the overall capacity as prevailing in the short run is identified. Figure 2 demonstrates how the supply side of the market may operate in the long run. In Figure 2(a), it is assumed that there is an expansion of the market which is accommodated by an increase in total supply shown as TS_1, with shifts also occurring in the SCS function. Under this condition the MSC curve or segment, is not eroded or displaced. In Figure 2(b), the assumption is made that there is no expansion in the market. In this instance, a positive shift in the SCS curve will likely trigger a reduction in the MSC segment and yield a condition of indeterminateness as to whether the total supply function will increase, decrease or remain at the previous level.

THEORETICAL MODEL OF SUPPLY IN SHIPPING--LONG TERM



(a) With market expansion



(b) Without market expansion

Figure 2

It is within this context that the potential of a Canadian merchant marine must be evaluated taking into account certain fundamental changes which have taken place in the recent past, and in particular that of greater government participation.

ECONOMIC AND INTERNATIONAL DEVELOPMENTS

A. Costs

It is well recognized that variations in the level of costs may arise not only from different sizes of vessels, but also from such factors as routing, crew complements, and the segment of the shipping market being examined. Perhaps the most significant development in recent years was the increase percentage fuel costs represented in terms of overall costs. Over the decade fuel costs have become the major component in ship operating costs, with the figure rising from approximately 10% in the early 1970's to a recent estimate of 60%.[14]

Manning costs are also a major factor affecting daily operating costs; with annual crew costs ranging from a low of $200,000-$240,000 for Indian and Phillipine crews to a high of $1.8 million for U.S. crews.

Shipowners in high labour cost developed countries have thus attempted to employ some low cost labour from developing countries, and to reduce manning levels. For example, in 1970 a containership had a conventional 35 man crew, which has since declined to 25, and some firms such as Hapag Lloyd are currently experimenting with an 18 men crew, with the ultimate goal of a 12-13 man crew.

However, unions have strongly opposed both the reduction of manning crews and the substitution of low cost labour from developing countries. With regard to the latter, efforts have been made to develop a basic ITF world wide pay scale, but a sharp difference still prevails between the rates paid by Far Eastern and developing countries as compared to the European or major industrialized countries. This is partly due to the significant wage increases which occurred between 1978-1980--55% in the U.K., 33% in Norway, 22% in Germany, and 15% in Japan. The increases in the wage rates in the high cost developed countries have thus reduced the significance of this factor as a deterrent for the economic viability of a Canadian deep sea flag fleet.

On the technological level, the major development has been the doubling in the average size of vessels, both tankers and containers. This has led to a degree of consolidation of cargo moving between one or two ports in a country, to generate levels of capacity utilization to secure economies of scale.

B. Government Participation

Increased involvement by governments or international bodies has been most marked in deep sea shipping over the last decade. The most significant success of an international body has been that of UNCTAD in putting into effect the Code of Conduct given the acquiescence of EEC countries; though these countries have indicated that they will not apply the Code to trade between developed countries. The Code, which is often identified by the formula

40-40-20, put into legal effect the notion that countries have a right to participate in their trades; and although applying only to the liner sector at this juncture, efforts have already been made to extend the cargo sharing concept to the bulk sector. This issue although rejected at the UNCTAD V session held in Manila in 1980 will, however, likely be reviewed in the not too distant future.

Another development is the determination of UNCTAD to see the phasing out of 'flags of convenience' (such as Liberia, Panama, Singapore, Cyprus) or 'free flags'.[15] The increased participation by developing countries in terms of the world fleet can be seen from Table 3.

Table 3

Distribution of World Fleets by Grouping of Countries

Grouping	1976 (%)	1981 (%)
Developed Market Economy Countries	56.1	51.3
Developing Countries	6.8	12.4
Socialist & East European and Asian	6.1	7.4
Open Registry Countries	30.6	28.6
	99.6*	99.7*

*Figures do not add up to 100% due to rounding.

Source: UNCTAD Secretariat, 1982.

Both developed and developing countries practice discrimination in ocean shipping. The traditional maritime nations usually practice discrimination by favourable taxation and depreciation measures. Subsidies, direct or indirect, can affect the competitive capabilities

of national flags. Moreover, there has tended to be somewhat of a perverse argument which contends that such discriminatory practice, which aid to reduce nominal costs, still leaves the shipowner free to operate under a commercial regime and the shipper with the option to choose his shipping line. However, the real costs have not changed, but rather the subsidies can be taken to represent a form of revenue, thus enabling a shipping firm to lower the rate charged to secure a reasonable return.

In fact, with a certain level of subsidies, the resultant effect can approximate a similar result that would prevail under cargo preference or reservation measures. Nevertheless, the latter measures are normally considered a serious problem by analysts in developed countries.

It is generally suggested that state owned fleets utilize non-commercial practices in shipping but this is really a question of degree. Although many industrial countries have strongly indicated support for free competition, in practice this has not occurred, with the Grotius doctrine of freedom of the seas being more of an ideal than reality.[16]

It is now appropriate to view the impact of the expanding capacity in terms of shipping services which the developing countries account for. It has been asserted that a goal of 20% of the world tonnage should be owned by developing countries by 1990 and the progress made between 1976 and 1981 when their share grew from 6.8% to 12.4%, would suggest that this goal will be achieved.

In terms of the theoretical model outlined in the preceding section, this could be equated to a shift in the SCS curve to the right, and with very modest levels of growth in the world economy could lead to a reduction in the share accounted for by the market determined segment. This development would likely generate even greater protectionist measures by the developed countries.

Most countries do enact some degree of discrimination which may be effected through such direct measures as cargo sharing, bilateral agreements, reservations on government cargo or more indirect methods such as those related to currency, tax benefits, and the usage of national flag vessels as part of the sales contract.

CONCLUSIONS

It is clear that the economics of a Canadian flag fleet ought to be viewed within the context of available capacity in shipping. Although the factor of over-ordering and over-expansion has not been dealt with, this element cannot be ignored as significant increases in deliveries will be maintained until 1984.

This increase in capacity by both established maritime and developing nations would thus suggest that the economic viability of a Canadian flag fleet in domestic terms should be based mainly within the context of an overall policy in which the fiscal arrangements do not place Canadian shipowners at a disadvantage to the traditional maritime nations.

The granting of some of the tax conditions as indicated in Table 2 would not appear to be diverting

resources domestically to an industry with lower productivity. Relative costs of operation between Canada and the traditional maritime nations have improved, but the changing market shares and increased capacity being provided by low cost or new national flag fleets introduce an element of uncertainty, which perhaps can only be minimized with greater government involvement.

FOOTNOTES

1. R. M. Conlon, International Transport Costs and Tariffs: Their influence on Australian and Canadian Manufacturing. School of Economics, The University of New South Wales, manuscript 1982, pp. 72-73.

2. K. C. Griffin, "The Canadian Deep Sea Fleet 1981, Rule Britannica," Seaports and the Shipping World, April, 1982, 26-36.

3. Transport Canada, A Shipping Policy for Canada. Ottawa, 1979, p. 51.

4. See R. O. Goss, "Investment in Shipping and the Balance of Payments: A Case Study of Import Substitution Policy." Studies in Maritime Economics, Cambridge University Press; London, 1970, pp. 46-60.

5. An assessment of operating costs of various types of ships was effected in the U. S. Dept. of Commerce, Maritime Administration Study, "Established Vessel Operating Expenditures, 1976" (June, 1975).

6. UNCTAD, "Merchant Fleet Development" TD/222, Manila, (May, 1979), p. 7.

7. UNCTAD, "Costs and Freight Rates in Liner Trades" TD/BK.4/128, Geneva, (1975), p. 11.

8. C. T. Grammenos, "Bank Finances for Ship Purchase" (Bangor Occasional Papers in Economics No. 16 University of Wales, 1979); UNCTAD "Technical and Financial Assistance in Shipping and Ports; TD/BK.4/161, Geneva, (1977).

9. E. J. Dosman, The Canadian Deep Sea Fleet Issue in Comparative Perspective. National Transportation Policy Project, May, 1975, p. 4.

10. Donald Dewey, "Information, Entry and Welfare: The Case for Collusion," American Economic Review, 69, 1979, 587-594.

11. W. J. Baumol, "Contestable Markets: An Uprising in the Theory of Industry Structure," American Economic Review, 72, 1982, 1-15.

12. J. Davies, A Critical Review of Shipping Economics, Study for the Canadian Transport Commission, 1982.

13. Gary W. Dicer and Gerald D. Sentall, Economic Modeling of Changing Maritime Transport Patterns in the 80's; A New Approach, Proceedings, Transportation Research Forum, VXX, No. 1, 1979, 151-158.

14. Lloyd's Shipping Economist, August, 1979, p. 8.

15. Ibid., November, 1979, p. 4.

16. Edgar Gold, Maritime Transport (Lexington, Mass.: Lexington Books), 1980, pp. 43-51.

Freight Rate Stability And Resource Allocation In Liner Shipping

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ABSTRACT

Whereas the stable freight rates which liner conferences endeavour to supply may have the positive consequences of reducing the risks of international commerce by allowing forward contracts to be made with relative certainty as to the price of freight, they also have the negative effect of letting changes in demand generate wide fluctuation in the quantities carried. This in turn translates into an inefficient usage of capacity with consequential detrimental effects on the allocation or resouces in the industry. A more flexible, or peak load pricing policy, in contrast, by rationing space in high demand periods through a rise in prices and encouraging use in off peak periods through a fall in prices, would much more effectively facilitate an efficient utilisation of capacity and therefore a desirable allocation of resources. But prices in liner shipping are discriminatory. Conequently, assuming customary profit maximising behaviour it may be that in peak demand periods when capacity is constrained liner companies carry relatively large amounts of high paying cargoes, ignoring low paying varieties, whereas in off peak periods when capacity is freely available as much low paying cargo will be carried as is possible. If this is the case then even though freight rates remain stable, space will be rationed as in a peak load fashion, with the discriminatory selection of cargoes having the same affect as demand induced changes in the price level. It is the purpose of this paper to investigate the nature and prevalence of this possibility.

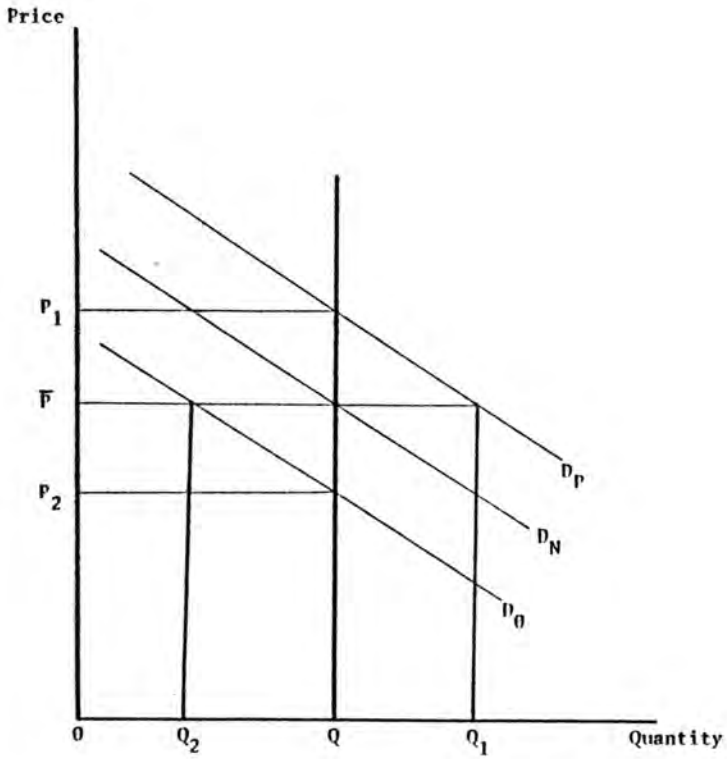
1. Introduction

Relative stability of freight rates is one of the most widely quoted characteristics of liner conference organisation.[1] Essentially these stable prices arise out of two distinct sources. Firstly stable freight rates are a deliberate part of the service package offered by conferences and it gives them an important marketing advantage over chartered and to a lesser extent non-conference tonnage. Secondly it is inherently difficult and often time consuming to change prices given that it requires consensus amongst the members of the cartel and that that cartel in any case operates in oligopolistic interdependence with actual or potential competitors. But irrespective of the relative importance of either source, the consequential relative price stability is a double edged sword.

In the first place, price stability minimises the business risks of traders who are enabled thereby to make forward contracts with certainty and this in turn is likely to translate into a reduction in the costs of international commerce.[2] It is generally regarded, however, that this price stability is won only at the cost of an inefficient utilisation of scarce resources.[3] The essential logic of this assertion is illustrated in Figure 1. Price is fixed at $\bar{P}$ and under normal conditions of demand, DN, OQ is demanded. With peak demand, DP, the constant price $\bar{P}$ results in the quantity increasing substantially to OQ_1 whereas off-peak demands, DO, results in the quantity demanded falling sharply to OQ_2. Thus when prices are stable changes in the conditions of demand generate large changes in the quantity demanded and therefore imply corresponding changes in capacity utilisation. If, however, prices were allowed to rise to P_1 during peak periods and fall to P_2 during off peak

FIGURE 1

Freight Rate Stability And Changes
In Demand



periods the quantity demanded could be stabilized at OQ. In this way a fixed quantity of output may be rationed amongst potential buyers on the basis of willingness to pay.

Now in the liner shipping industry not only is capacity relatively inelastic in the short run[4] but its economical use requires that it be operated at a fairly constant level. This operational mandate arises out of the nature of the short run cost function incurred in liner shipping which exhibits continuously declining unit costs.[5] This in turn puts a premium on utilisation and ideally optimal operational efficiency and minimum unit costs would occur with 100% load factors. Of course in supplying a scheduled service it is impossible to operate consistently at such load factors, and in practice a margin of reserve capacity will be supplied to accommodate minor variations in demand and to facilitate cargo loading, stowing and discharge operations when the cargo mix is complex. However, in order to minimise unit costs it will be imperative that this margin of reserve capacity be kept as small as possible and this in turn translates into a need for high and stable load factors.[6]

Maintaining stable load factors, however, is no easy task for a carrier given that demand is derived and thus determined principally by the buoyancy of the economies of the trading countries. If demand cannot be controlled, the only other possible method of stabilising load factors would be to make corresponding adjustments in capacity. But this likewise is not possible in the short run as seen above.

In sum, then, a situation exists where:

1) prices are stable
2) demand is variable and
3) capacity is fixed in the short run.

As for the consequence of this assemblage of factors, when demand is low, the stable prices discourage additional use and thus encourage an underutilisation of capacity. Alternatively when demand is high, the stable prices will prevent the fixed capacity from being efficiently rationed on the basis of willingness to pay.

Given conditions 2) and 3), however, economic theory posits that a much more effective utilisation of capacity may be achieved through the use of a peak-load pricing policy.

2. The Nature of Peak-Load Pricing Models

Peak-load pricing and investment problems arise in markets for both goods and services wherein demand exhibits significant variation over normally cyclical patterns of hours, days, weeks or seasons or some grouping thereof. The usual reason for this patterning is that demand may be influenced by environmental phenomena such as winter and summer or by behavioural phenomena such as the regular work day or work week. However, irrespective of the particular source of the demand cycles, it is necessary for a peak load situation that its periodicity occurs over a space of time too short to permit the capital stock to be varied so as to keep price continuously equal to long run marginal costs.[7] Additionally it is necessary that the product cannot be stored in periods of slack demand for resale in peak periods. This of course as an of the principal characteristics of transport industries.

Given these conditions, the basic problem is to discern a set of prices which

1) facilitates the accommodation of the maximal demand in the peak periods, given the capacity constraint;
2) minimises the underutilisation of capacity in off peak periods; and
3) covers costs.

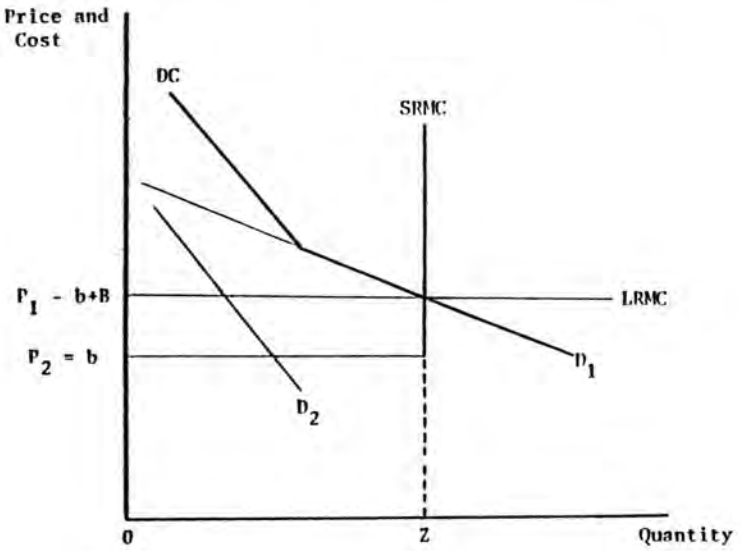
The pioneering work on the analysis of these issues was Steiner's 1957 paper [8] though since then the literature has mushroomed, sustaining itself, customarily, on the refinement of his analysis and the progressive relaxation of his assumptions.[9] However, almost all peak-load pricing models share the common characteristic of postulating that social welfare will be maximised in industries subject to the above conditions when off peak users are charged a price equal (or close to) short run marginal costs whilst peak demand users are charged at price equal (or close to) long run marginal costs. This is the case in Steiner's "firm peak case" which is illustrated in Figure 2.

In the diagram, capacity is chosen by equating price along the aggregate demand for capacity curve, DC, with LRMC. Now since DC = D_1 at this maximum capacity output, peak period users consume OZ and pay P_1 = LRMC = b+B. Off peak consumers, however, consume less than capacity output and are charged SRMC = b. Notice that capacity is fully utilised at least once over the demand cycle and that only peak period customers are required to contribute to capacity costs. This pricing policy also ensures that the firm breaks even and that social welfare - defined as the sum of consumer's surpluses (in all periods) plus producer's surplus - is maximised.

Thus the essential moral of the peak load pricing story is that welfare is maximised when prices, far from remaining constant, vary in response to the strength of demand. This, same pricing policy, moreover, would also help achieve the stable load factors required for efficiency in liner shipping, as seen earlier.

FIGURE 2

Steiner's 'Firm Peak' Peak Load Pricing Model



D_1 = demand in peak period

P_2 = demand in peak period

DC = effective demand for capacity: it equals the vertical summation of D_1 and D_2

b = SRAVC which is assumed constant. It also equals SRMC until full capacity Z is reached after which SRMC rises vertically.

B = capacity costs which are assumed constant and . . B+b = LRMC which will be constant.

3. Price Discrimination and Short Run Profit Maximisation in Liner Shipping

If peak load pricing maximises social welfare given a fixed capacity and a variable demand then the stable freight rates of the liner industry ought positively to be prejudicial to social welfare. Indeed, it is precisely this sort of reasoning that lies at the heart of the customary condemnation of the excessive price stability brought about by conference organisation.[10] This thinking, however, overlooks the fact the output of the industry is a multi product service offering which is sold at discriminating rates and this, coupled with assumptions of entrepreneurial rationality and profit maximisation may automatically bring about a peak load tendency in the average level of freight. This in turn may result in a utilization of capacity and a rationing of space similar to that which would be achieved if a formal peak load pricing policy had been adopted. The rationality of this assertion is illustrated in the hypothetical example depicted in Table 1.

If we assume the vessel has a capacity of 100 tons, then in both periods it is filled to capacity. In period P, the peak period, when demand is high and capacity scarce, it is the high rated cargo which the vessel would obviously seek to carry first and such was its availability that capacity was filled when the offerings of commodities a and b had been exhausted and 20 tons of c lifted. In period O , however, when demand is low and capacity freely available a liner may endeavour to lift as much cargo of any type that it can, and in the example above the carrier after exhausting categories a - f, topped up his vessel with 15 tons of g.

This type of general behaviour has three important implications. Firstly, for the carrier it is logical that in peak periods it

TABLE 1

Freight Rate Discrimination and Peak Load Average Freight Rates: A Hypothetical Example

1	2	3	4	5	6
Commodity Type	Freight Rate ($/ton)	Quantity in Period P	3 X 2	Quantity in Period O	5 X 2
a	100	40	4,000	20	2,000
b	80	40	3,200	20	1,600
c	60	20	1,200	10	600
d	40	-		10	400
e	20	-		15	300
f	10	-		10	100
g	5	-		15	75
			Σ 3X2=$8,400		Σ 5X2=$5,075

Assume vessel capacity = 100 tons.

Average freight rate in peak period P = $\frac{8,400}{100}$ = $84

Average freight rate in off peak period O = $\frac{5,075}{100}$ = $50.75

carries firstly the high rated cargo. Now assuming freight rates to be determined on the generally accepted principal of charging what the traffic will bear, this behaviour also means that space will be rationed on the basis of willingness to pay.

Secondly in periods of slack demand it is inherently profitable for a carrier to lift any cargo whose freight rate is above cargo handling costs. And if demand is such that capacity cannot be filled, a carrier may lift cargoes down to the type whose price equals cargo handling costs, costs which are usually assumed to approximate SRMC. Thus as in the Steiner 'firm peak case' when off peak demand is less than available capacity, the quantity will be carried such that P = SRMC.

Thirdly, it is evident from the example that the profit maximising behaviour of individual lines will result in a peak load tendency in the average level of freight. Thus in period P, the average level of freight, defined as $\Sigma TR/\Sigma Q$ = \$84 per ton, whereas in period O it equalled \$50.75 per ton.

Consequently the average freight level varied directly with the strength of demand, as would be the case of a formal peak load pricing policy was adopted.

It may be, then, that the controversial stable and discriminatory freight rates of conferences provide the best of all worlds - certainty to the shippers and, through the beneficient avarice of shipowners, an efficient utilisation of scarce resources. However, before attempting to test whether this process is observable in the real world some qualifications need be made in respect of the 'passed over' cargoes in the peak period (i.e. d - g). Clearly they do not disappear. It may be that in peak periods sufficient chartered tonnage will be attracted into the market to service them.

Or they may simply have to wait until sufficient conference space becomes available. Either way, the quality of service available to them is being reduced in a manner comensurate with their willingness to pay.[11]

4. Testing the Hypothesis

To examine whether or not a peak load tendency exists in the average level of freight, the East Coast of Canada/U.K. conference was chosen because data was available, on a quarterly basis, for both the quantities of each type of cargo moving and the book freight rates levied by the conference on each type of cargo. The aggregate data are summarised in Table 2 and in index form in Table 3.

The volumes represent the total cargo (conference plus non conference[12]) moving over the route while the freight rates used in the compilation of column 4 are the unadjusted contract conference rates.

From the data, it is evident that considerable variation the quantity of cargo carried was evident in each of the years covered. This, in turn,means that load factors were unlikely to have been stable. Total revenues, however, were even more volatile. The average freight level, was much more stable, as is evident in comparing columns 4 and 3 in Table 2. In the calculation of both total revenues and the average freight level a problem was that the book freight rates had not remained completely stable but had changed. To abstract from this change Table 3 provides an index of freight rate changes, and, in customary fashion, this price index may also be assumed arguably to abstract from seasonal and cyclical influences on prices or, in this case revenues.[13] In

TABLE 2

Cargo Volumes, Revenues and the Average Freight Level on the East Coast Canada/U.K. Route

1 Year & Quarter		2 Total Cargo Volume (Short tons)	3 Total Revenue $C	4 Average Freight Level (3/2) $C
1978	2	222,741.7	11,446,818	51.39
	3	187,432,4	10,115,884	53.97
	4	169,977.0	9,141,736	53.78
1979	1	114,293.9	6,224,886	54.46
	2	187,487.3	11,861,044	63.26
	3	189,462.4	12,452,606	65.73
	4	196,270.5	13,756,679	70.09
1980	1	139,717.6	10,564,962	75.62
	2	220,770.7	16,080,665	72.84
	3	175,227.2	14,660,825	80.24
	4	226,918.3	18,680,233	82.32
1981	1	136,961.7	5,703,939	41.65
	2	229,197.1	20,936,941	91.35

Sources: Cargo volumes obtained from Statistics Canada: they include the principal commodities moving over the route. The freight rates used in the calculation of column 3 were obtained from the Canadian Transport Commission. The

TABLE 3

Indices of Cargo Volumes, Revenues and Prices on the East Coast of Canada/U.K. Route

1 Year & Quarter		2 Index of Cargo Volume	3 Index of Total Revenue	4 Index of Average Freight Level	5 Freight Rate Index[1]	6 4 ÷ 5
1978	2	159.42	108.35	67.96	79.51	0.85
	3	134.15	95.75	71.37	79.51	0.90
	4	121.66	86.53	71.12	79.53	0.89
1979	1	81.80	58.91	72.02	86.47	0.83
	2	134.19	112.27	83.66	86.64	0.96
	3	135.60	117.86	86.92	88.95	0.97
	4	140.48	130.21	92.69	89.25	1.39
1980	1	100.00	100.00	100.00	100.00	1.00
	2	158.01	152.20	96.32	100.03	0.96
	3	125.41	138.77	106.11	106.36	0.99
	4	162.41	176.81	108.86	106.43	1.02
1981	1	98.03	53.99	55.78	116.62	0.48
	2	164.04	198.17	120.80	116.62	1.04

Note :

[1]The freight rate index is a chain Laspeyres index. As the base year of the freight rate index was 1st quarter 1980, this was also chosen as the base year for the other indices calculated. The freight rate index was compiled by the Canadian Transport Commission.

column 6 of Table 3 the index of the average freight is divided by the price index to focus on the residual peak load element in the average freight level. As column 6 shows the values are fairly close to unity indicating that the index of the average freight level correlates closely with the freight rate index. This and the above described relations are illustrated in Figure 3 which graphs the indices of cargo volume, revenue, average freight level and freight rates.

Thus it appears that with the exception of the first quarter of 1981, the peak load tendency in the average freight level, as hypothesised earlier, was not observed to any significant extent. Moreover, although the fall in the average freight level in that quarter coincides with a significant drop in cargo volumes, which is what the peak load element would suggest, this was not repeated in the first quarter of 1979 and 1980 when cargo volumes dropped to similar levels.

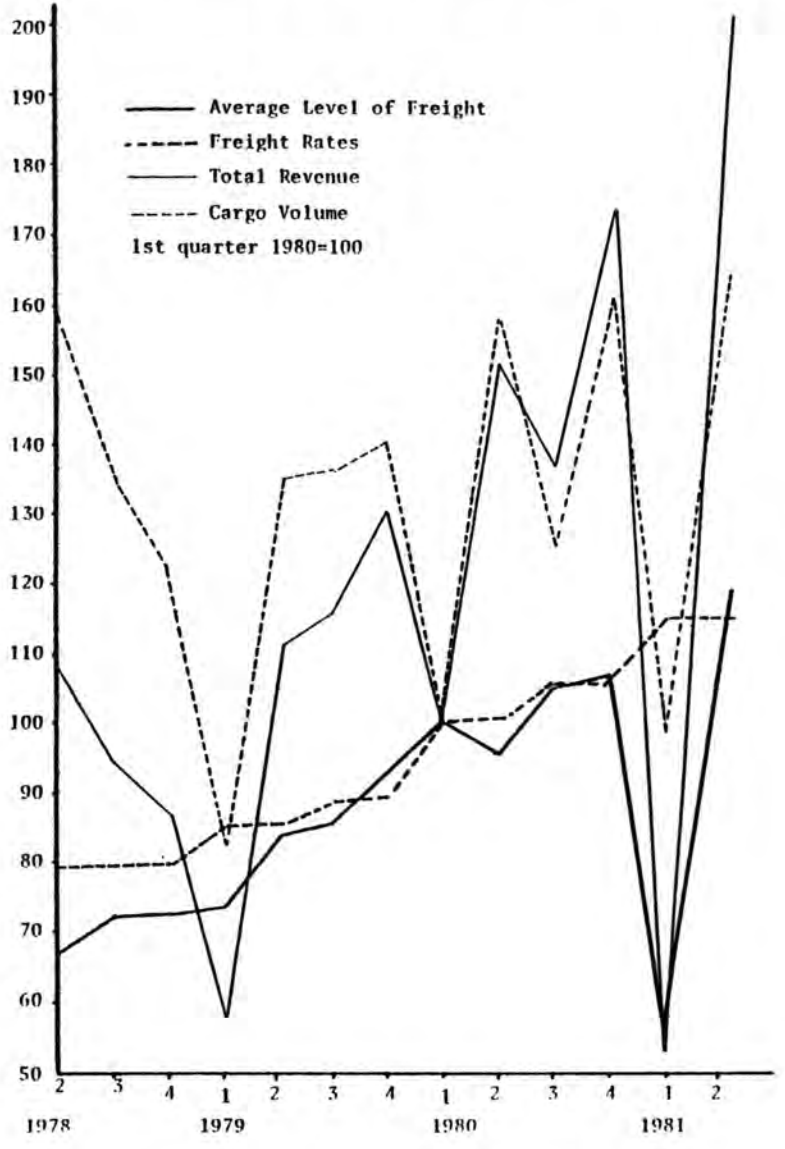
Concerning the reason why the postulated peak-load element appears not to be present,the most likely explanation is that capacity was never strained.[14] Given sufficient capacity to carry all available cargo at all times, the peak load element in the average freight level would not become operative: there would be no peak load problem.

6. Conclusions:

Although the excessive freight stability of liner conferences has been criticised for bringing about an inefficient utilisation of capacity, it was hypothesised that this need not necessarily be true. Assuming rational profit maximising behaviour, and given a discriminatory tariff schedule, capacity constraints may bring about

FIGURE 3

Indices of Cargo Volume, Revenue, Freight Rates and the Average Level of Freight on the Canada/U.K. Route



a rationing of space on the basis of willingness to pay through encouraging a discriminatory selection of cargo types, thus generating a peak load tendency in the average freight level. It is clear, however, that the hypothesis was not confirmed in the case of the East Coast of Canada/U.K. conference, most likely because capacity was at all times freely available, thus rendering peak load pricing irrelevant. In trades where capacity is constrained, periodically, however, the process may possibly be at work. Thus in a multi product setting where price discrimination is practised, one should not automatically condemn stable prices as resulting inevitably in an inefficient utilisation of resources: a more pragmatic and detailed analysis is required before any firm determination can be made.

Notes and References

1. See eg. Marx, D., "International Shipping Cartels" (Princeton U.P. 1953) pp. 240-247; UNCTAD, "The Liner Conference System" TD/B/C.4 Rev. 1, (New York 1970) pp. 32-41; Deakin, B.M. and Seward, T., "Shipping Conferences - a study of their Origins, Development and Economic Practices" (Cambridge U.P., 1973) pp. 111-117; Sletmo, G.K. and Williams, E.W., "Liner Conferences in the Container Age" (MacMillan, New York, 1981) pp. 245-250.

2. Marx, ibid., p. 248; Ellsworth, R.A. "Competition or Rationalisation in the Liner Industry", Journal of Maritime Law and Commerce, Volume 10, No. 4 (1979), p. 497.

3. Marx, ibid., Bennathan, E. and Walters, A.A., "The Economics of Ocean Freight Rates" (Praeger, New York 1969), p. 59; Roberts, J., "The Economics of Ocean Liner Shipping Regulation", (U.S. Department of Transportation, Washington, D.C., 1978), p. 60.

4. With container services, increasing capacity through increasing frequency cannot be easily accomplished because of the consequential disruption of frequencies and the steep rise in fuel prices this would entail. Reducing capacity through reducing frequency likewise may create scheduling problems and will also have a negative effect on demand and is thus not normally a workable option. Adjusting capacity by changing the composition of the fleet may be even more difficult to achieve speedily. For an analysis of these problems see Davies, J.E., "An Analysis of Cost and Supply Conditions in the Liner Shipping Industry", forthcoming in the June 1983 edition of the Journal Of Industrial Economics.

5. Davies, J.E., ibid.

6. Ibid.

7. Mohring, H., "The Peak Load Problem with Increasing Returns and Pricing Constraints", American Economic Review, Volume 60, No. 4 (1970), p. 693.

8. Steiner, P.O., "Peak Loads and Efficient Pricing" Quarterly Journal of Economics, Volume XXI (1957), p. 585.

9. See eg. "Symposium on Peak Load Pricing", containing articles by Joskaw, P.L., Crews, M.A., Kleinderfer, P.R., Wendes, J.T., and Nguyen, D.T., Bell Journal of Economics, Volume 7, No. 1 (Spring 1976).

10. See note [3] supra.

11. See Jansson, J.O., "Intra Tariff Cross Subsidisation in Liner Shipping" Journal of Transport Economics and Policy, Volume 8, No. 3, 1974, especially pp. 307-8 for discussions that reflect favourably on this conclusion.

12. In 1979 the conference carried 87% of the cargo moving over this route.

13. For a discussion on the role of price indices in accommodating seasonal and cyclical variation in prices see Pendyck, R.S.,and Rubinfeld, D.L., "Econometric Models and Economic Forecasts" (McGraw Hill, 1981) p. 488.

14. Over the period 1969 to 1975, load factors obtained on the conferences serving the North Atlantic generally averaged 74.4%. See Sletmo and Williams, op.cit., p. 308.

AN ASSESSMENT OF CARRIER MARKETING STRATEGIES THROUGH EXPORTER SURVEY

by

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ABSTRACT

During 1981 a study of Eastern Canadian shippers using marine carriers for their containerized shipments was undertaken in order to assess the carrier selection decision. One component of this study evaluated the usage of various information sources, and also evaluated the performance of carriers, providing some insight into the shipper's views of carrier marketing effort. The influence of this effort in inducing carrier switching is discussed. The study concludes that advertising is solely informational, preventing carrier elimination through creating awareness, but that carrier sales representative service is a strong determinant of continued use. Freight rates are correlated with carrier switching.

LITERATURE REVIEW

Very little transportation research has evaluated the role of marketing effort in the carrier selection decision, the focus of this paper. Most carrier selection

research has concentrated on the criteria used in the decision process for other modes of transport. For example, Evans and Southard (1974) studied shipper and carrier perceptions in the Oklahoma trucking industry. This study is an excellent survey of choice criteria important to both parties and how the perceptions of both buyer and seller differ. Saleh and LaLonde (1972) also studied the U.S. motor carrier industry, concluding that service offerings were perceived by shippers to be homogeneous, and therefore price was the only influencing variable. However, importance of criteria does not imply salience in the choice decision, and so these studies do not assess the impact of the criteria on the actual choice made.

As for marketing variables, only Stock and LaLonde's 1978 mode selection study and Saleh and LaLonde's 1972 study of the trucking industry discussed the sources used by the buyer to assess his options. Stock and LaLonde concluded that shippers relied heavily on past experience, consulting carriers' sales representatives second most frequently and company records third. These findings question the role played by advertising in the decision process.

Few studies of the carrier evaluation process have been undertaken in the marine transport industry.[1] Of these, none evaluate the role of marketing factors using performance ratings and knowledge of the actual carrier

chosen in a particular purchase situation in order to define the areas of marketing concentration.

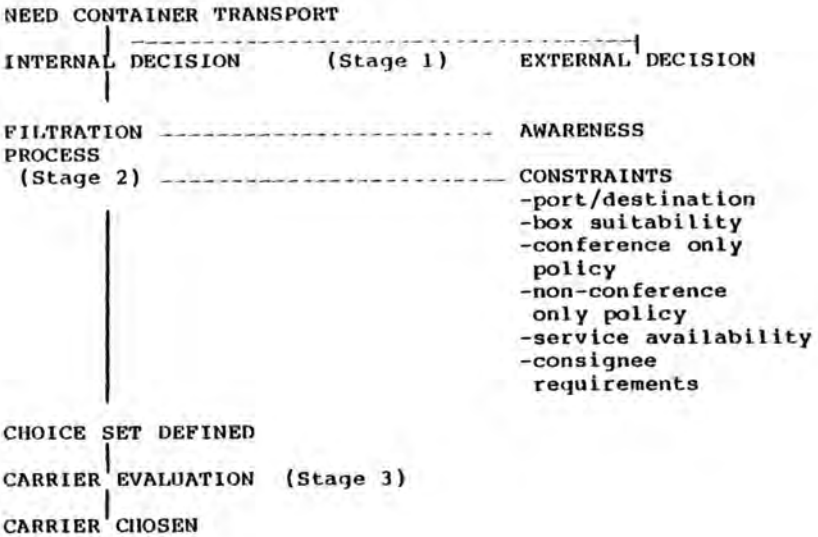
THE GENERAL MODEL

The carrier selection process is viewed as a three-stage purchase process. The first stage concerns the location of the selection decision, internal or external to the shipper firm, separating those firms controlling the decision from those abdicating that control to an external party, either a freight forwarder or the consignee. This paper focuses solely on the internal decision process, i.e. stages two and three.

In the second stage, the uncontrollable variables reduce the number of choice options. These variables were seen to be awareness of options, port/destination factors, and the ability of the carrier to meet the box or service requirements of the shipper. Once all of these factors have been accounted for, the shipper enters the third stage: carrier evaluation.

The underlying rationale for this view of the selection decision is found in marketing theory. Kotler (1980) suggests that buyers move through a series of option-reducing stages; this progression is represented in Figure 1.

FIGURE 1



RESEARCH QUESTIONS

In order to evaluate marketing effort completely, a series of research questions must be answered:

1. Who controls the decision, and therefore where should the marketing effort be directed? This research should include profiles of firms that choose the carrier and profiles of those that abdicate responsibility for the decision, as well as profiles of the type of individual in the contact firm.

2. What is the relative role of awareness and the constraints limiting carrier options?

3. Where does the shipper seek information on carrier options in order to make his selection decision?

4. How do carriers rate? Are they providing the services/meeting the criteria established by shippers as being important considerations in the choice made?

5. On what criteria do shippers choose carriers? This needs to evaluated in terms actual choices made in order to know potential market opportunities and areas of marketing concentration. Also: What factors induce reassessment of carriers and which of these are implicated in carrier switching?

The answers to each of the above questions are papers in themselves. As this detail is obviously beyond the scope of this paper, only general insights only will be provided.

METHODOLOGY

The technique used to collect the data for this study was mail questionnaire with telephone followup. This insured confidentiality through aggregated response reporting and enabled the collection of much more information than would have been possible for the same cost by either telephone or personal interview. The telephone followup was used to clarify confusing answers and reduce non-response bias.

The 14-page questionnaire developed was sent to a 5 percent sample of known marine shippers and the results reported below are based on an eligible response rate[2] of 62 percent, or 61 companies.

FINDINGS

1. Who controls the decision and therefore where should the marketing effort be directed?

Decision control was assessed in the context of the locus of the selection decision, internal or external to

the firm. Of the 61 respondents, 27 made the decision exclusively within the firm, 10 respondents indicated that the decision was made exclusively outside the firm - for 5 by a freight forwarder and for 2 by the consignee. For the remaining 3, the decision was sometimes made by a freight forwarder and sometimes by the consignee. A combination of internal and external decision-making was indicated by 24 companies - 8 making the decision internally less than 25 percent of the time and the other 16 internally greater than 60 percent of the time. Therefore, a substantial number of Canadian businesses abdicate decision control to external parties. This research evaluated only the influence of marketing variables on a particular internal decision.

2. What is the relative role of awareness of carrier alternatives?

Based on shipper awareness of carrier offerings, carriers could be divided into three broad categories: (i) those with high visibility and strong awareness levels, (ii) those carriers with mediocre to poor awareness levels, and awareness is a strong factor in their consideration as an alternative, and (iii) those who are not considered because of poor awareness. Only 8 of the 30 listed carriers fell into the first category. Lack of awareness eliminated 9 from further consideration by the respondents. It is apparent that many carriers could

benefit from marketing efforts to increase the consumer awareness of their services.

By what means can carriers increase awareness? Controllable marketing effort is generally considered to be sales representative programmes, advertising plans, customer service levels, price (if competition occurs on price), and service offering. Uncontrolled marketing occurs in the form of word-of-mouth promotion; both will be discussed here.

3. On what sources of information does the shipper rely in decision-making?

For all decision-makers, the greatest reliance is placed on the carrier marketing effort, in the form of both the carrier sales representatives and the sailing schedules as published in either the Globe and Mail or the Gazette's Marine News (Table 1). Other marketing efforts, such as yellow page advertisements and trade displays, were not indicated as important information sources for the shipper. Word-of-mouth sources, such as other executives outside the firm, are not heavily consulted, supporting the viewpoint that industrial buyers place little reliance on word-of-mouth sources.[3] It is surprising that internal deciders rely on freight forwarders and/or customs brokers as information sources more often than their own company records. Government agencies have little presence in the provision of information. In general, this information search pattern

TABLE 1

INFORMATION SOURCES USED

SOURCE	% USAGE
Federal Government Agency	3.1%
Provincial Government Agency	0.0%
Other Governmental Agencies	7.9%
Carrier Sales Representative	78.1%
Advertising, Direct Mail	34.4%
Internal Records	31.2%
Traffic Club	9.4%
Other Executives Within Firm	6.2%
Other Executives External, Friends	15.6%
Brokerage House, Investment Counsellor	3.1%
Freight Forwarder, Customs Broker	46.9%
Yellow Pages	0.0%
Globe and Mail, Marine News	54.7%
Trade Displays at Conferences	3.1%
Newspapers, Magazines (Articles not advertisements)	21.9%
Other	4.7%

indicates that carrier marketing effort may play a significant role in carrier choice, and suggests that carrier effort should be expended in planning sales force coverage, territory allocation, and sales call frequency, as well as in insuring accuracy and detail in the published sailing schedules in the Globe and Mail and Marine News. It must be remembered, however, that frequent usage does not imply that marketing effort is either efficient or effective in inducing the use of a particular carrier. For that, performance must differ between carriers that are "chosen" and those that are "not chosen" for a particular purchase situation, and correlated with switching behaviour.

4. How do carriers rate?

One interesting approach to evaluating industry performance is to evaluate the desires of the consumers of that industry's product, in this case carrier services, in the context of the product's performance measured on those critieria by the consumers.[4] In the questionnaire, both of these variables were collected, the mean ratings are presented in Table 2. For clarity, these are then placed on a grid in order to determine areas in need of improvement, and areas where current carrier service is adequate (Figure 3).

TABLE 2

IMPORTANCE - PERFORMANCE RATINGS

CRITERIA (CODE)	PERFORMANCE MEAN RATING OF CARRIERS (1)	IMPORTANCE MEAN RATING ALL SHIPPERS (2)
Tracing Capability (A)	2.37	3.36
Frequency of Sailings (B)	2.40	4.26
Directness of Sailings (C)	2.28	4.23
On-time Pick-up and Delivery (D)	2.27	3.90
Cost of Service (E)	2.73	4.56
Sales Representative Service (F)	2.55	3.10
Fast Claims Response (G)	2.90	2.97
Past Loss and Damage Experience (H)	2.60	2.86
Informational Nature of Advertising (I)	2.88	1.97
Reputation for Reliability (J)	2.29	4.26
Transit Time (K)	2.40	4.23
Co-operation between Personnel (L)	2.21	3.68
Carrier Flexibility (M)	2.54	3.59

NOTES: (1) Based on 114 carrier-ratings by shippers. Rated on a scale of 1 to 5, where 1=excellent.
(2) Based on the importance of this criteria to the respondent. Rated on a scale of 1 to 5, where 5=very important.

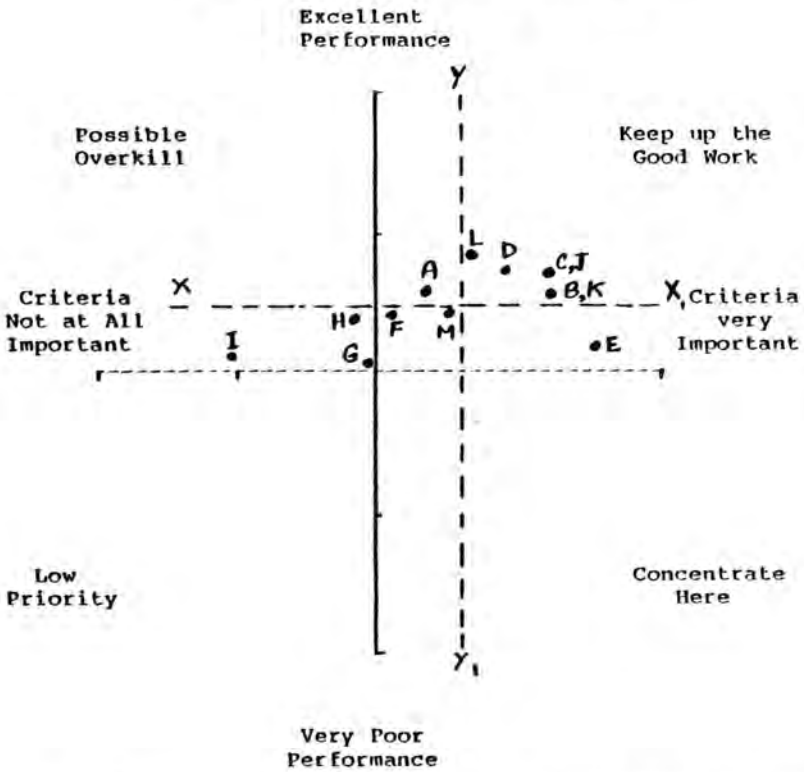
According to the results presented in Figure 3, overall carrier performance is viewed to be good, of acceptable quality. In fact, both carrier advertising and damage record/claims response are much better than Canadian exporters desire. However, there is another side to this coin: performance on these items may be of sufficiently good quality all the time that shippers no longer view these dimensions as important or may deny their importance because the criteria is not socially acceptable.[5]

Martilla and James (1977) point out that the positions of the axes is judgemental, and if these are moved to the overall mean locations, as represented by X-X1 and Y-Y1, a slightly different picture emerges. In this scenario, cost of service drops into the realm of "concentrate here," i.e., carriers must improve their rates. It would be preferable to discuss this dimension on a route-by-route basis, but that is beyond the scope of this paper. Suffice it to say, carrier performance is generally adequate to meet shipper needs. Therefore, two questions remain: what criteria are correlated with choice and what induces switching of carriers?

5. Which performance factors are correlated with choice? What shipper problems precipitate carrier switching?

FIGURE 3

IMPORTANCE - PERFORMANCE ANALYSIS



NOTE: Categories derived from Martilla and James (1977).

As importance alone is insufficient to predict choice, the salient criteria for choice must be defined through evaluation of actual purchases; that is, the performance of carriers "chosen" must be significantly different from that of carriers "not chosen" on the particular criteria.

Saleh and LaLonde (1972) in their study of motor carrier users concluded that shippers view the service offerings of motor carriers as homogeneous. However, this research indicates that the same cannot be said of marine carrier services, as clear differences were perceived between carriers. The performance ratings varied between chosen and not chosen carriers (Table 4). When services are viewed as homogeneous, price is the only differentiated dimension. Since this is not the case, price (cost of service to the shipper) cannot be the only choice criteria.

Table 4 indicates that carriers are differentiated on four dimensions: frequency of sailings, cost of service, sales representative service and the appropriateness of a carrier (a subjective factor). The last two showed the strongest differences. Which of these differentiating dimensions is correlated with the chosen carrier must now be determined and verified through discriminant analysis.

The correlation scores are shown in Table 5. All four of these dimensions are correlated with choice, confirming their role in the selection process. Discriminant analysis was undertaken on these four factors in order to determine the relative role that each plays in the selection process; cost of service and frequency of sailings play an incrementally insignificant role in the choice, with "appropriateness" and sales representative service being the significant factors in the decision of

TABLE 4

DIRECT COMPARISON ON CARRIER RATINGS

CRITERIA	MEAN RESPONSE (1) CHOSEN CARRIER	NOT CHOSEN CARRIER	SIGNIFICANCE (2)
Tracing Capability of Carrier	2.35	2.38	N.S.
Frequency of Sailings	2.06	2.52	.04
Directness of Sailings	2.07	2.36	N.S.
On-time Pick-up and Delivery	2.04	2.35	N.S.
Cost of Service	2.39	2.86	.04
Sales Representative Service	2.13	2.72	.01
Fast Claims Response	2.53	3.06	.08
Loss and Damage Experience	2.33	2.69	N.S.
Informational Nature of Advertising	2.88	2.88	N.S.
Carrier's Reputation	2.10	2.36	N.S.
Transit Time	2.20	2.48	N.S.
Co-operation Between Personnel	1.92	2.32	.08
Carrier Flexibility	2.41	2.59	N.S.
Carrier Appropriateness	2.00	2.62	.007

NOTES: (1) Carriers were rated on a 1-5 scale.
1 = excellent, 5 = very poor.
(2) Significance established at p .05 level.
N.S. means not significant at p .10 level. (A one-tailed t-test used.)

which carrier to use and accounting for 80 percent of the variance. As sales representative service is a clear factor in the use of a particular carrier, is it also associated with carrier switching?

In their studies of cargo transportation, both Cook (1967) and Cunningham and Kettlewood (1976) concluded that source loyalty is of particular importance in the transport purchase decision. In general, this research found that switching behaviour in reassessment situations

TABLE 5

CORRELATION WITH CHOICE

PERFORMANCE CRITERIA	SIGNIFICANCE OF CORRELATION (1)
Frequency of Sailings	p=.04
Cost of Service	p=.03
Sales Representative Service	p=.01
Appropriateness of Carrier	p=.006

NOTE: (1) Significance of a one-tailed Pearson correlation test.

as highly loyal shippers. However, 14 respondents indicated that their firms switch 1 out of every 2 reassessment situtions; these shippers are relatively unhappy with their past choice(s) and can be considered as dissatisfied users.

Shipper problems which precipitate carrier re-evaluation are reviewed in Table 6. Of these, cost of service and sales representative contact appeared most frequently. Poor box quality and other carrier service factors were not indicated frequently enough to evaluate their role in precipitating switching.

But which of these reassessment factors actually induces carrier switching, i.e., which are correlated with a change in the carrier used? Correlation analysis indicates that cost of service is a correlate of switching behaviour ($r=0.310$, $p=.02$), whereas, sales representative contact is not significant. Contact by other carrier's sales representative(s) is not persuasive in inducing

TABLE 6

REASSESSMENT FACTORS

SOURCE	FREQUENCY (1)
Poor Quality Box Supplied	3
Carrier Unable to Supply Suitable Box	7
Slow Claims Response	-
Cost of Service	30
Poor Pick-up and Delivery	3
Customer Complaints	4
New Corporate Policy	2
Sales Representative Contact	13
Loss and Damage Experience	3
Scheduled Review	6
Other (2)	6
n =	45

NOTES: (1) Respondents were asked to check "all that apply."
(2) The other responses included carrier changing ports of operation, lack of space, missed ship quayside with a frequency of one each. The sailing schedule accounted for three.

switching, although the correlation analysis on choice indicated that it is a very strong determinant of continued use.

COMMENTARY

Carrier advertising was not seen as important by those shippers answering the questionnaire. Its role is solely informational. Although not instrumental in differentiating carriers, it is important in creating awareness and so is a factor in preventing the elimination of the carrier in the second stage of the model and contributing to the "appropriateness" of a carrier. On the other hand, personnel co-operation and sales

representative service were perceived to be of average to above-average importance to the shipper. In addition, "chosen" and "not chosen" subgroups are significantly differentiated on the sales representative dimension. This raises the question: Is sales representative service really not important, or is it just that shippers do not want to admit that it is an important factor in their decision, given its emotional rather than rational nature? This marketing variable is a factor in continued use although not in inducing switching. Freight rates, although not prime factors in the choice of a particular carrier, do induce reconsideration of carrier alternatives and are correlated with switching although not with continued used.

FOOTNOTES:

1. The author is aware of only three: Mallen and Pernotte (1972), Atlantic Provinces Transportation Commission (1981), and Pearson (1980). Of these, only the last exclusively evaluates container transport by sea.

2. The "eligible" response rate is an estimate as 39.6% of the total mailing responded as "non-exporters of containers in 1981." The actual overall response rate was 63.3%.

3. Bonoma and Zaltman (1978) conclude that word-of-mouth promotion is often underestimated; Wind (1970) disagrees indicating that word-of-mouth sources are not as important in industrial purchases as they are in consumer purchases.

4. For the best illustration of this technique, see Martilla and James (1977).

5. Greenberg (1972), p.5.

BIBLIOGRAPHY:

Atlantic Provinces Transportation Commission (1981), "Quality of Transportation Services - What are the Problems,?" presented at The Shipper-Carrier Conference, sponsored by The Halifax Board of Trade, Halifax, Nova Scotia, (April).

Bonoma, Thomas V. and Gerald Zaltman (1978), "Organizational Buying Behavior," Chicago, Illinois: American Marketing Association.

Cook, W.R. (1967), "Transport Decisions of Certain Firms in the Black Country," Journal of Transport Economics and Policy, 1, 3, 325-344.

Cunningham, M.T. and K. Kettlewood (1976), "Source Loyalty in the Freight Transport Market," European Journal of Marketing, 1, 60-78.

Evans, R.E. and W.R. Southard (1974), "Motor Carriers' and Shippers' Perceptions of the Carrier Choice Decision," The Logistics and Transportation Review, 10, 2, 145-147.

Greenberg, Marshall C. (1972), "Multidimensional Scaling," in Robert Ferber, ed., Handbook of Marketing Research, New York: McGraw-Hill Inc.

Kotler, Philip (1980), "Principles of Marketing," Englewood Cliffs, New Jersey: Prentice-Hall.

Mallen, Bruce and Jean F. Pernotte (1972), "Decision-making and Attitudes of Canadian Freight and Cargo Transportation Buyers," Montreal: Sir George Williams University.

Martilla, John A. and John C. James (1977), "Importance - Performance Analysis," Journal of Marketing, 41 (January), 77-79.

Pearson, Roy (1980), "Containerline Performance and Service Quality," University of Liverpool: Marine Transport Centre.

Saleh, F. and Bernard J. LaLonde (1972), "Industrial Buying Behavior and the Motor Carrier Selection Decision," Journal of Purchasing, 8, 1, 18-33.

Stock, James R. and Bernard J. LaLonde (1978), "The Purchasing Approach to Transportation Mode Selection," Journal of Purchasing and Materials Management, Spring 2-5.

CHANGING HINTERLANDS FOR EASTERN CANADIAN CONTAINER PORTS: 1978-1981

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1. ABSTRACT

This paper examines changing patterns of origins and destinations of container traffic flows through the ports of Montreal, Saint John and Halifax between 1978 and 1981. During these years, Montreal's share of this market increased from 42% to 57%, largely at the expense of Halifax. Each port exhibits its own distinctive patterns of origins and destinations. Rapid growth of Canada-U.S. transborder container movements through eastern Canada ports in general, and Montreal in particular, contributed to the absolute and relative growth of the port of Montreal.

2. METHODS

Containerized traffic flow data were collected in two separate studies conducted by the Canadian Marine Transportation Centre (CMTC) and funded by the Transport Universities Programme of Transport Canada. The first study collected and analysed a 20% random sample of inbound and outbound container ship sailings through Montreal and Halifax for 1978.[1] The second study collected and analysed a similar 10% random sample from Montreal and Halifax for 1981, and from Saint John for years 1978 and 1981.[2]

TABLE 1. SAMPLE OF SAILINGS

PORT	1978			1981		
	Sailings	Sample Size		Sailings	Sample Size	
	N	%	n	N	%	n
MONTREAL						
Export	185	20%	37	201	10%	20
Import	185	20%	37	199	10%	20
SAINT JOHN						
Export	225	10%	22	264	10%	26
Import	191	10%	19	226	10%	23
HALIFAX						
Export	290	20%	59	341	10%	34
Import	290	20%	59	324	10%	33

Data collected included: commodity flow (import or export); sailing (shipping line, vessel and date); shipper location (province, state, country); discharge port (for exports); loading port (for imports); destination (geographic location of consignee, final market); cargo (3 digit SIC commodity description); weight (in thousand kilos); number of containers in shipment; and container type (size, mafi, ro-ro, etc.).

Detailed analysis of this information is contained in the 1978 and 1981 (forthcoming) CMTC reports. The present paper focuses on 1978-1981 changes in (1) volume of import and export flows (measured in TEUs), (2) origins and destinations of cargo, and (3) commodities shipped, by major SIC category.

3. BACKGROUND

3.1 Growth in Containerized Traffic

It is useful to examine growth of containerized traffic through eastern Canadian ports within the context of world growth in containerized port traffic.

Table 2 shows that world containerized port traffic doubled from 1975-1980, based on TEU data provided by the ports. TEU traffic through the three major eastern Canadian ports increased at about the same rate over the 1975-1980 period; however growth was very different in each of the ports. Between 1975 and 1980 Montreal traffic increased 2.77 times, Saint John traffic increased 1.86 times, and Halifax traffic increased 1.58 times. Most of Halifax's growth occurred earlier in the 1970's.

In contrast to growth in containerized traffic through eastern Canadian ports, which paralleled the doubling of world traffic from 1975-1980, western Canadian traffic through Vancouver increased by only 1.32 times during this period.

3.2 Changing Market Shares Among Eastern Canada Ports

Changes in port shares of total traffic through eastern Canadian container ports are also shown in Table 2. From 1975-1980 Halifax's share fell from 48% to 39%, with a further estimated decline to about 29% in 1981. Simultaneously, Montreal's share rose from 36% in 1975 to 51% in 1980, with a further estimated rise to 57% in 1981. Saint John's market share remained relatively stable, fluctuating between 15% and 22%. To this point, the discussion on growth in TEU traffic is taken from published sources. We now turn to findings of the CMTC sample surveys.

TABLE 2

CONTAINERIZED TRAFFIC 1975-1980 EXPRESSED IN TEUs (000s)

AND 1975-1981 MARKET SHARES OF EASTERN CANADA PORTS

	1975	1976	1977	1978	1979	1980	1981	1980/1975
1. Montreal	108.5 (36)	132.5 (40)	143.9 (34)	193.3 (42)	266.2 (45)	300.6 (51)	n.a. (57)*	2.77
2. Saint John	46.9 (16)	87.7 (27)	94.0 (22)	84.4 (18)	87.6 (15)	87.4 (15)	n.a. (15)*	1.86
3. Halifax	143.6 (48)	109.4 (33)	190.6 (45)	185.5 (40)	233.5 (40)	226.4 (39)	217.5 (29)	1.58
4. Sum (1+2+3) (Market Share)	299.1 (100)	329.6 (100)	428.4 (100)	463.2 (100)	587.3 (100)	614.5 (100)	n.a. (100)	2.05
5. Vancouver	96.9	104.4	113.1	119.8	113.0	127.9	n.a.	1.32
6. World	17,410	20,214	22,991	27,039	31,986	36,510	n.a.	2.10

NOTE: Figures in brackets represent the market shares of each eastern Canada port.
Source: Containerisation International Yearbooks 1978-1982
* 1981 market shares based on unofficial tonnage estimates

4. FINDINGS

4.1 Containerized Imports and Exports

Estimated containerized imports and exports through Montreal, Saint John and Halifax for 1978 and 1981 are reported in Table 3. Containerized imports through Montreal increased by 30% from 1978-1981, imports through Halifax decreased by 18%, and imports through Saint John decreased by 4%.

On the other hand, container exports through Montreal increased by 60% from 1978-1981, exports through Saint John increased by 8%, while exports through Halifax fell by 8%. Total imports and exports increased 45% in Montreal, 3% in Saint John, and decreased 13% in Halifax.

Since official figures for 1981 TEU traffic through Montreal, Saint John and Halifax are not yet published, it is not possible to compare both 1978 and 1981 published data with CMTC sample survey data from these years. Table 4 compares CMTC estimates with published data on TEU traffic for 1978. The ratio of the CMTC TEU estimate over published TEU data is .87 for Halifax, .83 for Saint John and .79 for Montreal. CMTC estimates may differ from TEUs reported by the separate ports for various reasons: (1) methods of calculating TEUs may differ concerning inclusion/exclusion of mafis, roll-on roll-off cargo and knock-down crates; (2) inclusion by ports of domestic TEU feeder traffic; and (3) sampling variability. A comparison of CMTC estimates for 1978

TABLE 3

CONTAINERIZED IMPORTS AND EXPORTS THROUGH EASTERN CANADA PORTS:

1978-1981 CHANGES IN ANNUAL TEU'S (000's) ESTIMATED FROM CMTC

SAMPLE SURVEYS

	Imports			Exports			Traffic		
	1978	1981	%Δ	1978	1981	%Δ	1978	1981	%Δ
Montreal	79.2	103.2	30	74.0	118.4	60	153.2	221.6	45
Saint John	26.8	25.6	-4	43.1	46.6	8	69.9	72.2	3
Halifax	76.8	62.9	-18	85.0	78.2	-8	161.8	141.1	-13
Total	182.8	191.7	5	202.1	243.2	20	384.9	434.9	13

Source: CMTC database

NOTE: TEUs exclude MAFIs and KDBs

and 1981 with the published data reported in Table 2, however, indicates that the direction and order of magnitude of estimated 1978-1981 changes are generally consistent with published data.

TABLE 4. COMPARISON OF 1978 CONTAINER TRAFFIC DATA FOR EASTERN CANADA PORTS (000s, TEUs)

	CMTC Estimates (1)	Published Data (2)	Ratio (1)/(2)
Montreal	153	193	.79
Saint John	70	84	.83
Halifax	162	186	.87
TOTAL	385	463	.83

(1) Montreal and Halifax data are derived from a 20% sample of container ship sailings, Saint John data are based on a 10% sample.

(2) Containerisation International Yearbook 1981. Published data provided by the ports.

Having set the stage by reviewing the growth of container traffic through eastern Canada ports, changes in the hinterlands served by these ports will now be examined.

4.2 Containerized Imports by Shipper Location and Destination

Shipper locations for imports are shown in Table 5. The most striking first impression is that the three ports exhibit unique patterns on this dimension. Montreal imports originate predominantly in northern Europe, Saint John imports in the Far East, including Australia/New Zealand, and Halifax imports are still more diverse -- from northern Europe, southern Europe

TABLE 5. CONTAINERIZED IMPORTS THROUGH EASTERN CANADA PORTS BY SHIPPER LOCATION (TEUs)

	Montreal		Saint John		Halifax	
	1978%	1981%	1978%	1981%	1978%	1981%
1. NORTHERN EUROPE	90.1	87.9	3.2	*	52.8	55.5
U.K./Ireland	51.1	36.3		-	13.6	5.4
Sweden	*	*		-	20.9	9.6
West Germany	16.1	19.0		-	5.5	13.7
Belgium	3.4	7.6		-	*	3.2
Netherlands	4.6	8.8		-	*	*
France	9.8	12.8	3.2	-	6.5	9.6
Other	5.1	*		-	*	12.3
2. SOUTHERN EUROPE	2.4	8.8	31.6	27.3	11.8	20.2
Italy	2.1	*	26.9	25.1	9.2	11.1
Other, Israel	*	*	4.7	*	*	9.1
3. FAR EAST		*	63.8	66.7	19.9	20.6
Japan			27.8	30.3	4.0	2.7
Taiwan			6.3	7.0	6.4	4.5
South Korea			6.2	6.9	2.9	3.3
Hong Kong			3.8	5.5	2.7	3.3
Australia/N.Z.			13.6	10.3	3.9	4.5
Other			6.1	6.7		2.3
4. CARRIB/CENT/S.AM.			*	*	*	*
5. CANADA/U.S.		*	*	*	*	1.5
6. OTHER	*	*	*	*	*	1.7
TEUs (%)	100%	100%	100%	100%	100%	100%
TEUs (Est. 000s)	79	103	27	26	77	63
Sample %	20	10	10	10	20	10

* Indicates under 2%
Source: CMTC database

and the Far East locations.

Between 1978 and 1981 Montreal imports from northern Europe remained near 90%, while imports from southern Europe and the Mediteranean increased from about 3% to 9%. By 1981 over 96% of imports through Montreal originated in Europe and the Mediteranean.

Saint John imports, by country of origin, remained relatively stable from 1978-1981.

Imports through Halifax originating in northern Europe increased marginally in relative importance, from 53% to 56% of total imports. The share of imports originating in southern Europe increased from 12% to 20%, while the share of imports from the Far East and Australia/New Zealand remained stable around 20%.

Table 6 shows the frequency distribution of TEU imports through these three ports in 1978 and 1981, by destination. The inland hinterlands served by the separate ports changed little during this period, except for some changes related to transborder shipments.

For imports through Montreal, approximately 27% had Quebec destinations in both 1978 and 1981, while those destined for Ontario and other provinces fell from about 34% to 28%. Imports through Montreal transhipped to the U.S. increased from about 38% to 44%.

Imports through Saint John to Ontario remained stable around 39%, while those to Quebec fell from

TABLE 6

CONTAINERIZED IMPORTS THROUGH EASTERN CANADA PORTS

BY DESTINATION (TEUs)

	Montreal		Saint John		Halifax	
	1978	1981	1978	1981	1978	1981
Nova Scotia	* .1	*	*	2.5	20.4	17.8
New Brunswick	* .02	*	5.6	9.1	*	*
Quebec	27.1	27.5	53.1	44.7	29.2	33.3
Ontario	29.9	21.6	39.5	38.4	31.5	30.1
Other Canada	4.1	6.3	*	5.3	4.1	5.1
TOTAL CANADA	61.4	55.5	99.0	100.0	87.3	86.5
U.S. North East	5.8	10.0	*		6.0	3.5
U.S. Mid-West	31.8	32.9			4.6	8.1
Other U.S./ff	*	1.6	*		2.0	*
Other	*	*				
TEUs (%)	100%	100%	100%	100%	100%	100%
TEUs (Est.000s)	79	103	27	26	77	63
Sample %	20	10	10	10	20	10

* Indicates under 2%; ff indicates freight forwarders and U.S. unspecified included. Source: CMTC data base

53% to 45% from 1978 to 1981. Imports destined for Maritime provinces increased by about 4% as a proportion of all imports.

The portion of imports through Halifax destined for Quebec and Ontario increased from 60% to 63%, while shipments to U.S. destinations remained at about 13% of all imports.

4.3 Containerized Exports by Shipper Location and Destination

Table 7 compares the percentage distribution of exports in 1978 and 1981 by the province and state of the shipper. Evidence of change in the pattern of transborder shipments is found here also.

For Montreal, the percent of exports originating in Quebec fell from 31% in 1978 to 19% in 1981. Exports originating in Ontario remained stable at about 24%, while those originating in other provinces fell by about 3%. Overall, exports through Montreal originating in Canada fell from 64% to 46% between 1978 and 1981 as transborder shipments increased in relative importance, accounting for over 50% of export TEU's through Montreal in 1981.

The origin of exports through Saint John also shifted somewhat between 1978 and 1981. Increasing in relative importance were shipments from New Brunswick and Ontario, which were offset in about equal measure by reductions in the percentage of shipments from Quebec and other provinces. Shipments originating in the U.S. did not change in relative

TABLE 7

CONTAINERIZED EXPORTS THROUGH EASTERN CANADA PORTS

BY SHIPPER LOCATION (TEUs)

	Montreal		Saint John		Halifax	
	1978	1981	1978	1981	1978	1981
Nova Scotia			*	*	9.0	16.4
New Brunswick			3.1	8.5	*	*
Quebec	31.5	19.2	38.7	33.1	32.8	28.3
Ontario	25.7	23.6	26.9	31.3	25.9	29.6
Other Canada	7.2	3.5	18.2	12.4	4.3	5.5
TOTAL CANADA	64.4	46.3	86.9	85.3	73.3	80.0
U.S. North East	9.2	17.6	6.0	7.7	14.5	9.0
U.S. Mid-West	21.9	27.2	*	*	3.7	2.4
U.S. West	*	5.0	*	*	*	*
Other U.S./ff	3.6	2.0	3.5	*	7.2	7.1
Other	*	*	*	*	*	*
TEUs (%)	100%	100%	100%	100%	100%	100%
TEUs (Est. 000s)	74	118	43	47	88	78
Sample %	20	10	10	10	20	10

* Indicates under 2%; ff indicates freight forwarders and U.S. unspecified included.

Source: CMTC data base

importance.

Exports through Halifax originating in the Maritime provinces increased by about 6% in relative importance, shipments originating in Quebec fell by 4%, while those from Ontario rose by 4%. Overall, 80% of Halifax's 1981 exports originated in Canada, compared to about 46% of Montreal's 1981 exports. The percentage of Halifax exports originating in the U.S. fell from 26% in 1978 to 20% in 1981.

Table 8 shows 1978 and 1981 containerized exports through these ports by destination. As with import origins, each of the three ports has its own distinct pattern of export destinations.

Exports through Montreal to northern Europe represented 92% of exports in 1978, which increased to 97% in 1981. Saint John, by contrast, had less than 2% of exports destined for northern Europe, while 76% of 1978 exports and 84% of 1981 exports went to the Far East. Halifax again shows a more diversified pattern than either Montreal or Saint John, with most exports destined for northern Europe but with southern Europe/Mediteranean and Far East exports well represented.

Between 1978 and 1981 the relative importance of exports to the Far East, including Australia/ New Zealand, increased for both Saint John and Halifax. Southern European exports through Saint John declined in relative importance from 1978-1981, while exports to the Caribbean/Central America/South

TABLE 8. CONTAINERIZED EXPORTS THROUGH EASTERN CANADA PORTS BY DESTINATION (TEUs)

	Montreal		Saint John		Halifax	
	1978%	1981%	1978%	1981%	1978%	1981%
1. NORTHERN EUROPE	91.8	96.5		*	53.5	75.9
UK/Ireland	48.3	42.2			13.4	21.7
Sweden	*	*			4.2	13.3
West Germany	9.9	9.8			11.2	12.0
Netherlands	12.9	13.1			4.2	4.8
Belgium	11.7	12.2			7.0	8.9
France	9.0	11.4	*		7.1	10.3
Other	*	6.5			6.4	4.9
2. SOUTHERN EUROPE	*	*	19.1	4.2	16.4	7.3
Italy	*		13.2	*	5.8	3.1
3. FAR EAST	*	*	76.0	84.2	18.2	14.2
Japan			36.8	46.5	3.1	*
Taiwan			5.0	5.6	2.1	2.5
Thailand			1.4	2.1		
South Korea			4.9		3.5	*
Hong Kong			3.0	3.0	3.6	2.2
Australia/NZ			16.5	22.4	4.9	6.9
Other			8.4	4.6	*	2.6
4. CARRIB/CENT/S.AM.	*		*	7.6	2.2	*
5. CANADA/U.S.	*		*	*	3.9	2.9
6. AFRICA/MID EAST	*	*	2.2		*	*
7. OTHER	*		*	*	6.0	3.0
TEUs (%)	100%	100%	100%	100%	100%	100%
TEUs(Est. 000s)	74	118	43	47	88	78
Sample %	20	10	10	10	20	10

* Indicates under 2%
Source: CMTC data base

America increased in relative importance.

4.4 Commodity Flows

Table 9 reports containerized imports through Montreal, Saint John and Halifax by selected SIC commodity groupings. Cargo imported through all three ports is highly diversified, although some minor areas of specialization are evident. Restricting comments to 1978-1981 import changes, the following changes are apparent, but relatively unimportant within the overall picture: in Montreal, imports of chemicals, industry specific (IS) machinery, and road motor vehicles and parts increased in relative importance; in Saint John imports of alcohol products decreased markedly while those classified as non-metallic mineral biproducts increased; in Halifax imports of road motor vehicles and parts fell by almost half. Overall, however, the types of commodities imported have shifted very little from 1978 to 1981.

Changes in commodities exported through Montreal, Saint John and Halifax (Table 10) were more evident than those described for imports, but again the overall distribution was very stable. Container exports through Montreal of cereal grains, chemicals, and machinery increased in relative frequency from 1978-1981, while exports of asbestos decreased in realtive frequency. Exports of asbestos through Saint John remained stable, with increased importance of non-

TABLE 9. CONTAINERIZED IMPORTS THROUGH EASTERN CANADA PORTS BY CARGO (TEUs)

	Montreal		Saint John		Halifax	
	1978	1981	1978	1981	1978	1981
Meat	*	-	8.5	6.1	2.3	3.9
Fish	-	-	*	*		-
Dairy Products	-	-	*	-		-
Cereal Grains	-	*	*	-		-
Alcohol	11.4	10.8	13.0	3.9	7.1	9.1
Vegetables		-	2.9	3.9		*
Fruit Preparations		-	3.6	5.5		*
Synthetic Textiles	4.5	*	4.6	3.2	1.6	*
Chemicals	7.3	13.7	5.8	6.1	3.4	6.0
Iron & Steel/Basic Shapes	13.6	14.7	*	4.7	5.1	*
Metal b.p.		*	3.9	4.3		-
Non-Metallic Mineral b.p.		*	5.9	12.1		*
NIS Machinery	5.2	5.2	*	*	*	*
IS Machinery	2.8	4.9	*	*	2.8	3.5
Tractors, Agr. mach.	4.4	4.0	*	-	*	*
Road Miv. & Parts	10.0	5.7	*	*	17.9	8.2
Pneumatic Tires	*	-	3.1	*	3.2	*
Furniture	*	*	*	3.6	3.8	4.6
Kitchenware/Tableware	-	*	2.1	4.5	3.4	3.4
Apparel/Footware	*	-	3.6	3.4	5.1	4.0
Empties	*	*	*	3.9	*	*
General Cargo	4.1	8.7	11.0	7.6	8.6	16.1
Other	34.1	24.2	21.2	17.7	34.1	26.2
TEUs (%)	100%	100%	100%	100%	100%	100%
TEUs (Est.000s)	79	103	87	26	77	63
Sample %	20%	10%	10%	10%	20%	10%

* Indicates under 2%
Source: CMTC database

TABLE 10. CONTAINERIZED EXPORTS THROUGH EASTERN CANADA PORTS BY CARGO (TEUs)

	Montreal		Saint John		Halifax	
	1978	1981	1978	1981	1978	1981
Meat		-	*	*		-
Fish	*	*	2.7	3.6	4.0	7.8
Dairy Products	-	-	3.5	3.6	*	-
Cereal Grains		3.2	*	*		*
Fruits			*			4.3
Alcohol		-	*	*		-
Vegetable/Products	8.9	9.3	9.0	12.0	2.9	*
Rawhides Skins	*	-	2.8	-	3.0	*
Metal	2.5	*	3.7	*	6.1	3.3
Asbestos	8.9	5.3	16.7	16.6	9.3	*
Other C.N.M.M. [potash?]		-	*	3.7		-
Lumber	9.3	6.3	*	*	14.9	14.6
Pulp	4.9	3.7	3.6	-	3.1	*
Paper/Newsprint	5.1	*	9.3	6.0	5.6	*
Chemicals	6.0	10.7	14.3	8.3	2.1	5.6
Synthetics	3.1		*		3.8	*
Iron & Steel/Basic Shapes	11.2	8.5	9.6	5.3	7.8	*
Non-Metal b.p.		*	*	-		3.4
NIS/IS Machinery		4.7	*	-		-
Road Miv. Parts	4.4	*	2.9	5.0	4.2	6.6
Recreation Equip.		*	*	-		*
Pneumatic Tires	*	-		-	*	*
Empties	3.2	*	*	*	*	4.5
General Cargo		4.7	*	*		5.6
Other	31.2	30.9	13.6	20.8	29.6	23.0
TEUs (%)	100%	100%	100%	100%	100%	100%
TEUs (Est. 000s)	74	118	43	47	88	78
Sample %	20	10	10	10	20	10

* Indicates under 2%
Source: CMTC database

metallic minerals (potash), and decreased frequency of chemicals. Halifax recorded increased exports of fish products, fruits, chemicals, and non-metallic biproducts. The relative importance of lumber, pulp, paper and newsprint exports declined in all three ports from 1978-1981.

5. DISCUSSION

5.1 Growth

Continued rapid growth in containerized world trade dominated the period 1975-1980. Containerized trade more than doubled both worldwide and through eastern Canada ports. Part of this increased Canadian trade was due to traffic diversion from U.S. to Canadian east coast ports (1,107 TEUs in 1976 versus 60,899 TEUs in 1980). (Table 11) It is unclear whether the growing worldwide recession, by itself, had a different impact on container shipments through Montreal, Saint John and Halifax.

5.2 Port Market Shares

According to both published data and CMTC survey data, Montreal's share of traffic through these three container ports increased substantially from 1978-1981 at the expense of Halifax's share, Saint John's market share remaining stable. Several factors may have contributed to this shift:

Deregulation of the U.S. trucking industry, with consequent reductions in trucking rates, operated to the advantage of eastern Canadian versus U.S. ports

TABLE 11. TRANSBORDER CONTAINER MOVEMENTS
GAIN (LOSS) TO CANADIAN PORTS (IN TEUs)

	1976	1977	1978	1979	1980
East Coast:					
Imports	(296)	24,063	30,102	36,439	34,191
Exports	1,403	2,908	16,523	21,587	26,708
Total	1,107	26,971	46,625	58,026	60,899
West Coast:					
Imports	(28,197)	(27,044)	(32,797)	(33,651)	(38,176)
Exports	(5,481)	(10,313)	(14,541)	(14,663)	(17,347)
Total	(33,678)	(37,357)	(47,338)	(48,314)	(55,523)
GRAND TOTAL	(32,571)	(10,386)	(714)	9,711	5,376

SOURCE: Revenue Canada, Customs and Excise

and contributed to the growth of transborder container movements.

The transfer of a major carrier (Dart) from Halifax to Montreal in mid 1981 may have diverted more northern Europe import/export traffic to Montreal; however, this restructuring cannot be assessed here.

Development of keen price and service competition between conference and nonconference carriers serving Montreal may have diverted some traffic to Montreal from other Canadian and U.S. ports.

Continued development of reliable year-round service through Montreal further eroded some of the advantages previously held by the ice-free ports of Saint John and Halifax.

5.3 Changing Hinterlands

The North American hinterlands and foreign ports served collectively by Montreal, Saint John and Halifax did not alter appreciably from 1978 to 1981. The 1978-1981 period saw further reinforcement of established trade patterns, with Montreal traffic almost entirely dependent upon northern Europe, Saint John traffic dependent upon the Far East, Australia/New Zealand, southern Europe and Caribbean/Central America/South America. Halifax competed for shares in the markets served by both Montreal and Saint John. However, changing port market shares were accompanied by some changes in

the patterns of origins and destinations of cargo imported and exported through Montreal and Halifax, associated with Canada-U.S. transborder container movements. The gains to Canadian east coast container ports documented by Customs and Excise data from 1976-1980 are reflected in CMTC survey data collected from 1978 and 1981. The percentage of east coast port traffic with U.S. origins or destinations increased with Montreal recording the greatest gains.

5.4 Cargo

Examination of commodity flow patterns revealed only moderate changes in the relative importance of major SIC categories. It is unclear whether those changes reflect temporary responses associated with the growing world-wide recession, or more permanent shifts in the commodity-mix of imports and exports through the ports examined.

5.5 Future Changes

Growth in containerization of international cargo will continue in the foreseeable future, but at what rate is uncertain since most commodities that are readily containerisable have been. The unrestricted movement of traffic across the Canada-U.S. border has become an important factor in recent years and had increased direct competition between Canadian and U.S. east coast ports. Those ports which have benefitted most from recent changes in transborder

movements of imports and exports are also most vulnerable to changes in regulations which might restrict or impede such movements.

Economic factors underlying containerized movement of cargo by land and sea will continue to exert their influence. Future changes in factors such as fuel costs, size of container ships, operating costs, port costs, tariff structures, cargo-sharing conventions, and inter-modal competition will continue to affect transport decisions in subtle ways. Changes in these and other factors will ensure that patterns of traffic through eastern Canada ports will continue to fluctuate.

REFERENCES

1. Karen E. MacKinnon. A Comparision and Analysis of 1978 Export-Import Container Traffic Through the Ports of Halifax and Montreal. Halifax: Dalhousie University, Canadian Marine Transportation Centre. 1980. 150 pp.

2. Murray G. Brown and Mary G. Brooks. A Comparison of 1981 Export-Import Container Traffic Through the Ports of Halifax, Saint John and Montreal. Halifax: Dalhousie University, Canadian Marine Transportation Centre. 1982 forthcoming.

3. Containerisation International Yearbooks 1978-1982.

4. Revenue Canada, Customs and Excise.

NOTE: Definition of U.S. Regions used in Tables 6 and 7.

1. U.S. NORTH EAST: Maine, New Hampshire, Vermont, Massachussets, Connecticutt, Rhode Island, New York,

Pennsylvania, Maryland, Delaware, New Jersey.

2. U.S. MIDWEST: Illinois, Missouri, Indiana, Ohio, Iowa, Wisconsin, Michigan, Minnesota.

3. U.S. WEST: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona, Nevada, California, Oregon, Washington.

TECHNOLOGY AS A CONTRIBUTOR TO TRANSPORTATION CAPACITY

TRANSPORTATION ENERGY REQUIREMENTS TO THE YEAR 2000

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ABSTRACT

This paper presents forecasts of transport energy prices and demand to the year 2000 and discusses some of the issues arising in the area of fuel substitution, conservation and supply. It is argued that the sector's use of petroleum fuels by 2000 will be considerably above what it is currently. Today's lower prices may retard the introduction of fuel efficient transport equipment. With tighter oil markets likely to recur in the late 1980s and beyond, the transport sector must continue to press for energy savings wherever these are justified by cost-effectiveness.

INTRODUCTION

While the current markets for transportation services (and hence transportation fuels) are sluggish, the late 1980s and beyond will likely see a return to tight oil markets. It would be as well for the Canadian transport sector to recognize that the current low price and oversupply of oil are only temporary. By the end of the 1980s, with economic recovery, they will have disappeared. Until beyond 1985, however, the current oversupply will provide the transport sector with a 'breathing space', an

opportunity which it should seize to plan and to continue its energy-saving measures in a reasoned way.

There is no necessity to stress conservation at all costs. The fact must be recognized that, in 2000, the transport sector will still be overwhelmingly dependent on oil -- and in fact will be using more oil than it does now. Any changes in its oil consumption pattern must be met through incremental evolution of existing systems, with rationalization: improvements in efficiency must occur, as well as some conservation and fuel substitution.

Today's slack oil markets, however, present the transport sector with sizeable problems. In Canada and, in particular, in the transport sector in Canada, current price declines are a mixed blessing. They provide a welcome relief from the upward pressure on fuel prices which has severely affected all transport industries, but this relief is only temporary. Moreover, they act against Canadian self-sufficiency, conservation and off-oil programs. The slowing in these projects means increased dependency on oil from foreign sources in future. A further complicating factor is that today's easing oil markets will likely retard the introduction of more fuel-efficient transport equipment and vehicles that might otherwise have been in place by 1990. Yet the 1990s will likely bring a recurrence of rapidly rising oil prices.

The transport sector cannot afford to abandon its recent drive towards energy saving. It must continue to press for energy-saving measures, but with a rational approach which more than ever uses the cost-effectiveness

criterion. In a climate where energy prices will likely fall in real terms by 1990, industry and consumers are likely only to respond to measures which save money, not fuel.

This paper discusses the likely developments in the transport fleet to the year 2000, then presents Transport Canada's forecasts of likely energy price and transport fuel demands. The issues arising for the transport sector out of these forecasts are briefly exemplified.

THE FLEET TO THE YEAR 2000

The transportation sector is already investing in equipment which may still be in service in the year 2000. This is certainly true for urban transit vehicles, railway locomotives and aircraft, and also for some city pick up and delivery trucks. Thus, assumptions of new radical technological developments being widespread in the Canadian transportation system by the year 2000 must be treated with some skepticism. A corollary is that transport demand will be met through incremental evolution of the existing system, including some rationalization within and between modes.

A brief examination of the technology that will be in place is in order. Over the past two years, the passenger car has been singled out for special attention. In Canada, government action was restricted to setting voluntary targets for fuel efficiency to be maintained until 1985. Post 1985, the question must be resolved as to whether the standards will be continued in their present form or whether

they will be modified.

Due to the integrated nature of North American passenger car production, developments in the U.S. during the next year or so will have a crucial bearing on the Canadian decision. The general tenor of the current U.S. Administration is to relax all regulatory constraints on energy use and to rely virtually exclusively on the price mechanism. While this approach may help bring about a more fuel efficient passenger fleet in an era in which energy prices are rising in real terms, it is by no means certain that this will occur when there is the widespread perception of an oil glut and stagnation in energy prices. If such conditions persist, companies will not necessarily develop progressively more fuel efficient cars, nor will consumers necessarily buy them. Thus, setting appropriate standards for Canada will be a problem. It can be argued, for example, that it would be counter productive to make them more stringent than those in the U.S. as doing so would only restrict the choice of the Canadian consumer without any offsetting benefits of increased production or research and development in Canada.

Whatever the final decision, the lead times that must be afforded to manufacturers, coupled with the relatively slow replacement rate within the fleet, lead to the conclusion that, in the main, the vehicles being offered for sale now and during the next five years will form the backbone of the passenger car fleet up to the year 2000. The implications of this statement are twofold. Firstly, the fleet will be changing incrementally as no radical new

technology seems likely to emerge in the next few years. Secondly, this incrementally evolving fleet will continue to rely almost exclusively on gasoline as a fuel. Consequently, the demand for gasoline will continue to grow.

Additional aspects of the gradual evolution of the existing system can be found in the bus mode. Already, articulated buses are becoming an increasingly important means for offsetting the costs associated with operating urban transit systems in high-peak flow periods. Conversely, the use of shorter wheelbase reduced capacity buses has the countervailing effect during troughs in demand. The trucking industry also has the ability to make incremental changes through the adoption of more standardized equipment, as interprovincial weight and dimension standards are harmonized. The new generation of diesel engines slated to come on stream in the late 1980s will produce further fuel savings. Benefits will also accrue to the Canadian trucking industry from the recent relaxation in U.S. trailer width restrictions which will mean, for the first time, that Canadian carriers operating into the U.S. can maintain a single fleet. Similar comments can be made for the rail and air modes.

However, what is clear is that by the year 2000 there will still be an equipment and vehicle fleet in use very similar to the one in use or emerging right now. This disposes of the argument that new technologies will have profoundly changed fuel consumption patterns by 2000. There are also serious implications for the nature of the demand for fuels. During the last ten years, ever since

the original 1973-74 oil supply disruptions, it has been presumed that an increasing amount of the transportation fuel used in Canada would come from alternative sources, i.e., non petroleum. Given the hiatus that is now occurring in the development of almost all synthetic fuels, however, coupled with the life of transport vehicles, it is apparent that the 'lion's share' of transport fuels consumed at the turn of the century will still be conventional fuels. Some specific sub-markets may be carved out for a few unconventional fuels in the next 15 years or so. Nevertheless, the contention that these will amount to any significant part of transportation fuel demand must be treated with some caution. Instead, the next 15 years will be a period during which more sustained research, development and demonstration takes place to prove out novel fuels as candidates for the first quarter of the Twenty-first Century.

This, then, is the general and far more prosaic context in which transportation energy policy issues must be realistically viewed for the next two decades. While it may be comforting to look ahead in this way and recognize technologies we are already familiar with, there should be an accompanying element of disquiet. Because of the slow rate at which new technologies are likely to be adopted, the transport sector will remain dependent upon and vulnerable to changes in petroleum availability and price.

BACKGROUND TO FORECASTS

The persistent recession in Western economies since 1981, along with the development of new oil supply sources, conservation and off-oil efforts, have put substantial downward pressure on world oil prices. At the time these forecasts were done, OPEC had decided on a reduction in the benchmark price of crude oil. The cartel's production had fallen to 17 MM b/d from 31 MM b/d in 1979, and was losing markets to non cartel members. Despite these dramatic developments, however, the massive reserves and low production costs in the Middle East suggest that as the 1980s and 1990s approach, prices in Western nations will continue to be swayed by OPEC oil.

There are already signs of a world economic upturn. In February 1983 the leading business cycle indexes in seven major countries were all positive for the first time since August 1981. In the long term, prospects for growth are good. U.S. and European growth rates to 1995, for example, will likely be around 3% per year; that of Japan, above 5%.

It is difficult to assess how much of the current slack in production will be absorbed when the Western economies start to recover. The recession has masked the effect of new conservation and off-oil programs, as well as development of new oil sources, during the '70s and early '80s. The energy economies of most industrialized countries are showing signs of some structural change in response to rising energy prices. In Canada, for example, it took 541 megajoules to produce one unit of total

transport output (Real Domestic Product) in 1979, versus 586 megajoules in 1971 (see Table 1). Hopefully, this trend will continue. There is no doubt, however, that with the eventual economic recovery will come a resurgence of oil demand. The International Energy Agency, however, has estimated that tight markets will likely begin to recur towards the end of the 1980s. With the Middle East still holding a massive share of world oil reserves, OPEC will then be in a position to lead a price rise again.

What is the world price scenario likely to be over the 1980s and 1990s? For the forecasts contained in this paper, we have postulated the following. The benchmark price of crude has now dropped by $5, to $29 (U.S.) per barrel. It remains constant until 1985, when it begins to rise at two per cent less than the rate of inflation, and in 1989, it equals the rate of inflation. After 1992, it increases at one per cent over the rate of inflation and continues to do so until 2000. The associated crude oil prices are shown in Table 2.

The overall outlook for the Canadian economy to the year 2000 is fairly good (see Table 3). It is expected that the current environment of low growth and unemployment will persist until 1984, when recovery will begin. There will be an increase in investment starting in late 1984 which will help push up growth in GNE to an average of 4.1% per year from 1983 to 1985. Growth in transport RDP is also expected to be rapid, at 4.1%.

The 1985-90 period should be where the recovery really makes itself felt, with average rates of growth of GNE of

3.0% and personal disposable income per capita of 2.5%. Unemployment rates will be down to 8.6%, from 11.3% during 1983-85. Wage rates will continue to be moderate because of the restrictive effects of these fairly high unemployment rates on the wage bargaining process. From 1983 forward, there will be a fairly strong export performance, up about 3.9% per year. The rapid growth products will be grain, potash and possibly, iron ore. Imports of goods will also be strong. RDP in transport will average 3.4% annually.

From 1990 to 2000, the rate of expansion of the Canadian economy is expected to slow somewhat. Exports, GNE, RDP in transport and real disposable income per capita will grow less quickly. The employment situation will be better, however, with the unemployment rate continuing to decline to the year 2000.

TRANSPORT FUEL PRICES AND DEMAND

The expected economic performance to the year 2000 provides a background against which the trends in growth in transport services, and thus transport fuel demand, can be seen. The 1985-90 period will be characterized by big movements of bulk freight out of Western provinces. After 1990, freight traffic will grow less rapidly, as our markets for these bulk commodities mature. Passenger traffic should remain quite strong, however, driven by continued (moderate) growth in real disposable income per capita.

On the passenger side, relatively rapid growth in the population of driving age and in household formation will

sustain the need for automobiles, albeit at a lower rate of increase than in previous decades. Little change can be foreseen in the pattern of urban passenger travel and urban use of the automobile over the period, but the continued movement of more fuel efficient vehicles into the fleet will provide major energy savings per kilometer driven.

Moderate growth in air travel will occur into the 1990s, due to increases in employment, population and real disposable income per capita. The air fleet may show some increase in efficiency by 1990, but some of this is debatable, given the postponement of purchases of fuel-efficient aircraft in the early 1980s.

On the freight side, the increased shipments of grain through West Coast ports, relative to other ports in Canada, may result in higher fuel use per ton shipped. (Referring back to Table 1, this would imply a higher fuel intensity per unit of transport output in rail and, possibly, trucking.) There is room for increased efficiency in the truck fleet, as there is in automobile, but relatively little change in rail or marine fuel efficiencies is foreseen by the year 2000. This implies that these modes will largely be forced to absorb fuel price increases.

The scenario we have chosen causes the blended price of crude in Canada to 'dip' in the next several years, in real terms (see Table 3). The price in 1985, for example, will be 12% below the 1983 price in real terms. Even by 1990, the price will still be 7% below that of 1983. Post 1990, however, a rapid rebound sends it up 19% over five years in real terms, followed by another 2% increase to 2000.

What prices will the transport sector be facing to the year 2000? (See Table 4.) The 'dip' in the crude oil price is reflected in the real price of all transport fuels by 1985. By 1990, however, prices will have resurged and will exceed their 1981 level, in constant dollars. By the year 2000, the effect will be even more pronounced. There is a slight difference in the demand slate for diesel versus gasoline, with relatively more diesel being demanded in 1990. We do not foresee a major change in the diesel-gasoline price ratio, however. Refineries geared to higher diesel production will soon be coming on stream.

Associated demand levels are shown in Table 5. (These represent petroleum-based fuels only.) By 1990, after the 1985-90 period of economic resurgence, demand for all transport fuels should be up almost 20% over the 1981 level; by 2000 it will be 29% above the 1981 level. The strongest demand increase over 1981, 41%, will occur in diesel fuels, particularly in marine diesel, an increase of 76%. This results not only from economic growth, but from fuel substitution. Currently, marine engines are being constructed to burn blends which incorporate heavy fuel oil, but the main constituent is still diesel fuel. Gasoline, however, will post a large increase as well, 29% over the 1981 level by 2000. Aviation turbo, by contrast, will be up only 17%.

These magnitudes of increase of demand might surprise those who looked at the demand levels predicted in the original National Energy Program, where transport demand to 1990 was seen as staying at 1980 levels. The reasons are

several. The NEP demand projections for motor gasoline are postulated upon a version of the MOGAS model, which, some might argue, incorporates some unrealistic assumptions about miles driven per vehicle and much of whose explanatory structure reflects the pre-1973 period. The drastically different price scenario, however, is the most important reason for the different demand forecasts. The NEP/Alberta Agreement predicted a price level which, for gasoline, for example, was nearly 50% above 1981 in real dollar terms, by 1986. The price scenario here produces an equivalent level only 5% above 1981, by 1990, and 2% below 1983 in real terms.

ISSUES ARISING FROM THE FORECASTS

Space does not permit a complete treatment of each of the problems which may arise from the analysis presented above, but examples will be dealt with briefly under the headings of: efficiency, security of supply, substitution and conservation.

Examining the Efficiency issue first, there has been a widespread perception during the past ten years that severe impediments remain in the transportation system with respect to using energy efficiently. This is attributed to the existence of regulations and fiscal measures which were developed in an era when the price and availability of oil was not a serious strategic issue. A detailed analysis has been undertaken by Transport Canada over the past year to examine this contention. What has emerged is that price is a dominant factor in encouraging energy efficiency in the Canadian transportation sector. The

report finds that regulatory impacts on energy efficiency are quite diffuse. Further, a sensitivity analysis of the report's findings has demonstrated that the conclusions are consistent and do not alter markedly when various assumptions are progressively relaxed. Even the beneficial effects of the voluntary corporate average fuel economy standards are questionable. The effects might have been market led (due to real fuel price increases over the past five years) rather than the result of government initiatives per se. It is likely that the findings of this analysis will be controversial. The dominant school of thought in Canada over the past few years has contended that significant benefits could be obtained by restraining energy prices and obtaining offsetting gains in efficiency by regulatory and other means. The study suggests that, as Canada heads into a period of lower real energy prices, the goal of increased efficiency is in jeopardy.

Security of Transportation Energy Supply: This is conventionally dealt with in two ways: by the development of contingency planning measures to deal with disruptions in supply -- principally from offshore -- and by encouraging redundancy in the supply system in the long run. This latter aspect will be considered in the context of this paper under the heading of 'Substitution', albeit within the narrow context of non-petroleum fuels.

With respect to energy emergency planning, Canada is quite well prepared. Not only is there a formal mechanism at the federal level -- the Energy Supplies Allocation Board -- but there are also linkages between the federal

and provincial governments which are continuing to examine the measures necessary to cope with emergency shortfalls.

The situation in emergency planning is disquieting, however, when viewed in an international context. As indicated earlier, the present U.S. federal government has embarked upon a course of action radically different from its predecessor. In effect, dissimilar energy emergency planning approaches are being followed by the U.S. and Canadian governments. In particular, in the event of a world fuel shortfall, U.S. prices would be freed to find their own level while Canadian prices would continue to be controlled. Clearly, further examination of this problem is required due to the volume of international transborder flows involving both private and commercial transport vehicles.

Substitution: As off-oil programs involving the use of natural gas, electricity and coal have penetrated the stationary sectors, a major consequence has been to free up more oil for use in transportation. This, in turn, has meant that refineries have had to change their product slates to cope with the change in demand. Already some refineries have undergone major revamping, with others projected during the coming decade.

One aspect of the endeavour to maximize transportation fuel production from a given barrel of crude oil concerns the issue of fuel quality. Current specifications for fuels have developed over the past half century and are well understood by engine manufacturers, refiners and bulk users. Experiments and investigations are now under way

to see which of these specifications can be relaxed in order to further enhance the production of transportation fuels from crude oil. Currently, the effects of modifying the specifications for diesel fuel are being examined. The issue of whether or not transport can tolerate relaxed fuel specifications is one that will persist until the year 2000.

Although the current hiatus in energy price increases is retarding investment in alternative fuels, the breathing space is allowing a more careful and detailed analysis of the remaining alternatives. While Jerusalem artichokes are no longer being viewed as a principal source of domestic alternative fuels, propane, compressed natural gas and methanol (either straight or in blends) are still receiving detailed attention. The overwhelming requirement for transportation fuels to the end of the century is still for conventional petroleum-based fuels. Nevertheless, highly segmented specific sub-markets for alternative fuels are still likely. The penetration of propane over the last two years, for example, has been concentrated in urban commercial fleets, although there have been some passenger car conversions. Similar markets are foreseen for compressed natural gas. While the use of straight methanol in Canada is still a few years off (other than for research vehicles), there is the distinct possibility that small percentages of methanol in blends will become a 'transparent' alternative, especially if current proposals to phase out lead from gasoline are implemented.

What has been noticeable in the various analyses undertaken to date for alternative fuels, however, is that they are uni-dimensional, i.e., each analysis assumed that that fuel, and that fuel alone, is likely to penetrate a given market. This leads to an overestimate of how far the total of all alternative fuels can penetrate the market. As noted above, propane and CNG will likely compete for the same urban commercial vehicle market. The larger question of whether each of these fuels can obtain sufficient penetration, over a number of years, to sustain the development of the fuel, is yet to be seen. Again, a synthesis pulling together the various potential markets of these remaining candidate fuels in comparison with conventional fuels, remains to be done.

There are other implications attendant on increased use of alternate fuels. It is not likely that there will be tax forgiveness or conversion grants for each and every candidate alternative fuel. Further, there are certainly health and safety aspects attendant on the use of some of these fuels which need to be examined by governments. The re-introduction of propane as a transportation fuel in Canada, just two years ago, exemplified the complexity of some of these issues -- some of which have yet to be fully explored at the provincial and municipal level. For fuels which have not been used extensively before -- and propane was -- these issues are likely to be even more subtle.

Conservation: As was indicated above, a review of the impact of legislation, regulation and fiscal measures on the Canadian transportation sector has indicated that

price plays the dominant role in improving energy efficiency. This is certainly consistent with recent consumer research findings that appeals for conservation per se are strong motivators at the individual level. By contrast, cost savings do motivate.

Clearly, the importance of fuel price as a conservation measure touches on the degree to which the canon of conservation measures, developed by energy specialists over the last ten years, remains cost effective. To examine this issue, an analysis is being undertaken by Transport Canada to review the cost-effectiveness of practical conservation measures under different energy price scenarios.

CONCLUSIONS

There is much short term noise in the transport energy situation due to the current decline in crude oil markets and in demand for transportation services. Today's easing oil markets will likely slow the introduction of more fuel-efficient transport equipment that would otherwise have been in place by 1990. Further, the Canadian transport sector in the year 2000 will not radically differ from its present form, although there may be increased penetration of new technologies currently being introduced. The sector's use of petroleum fuels by 2000, in fact, will be considerably above what it is at present. With the likelihood that tight oil markets will return by the late 1980's and beyond, the transport sector must continue to press for energy savings wherever these are justified by

cost-effectiveness. In the interim, a continuing commitment to further analysis, research and development and demonstration will be required by government.

TABLE 1

FUEL INTENSITY RATIOS IN CANADA

MEGAJOULES PER UNIT OF OUTPUT (RDP)

Year	Rail	Inter-city & Rural Bus	Urban Transit	Trucking	Marine	Air	Total
1965	63.1	49.9	26.3	35.5	262.4	239.5	676.7
1968	59.0	50.0	27.0	36.8	241.1	210.9	625.2
1971	53.7	42.1	29.5	41.5	229.9	189.8	586.5
1974	50.7	N/A	34.2	48.7	246.7	158.9	N/A
1977	49.5	38.4	40.4	47.0	180.6	134.7	490.6
1979	49.2	46.1	42.2	51.4	218.3	133.5	540.7

SOURCE: Statistics Canada

TABLE 2

PROJECTED CRUDE OIL PRICES PER BARREL

Year	U.S. Inflation Rate (%)	World Crude "Marker" Price (U.S. $)	Blended Canadian Price (Nominal) (Cdn. $)	Blended Canadian Price (Real) (1981 Cdn. $)
1981				27.15
1983	6.84	29.00	35.69	30.36
1985	7.81	30.68	34.98	26.63
1990	5.75	40.54	49.50	28.29
1995	6.06	56.14	78.09	33.55
2000	5.79	78.22	108.69	34.35

NOTE: The following assumptions were made on price increases to the marker price:

1983-1984	zero nominal increase
1985-1986	2% below U.S. inflation
1987-1988	1% below U.S. inflation
1989-1991	at U.S. inflation
1991-2000	1% above U.S. inflation

TABLE 3

SELECTED ECONOMIC INDICATORS TO 2000
AVERAGE ANNUAL GROWTH RATE

	1982-1985	1985-1990	1990-1995	1995-2000
U.S. Real GNP	3.9	2.5	3.1	2.9
Gross National Expenditure, Canada	4.1	3.0	2.8	3.0
Consumer Price Index	5.8	5.5	6.3	6.3
Exports of Goods	3.9	3.9	3.9	3.7
Imports of Goods	6.7	5.2	5.1	5.2
Per Capita Personal Disposable Income	0.6	2.5	2.2	2.2
Population	0.9	0.8	0.7	0.5
Labour Force	1.5	1.2	1.1	0.9
Employment	1.3	1.8	1.4	1.3
Unemployment Rate (actual)	11.3	8.6	7.3	5.9
Real Domestic Product	4.1	3.4	2.9	3.1

SOURCE: Economic Analysis Directorate, Transport Canada.

TABLE 4

FORECAST PRICE OF TRANSPORTATION FUEL

(cents per litre)

Year	Rail Diesel	Aviation Turbo	Marine Diesel	Marine Bunker	Aviation Gasoline	Road Diesel	Road Gasoline
			Current $ Canadian				
1981	22.60	27.00	24.30	17.70	36.40	37.20	38.80
1983	29.23	34.92	31.43	23.28	45.72	47.24	48.69
1985	29.32	35.03	31.53	22.81	47.78	48.55	50.07
1990	41.36	49.41	44.47	32.28	67.02	68.28	69.63
1995	63.69	76.09	68.48	50.93	98.94	102.76	103.63
2000	88.33	105.53	94.97	70.88	136.41	142.13	142.56
			Constant 1981 $ Canadian				
1981	22.60	27.00	24.30	17.70	36.40	37.20	38.80
1983	24.86	29.70	26.73	19.80	38.89	40.18	41.41
1985	22.32	26.66	24.00	17.36	36.37	36.96	38.11
1990	24.12	28.82	25.94	18.83	39.08	39.82	40.61
1995	27.36	32.69	39.42	21.88	42.50	44.15	44.52
2000	27.92	33.36	30.02	22.40	43.12	44.92	45.06

SOURCE: Economic Analysis Directorate, Transport Canada.

TABLE 5

REFINED PETROLEUM PRODUCTS
TRANSPORT FUEL CONSUMPTION
(petajoules)

	1981	1985	1990	1995	2000
Motor Gasoline	1131.5	1191.7	1369.3	1415.9	1461.1
Road Diesel	211.5	205.6	269.1	279.7	290.1
Aviation Turbo	160.5	168.0	174.5	180.7	187.0
Aviation Gasoline	7.7	7.7	7.7	7.7	7.7
Rail Diesel	91.3	91.3	107.9	114.4	122.0
Marine Diesel	42.6	58.5	59.1	65.4	75.3
Marine H.F.O.	104.7	96.7	105.9	110.2	117.9
TOTAL	1749.8	1819.5	2093.5	2174.0	2261.1

SOURCE: Economic Analysis Directorate, Transport Canada.

ALTERNATIVE TRANSPORTATION FUELS: THE USE OF PROPANE IN HOLLAND

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ABSTRACT

This paper is a report on the use of liquefied petroleum gas as a transport fuel in Holland. Matters considered include the historical backgroumd of Dutch LPG use, pricing, safety, government regulations and their revision, and current prospects for further market development. The Dutch experience is of interest to Canadians because of the growing use of propane as an automotive fuel in Canada.

INTRODUCTION

The use of propane as a transport fuel in Canada is growing. Business and consumers are investing in the new capital that is required to distribute, dispense and consume it. Governments are working out new regulations that govern its use and are encouraging its development with incentive programs. In the light of this growing activity it is useful to know something of the experience of other countries where propane has been consumed as an automotive fuel for a considerable time. In this paper we examine its use in the Netherlands, where it has been a vehicle fuel for over a quarter century.

In Holland propane is marketed as a component of liquefied petroleum gas (LPG), with blends of propane and butane varying between 60-40% and 40-60%. (A regular change in blend occurs between winter and summer, with the winter blend containing more propane.) There are over 2,200 retail stations selling LPG in Holland, with about 450,000 vehicles equipped to use it (about 9% of the total vehicle fleet in 1980).

Its share of the automotive fuels market is in the 15-20% range in terms of kilometers driven. In April 1982 the retail price of LPG was approximately $0.366/ℓ, while gasoline sold at $0.752/ℓ.[2] This LPG-gasoline price ratio is among the lowest in Europe.

The Dutch began to use LPG to drive cars in the mid-1950's. The key factor in its development was the establishment of the Rotterdam area as a major oil entrepot for northern Europe. LPG is produced as a byproduct of oil refining, as well as in the exploitation of natural gas. About 2% of the crude oil put through a refinery comes off as LPG and the market for it in the geographical area supplied by the Dutch refineries did not match the market for gasoline and other petroleum products. Excess supplies were large for various reasons. First, the European petrochemical industry has preferred naptha as a feedstock and has not used as much liquefied gas as in North America. Thus, the Dutch export potential for LPG was more limited than it is for Canada. Secondly, while LPG is sold for home fuel uses as bottled gas, this market was declining over the period considered here due to the development of the Dutch natural gas network. In home use natural gas now accounts for a higher proportion of total energy demand in Holland than in any other European country. The Shell company had been distributing bottled gas in the home heating market since the 1930's. As the natural gas system was extended, this market declined.

Thus, while a byproduct that is only 2% of oil production would not appear to be an adequate base for a major effort in the development of alternative fuels (especially before OPEC had its effect on gasoline prices), in Holland it was, because the LPG surplus from the Dutch refineries, producing for export, was much more than 2% of domestic gasoline consumption. By Canadian standards there was also an incentive to develop a low cost alternative fuel, since European gasoline prices

were high even in the 1950's. A byproduct, that would simply be wasted if markets were not found for it, did not have to bear the weight of overhead cost that would be apportioned to gasoline. Thus potential profit margins on LPG as an automotive fuel were high. These conditions resulted in market initiatives in the private sector that got the use of LPG underway. The key innovator was a small firm, independent from the major producers of petroleum products, called BK-Gas. This company was purchased by Shell in 1971 and is still a leader in the industry.

The Dutch use of automotive LPG did not depend on the kinds of government encouragement that are now so familiar. It did, however, require government support, but in the form of inaction. While collecting heavy taxes on gasoline, the Dutch government chose not to place an equivalent excise tax on LPG. Possibly the fact that the growth potential for LPG appeared to be constrained by a physical limit helped it escape the tax burden assigned to gasoline. Taxing it for automotive use was difficult. The Dutch authorities did not wish to tax it in other uses and feared that tax avoidance, by way of channelling untaxed LPG into automotive uses, would be a serious problem. The total tax revenue lost by the government in the early years was small. Later, when tax losses became more substantial, the use of the fuel was presumably well enough established -- with considerable investment in infrastructure and vehicle conversions -- to make the application of an equal tax rate politically unpalatable. An equal tax rate would have killed the industry, since it would not pay the consumer to incur conversion costs. One observer commented that the Government was "forgetful" when it came to the taxation of LPG.

When consumption grew enough to make the loss in tax revenue substantial, the Dutch authorities decided to tax it in a way that still maintains a large price differential between LPG and gasoline for the

consumer. Both LPG and gasoline are subject to the Dutch value-added tax. While gasoline is also subject to a special excise tax on a per-liter basis, the LPG user is subject to a special flat surcharge on the road user tax, set at rates low enough to make it attractive to many consumers. As an illustration, consider the rates at the beginning of 1982. The VAT on LPG was f0.114/ℓ, 18% of the retail price. The LPG road surtax on a medium-sized car (one weighing in the neighbourhood of 1000 kg) was f420. Supposing it consumed 10 ℓ/100 km of LPG and was driven 30,000 km/yr, the road surtax would be about f0.14/ℓ. The total tax per liter of LPG in this case would be f0.254. At the same time the total tax on premium gasoline in Holland was f0.850/ℓ.

In Canada the first users of propane are those who run fleets of vehicles and find it economical to have their own storage and dispensing stations, rather than depending on the growth of a retail dispensing system. Vehicles that run only on propane are preferred. In Holland the problem of a sparse retail sales network for LPG was solved by the marketing of dual-fuel conversion kits. Even though retail outlets are now plentiful, the dual approach has persisted, presumably because of the greater flexibility it provides in international travel.

THE CONSUMER'S DECISION

Discussions of the desirability of using LPG in the Netherlands typically refer to an average breakeven point, measured in kilometers of driving per year, at which the conversion costs and other additional charges attributed to using LPG are just offset by the savings. This is, of course, a rough criterion, because such a breakeven point has a wide variance across different vehicle types and changes for a given vehicle in response to a number of variables. These are: installation charges and their rate of depreciation, interest on the funds so invested, extra insurance charges, an extra road tax, and the difference

in price between gasoline and LPG.

The road surtax has recently been increased in stages, after having been constant for a number of years. It varies by vehicle weight. In early 1982, for an average car in the neighbourhood of 1000 kg, the road tax was f517 ($246) if it was driven on gasoline and f1007 ($480) if it was driven on LPG, a difference of $234 per year. The fuel price differential has also been changing. It was then f0.812 ($0.387) per litre.

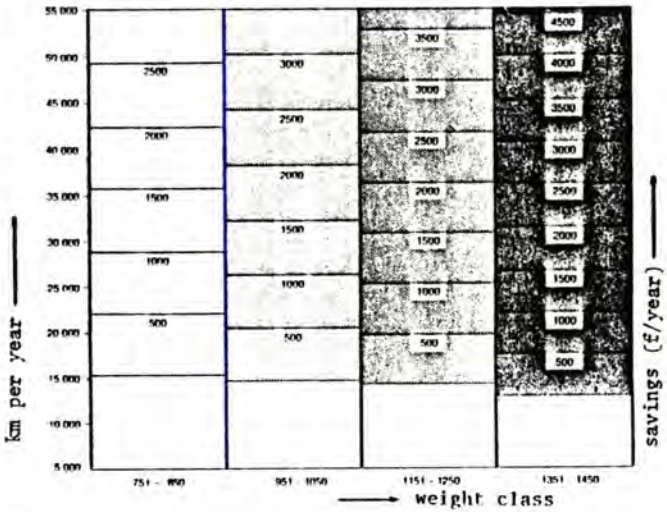
In the light of these variable factors one hears differing estimates of the average breakeven point, over the range 10,000 to 20,000 km/year. A plausible estimate of its current level is in the neighbourhood of 18,000 km/year. Because of the uncertainty relating to some of the parameters that underly a conversion decision, vehicle owners who drive in a sizeable range just above the breakeven point are unlikely to choose LPG. One informant observed that most of the conversions are on vehicles driven more than 30,000 km/year (and added that at more than 50,000 km/year diesel fuel becomes the preferred choice).

More detailed calculations are available. To illustrate, two analyses are briefly described here. The bar graph in Fig. 1, produced by BK-Gas, shows the potential savings from the use of LPG, for four different categories of vehicle weight, as annual usage increases. The lowest horizontal line in each bar shows the breakeven point; savings in guilders are shown at succeeding horizontal lines. The data upon which the graph is based are from September 1981 and differ somewhat from corresponding current figures presented elsewhere in this report. Note that the Dutch road tax varies directly with vehicle weight. Installing LPG equipment can move a vehicle into a higher weight class, though it will not always do so. Insurance premiums will also rise, not because insurance companies perceive converted cars to bear a

Figure 1

Calculated Savings Due To LPG Conversion

(Analysis produced by BK-Gas, 10/9/81)



Assumptions

a) Installation cost: f1800. Annual capital cost, 4-year depreciation, f450.
b) Increased insurance cost: f140/year.
c) Loss of interest: f90/year.
d) Weight class and road tax increases due to installation.
e) Fuel consumption increases relative to average for gasoline by 20%.
f) Price differential between premium gasoline and LPG: f1/liter.

Road Tax Schedule

	gas	LPG
751- 850 kg	f365	f 705
851- 950	436	816
951-1050	532	952
1051-1150	631	1091
1151-1250	728	1228
1251-1350	824	1364
1351-1450	922	1502

Fuel Consumption per 100 km by Weight Class

751- 850 kg = 8.7 1/100 km
951-1050 kg = 10.0 1/100 km
1151-1250 kg = 10.8 1/100 km
1351-1450 kg = 12.8 1/100 km

Dutch Guilder - Cdn Dollar Conversion Chart (2.1 f/$)

f	$
500	238
1000	476
1500	714
2000	952
2500	1191
3000	1429
4000	1905
4500	2143

higher risk of damage, but because the value of the car is higher. Many vehicle owners apparently do not report conversions to their insurance companies because they believe that LPG equipment is likely to withstand collision damage.

A reconstruction of one of the calculations underlying Figure 1 will provide a useful illustration. Consider a car in the weight category 851-950 kg that is driven 20,000 km/year and moves up into the next weight class. The net savings due to LPG use are calculated as follows:

Annual costs of conversion	f	$
a) installation (f1800, assume a 4-year straight-line depreciation)	450	214
b) extra insurance premium	140	67
c) loss of interest on funds invested in conversion	90	43
d) extra road tax (f951-f436)	516	246
(i) Total fixed cost:	1196	570
Fuel costs		
Assumed gasoline consumption (50% city - 50% highway driving) @ 10 l/100 km: 2000 l/year Price differential, Gasoline-LPG: f1/l Gross saving (2000 x f1)	2000	952
less 20% increase in consumption by volume (LPG price not provided - assume f0.75/l, the price as of the end of 1981)		
0.2 x 2000 x 0.75 =	-300	-143
(ii) Saving in fuel expenditure:	1700	809
Net saving per year: (ii) - (i)	504	240

In their analysis, BK-Gas deliberately chose a "worst case" situation to show that high mileage drivers can benefit from using LPG even under adverse conditions. The 4-year depreciation period may be

too short. The estimate of the extra insurance premiums is high. The increase in fuel consumption, at 20%, is higher than that cited elsewhere; a 10-15 percent increase is more typical. On the other hand, the assumptions made here may be more realistic because of the vagaries involved in achieving fuel efficiency in practice, particularly on dual-fuel vehicles.

The effect of the Dutch decision to tax the use of LPG by a road surtax creates a perverse incentive, one aspect of which is illustrated in Fig. 1. Because both the tax and conversion costs are fixed, those who drive more and use heavier cars experience greater total and per-unit savings from LPG use. Thus, encouraging the use of an alternative fuel in this case is a double-edged sword from the viewpoint of energy efficiency and conservation. There is a gain through better use of the total hydrocarbon pool -- a low value product becomes more valuable and is wasted less. On the other hand, there is an incentive to drive more and use heavier cars, meaning that some of the gain is presumably lost. So long as a fixed tax is used (rather than an excise tax on LPG), the incentive to drive more will apply. The higher returns to heavier cars could be offset by making the road surtax appropriately progressive by vehicle weight. The Dutch surtax does rise by weight, but not sufficiently to eliminate the extra returns to heavier cars, as the diagram in Fig. 1 shows.

A similar but more detailed exercise was prepared for a parliamentary report that accompanied legislation on the taxation of LPG. It has the advantage of showing how the savings due to LPG-use vary across a number of well-known automobile types. Details are summarized in Table 1.

The calculations in this case are based on road taxes that prevailed in early 1981. These were lower than those used in Fig. 1 and

TABLE 1

Fuel Cost Savings and Breakeven Points by Type of Car

Type of Auto	Road Tax ($/yr) Gasoline Powered	Road Tax ($/yr) LPG Powered	Additional Costs due to LPG use ($/yr) Assuming Depreciation Period of 5 years	Additional Costs due to LPG use ($/yr) Assuming Depreciation Period of 2½ years	Fuel Cost Savings* ($/100 km)	Breakeven Point (km/yr) Assuming Depreciation Period of 5 years	Breakeven Point (km/yr) Assuming Depreciation Period of 2½ years
Citroën Dyane 6	120	178	230	401	2.25	10,200	17,800
Fiat 127/900L	140	248	280	451	2.63	9,600	15,500
BL Mini 1000	120	178	230	401	2.37**	9,700	16,900
Renault 14 TL	170	290	291	463	2.90	10,000	15,900
VW Passat	246	343	269	440	3.03**	8,900	14,500
Fiat 131	246	343	269	440	3.32	8,100	13,300
BMW 320	291	451	331	503	3.77	8,800	13,400
Mercedes 280	472	619	318	489	5.19	6,100	9,400

*This calculation involves the following assumptions: LPG usage is 20% more by volume than gasoline usage; the price differential in effect in February 1981 prevails; and driving is, on average, 50% city travel, 25% highway travel at a constant speed of 90 km/hr and 25% at a constant speed of 125 km/hr.

**Uses regular gasoline. All the rest are assumed to use premium gasoline.

were consistent with a breakeven point for an average vehicle (one weighing about 1000 kg) of 12,000 km. An increase in the tax differential between gasoline-equipped and LPG-equipped vehicles has since come about. It was designed to raise the breakeven point to 15,000 km. As already suggested, however, the actual breakeven point that prevails today is likely to be somewhat higher.

REGULATION AND RISK

The use of LPG in the Dutch automotive market developed gradually as a result of private initiatives, as already noted. In the 1950's and 1960's the Dutch government was not particularly concerned to promote the use of alternative fuels and was merely passive in the face of normal industrial developments in a country where petroleum refining and natural gas are big industries. At that time public concern over safety and environmental issues was not nearly so intense as it is now.

These factors influenced the nature of the regulations and the infrastructure which evolved. In regard to many matters now considered important there were either loose regulations or none at all. Having had less experience with LPG accidents, the companies involved were probably less concerned with safety matters than they are now. Viewed in the latter part of the 1970s the LPG industry which had grown in this environment was thought by many observers to involve too much risk and too little regulation. Pressure for new regulations developed in a context that went beyond automotive use, mainly due to expectations that the use of LPG in the petrochemical industry would grow rapidly, necessitating large-scale importation and the handling of much larger amounts of it within the country. These expectations emerged in 1979 when the price of naptha, for which LPG can be substituted, was high. Attention was also drawn to the regulatory issue by some accidents involving LPG. For these reasons pressures for change grew enough to

elicit a major re-evaluation of policy in this area.

Some important regulatory changes have occurred in a piecemeal fashion, starting in 1978. While this was underway, a major comprehensive evaluation of the regulatory framework was undertaken. The legislation and executive action that were to flow from this evaluation unfortunately were still being prepared at the time the research for this report was carried out. Two broad areas that are being given much attention are restrictions on bulk transport, storage and dispensing and the location and design of retail dispensing stations. A large amount of testing is being done at the Research Institute for Road Vehicles of TNO at Delft. The evaluation has also involved formal risk analyses. In both of these areas, among others, the Dutch work is likely to provide results of interest beyond their own country.

To provide an illustration of the regulatory issues under review, consider the question of the location of dispensing stations. Until 1978 the approval of locations was governed only by local authorities. The criteria were often weak and many stations were established in questionable locations. In the typical case these locations were established because existing gasoline/diesel stations were permitted one-by-one to add LPG dispensers to their operations without sufficient attention to safety considerations.

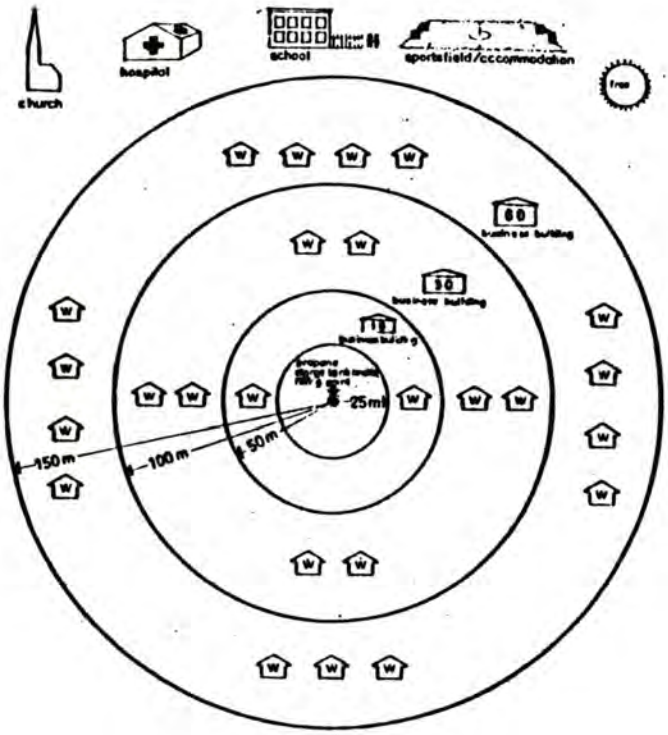
In 1978 a set of national guidelines was established and it has since been used by local governments in the licensing of new retail outlets for LPG. These guidelines are viewed as relatively arbitrary and as an interim measure until more rational constraints are developed, assuming that such is possible. To that end the guidelines are being tested as part of the risk analyses underway at TNO. The 1978 guidelines allow no buildings, other than service station offices and workshops, within a 25 m radius of LPG tanks and filling points. Service

station buildings must be 7.5 m away from tanks and filling points (except for tanks of capacity from 8-20m^3, when the distance increases to 15 m). These distances can be reduced by taking appropriate precautions (e.g. building a protective wall). Beyond 25 m and up to 150 m the numbers and types of buildings are limited. No vulnerable buildings (e.g. schools, cinemas) can be located within the 150 m radius and the density of houses and business dwellings must decrease as the 25 m ring is approached. Between 25 and 50 m only 2 houses or, alternatively, business buildings containing up to 10 people, are allowed. In the 50-100 m ring up to 8 houses or 30 office staff are allowed; in the 100-150 m ring the maximum numbers are 15 and 60, respectively. An illustration is provided in Figure 2.

Of the 2,200 stations selling LPG in Holland, 985 do not conform to the interim guidelines. In response to pressure from local governments and environmental groups, some attempt has been made (e.g., by compensating operators) to move some of the pre-1978 stations that most seriously contravene the new criteria. Detailed information on the extent of such moves was not available, but it is unlikely that it has been very extensive. If the final restrictions adopted turn out to be close to the interim measures, what to do about those of the 985 stations that remain will be a difficult problem. There was general agreement among informants that it is important to have well-designed standards on location at the time the LPG market begins developing.

In some areas new technology is being developed to solve safety problems. An intersting example is the serious problem of the overfilling of user vehicle tanks. Apparently it is widely done (though no hard data are available). To allow room for expansion, tanks are to be filled only to 80% of capacity. Every tank must be equipped with a test valve that lets off vapors at the 80% level. It is necessary to

Figure 2



Radians indicate allowed buildings:

i.e. houses W

and business buildings 30

Allowed buildings have to be considered cumulatively.

open it to check it, however, and many people do not bother to do so. Filling to more than 80% is usually not dangerous if the car is driven immediately and enough of the fuel is used before it expands. Even if this does not occur there is still considerable leeway above 80%. With a car sitting outside, excess fuel can escape without igniting, or even being noticed, in most instances. Customers apparently find it more convenient and sellers more profitable to fill beyond 80%. These facts, combined with the low frequency of fires, presumably explain the public's complacency in regard to overfilling.

The result is a few cases per year in which the vapors let off by the expansion relief valve ignite. This can occur when there is as little as 2% LPG in the air. The typical case mentioned was that of a car parked in a garage (perhaps heated) in which there is also a freezer, with a spark from the freezer motor causing ignition.

It appears likely that an automatic cut-off device to prevent over-filling will be required in the near future. Various techniques have been developed. One involves a gauge connected to a shut-off device on the tank filler valve. An alternative is a double-tank system in which a small tank, taking up at least 20% of the space within the large tank, fills very slowly when the remainder of the large tank is full. Thus, when the large tank appears to be full, it is actually only 80% full. The latter alternative is apparently considered the superior system but is the more expensive of the two.

One area of the Dutch regulations that appears to be less subject to change at present is that of the conversion of vehicles to use LPG. This is done by specialist firms, by local garages, and sometimes by vehicle owners themselves. The LPG equipment manufacturers are heavily involved in the training of mechanics for this purpose. A set of national regulations apply and each converted vehicle must be inspected

at one of 13 inspection stations spread over the country. When informants expressed any concern about the current system, it referred to the problem of compliance (i.e., some owners avoid inspection to evade the LPG road surtax) and to the possibility that more than one inspection per vehicle lifetime should be required.

HISTORICAL TRENDS AND FORECASTS

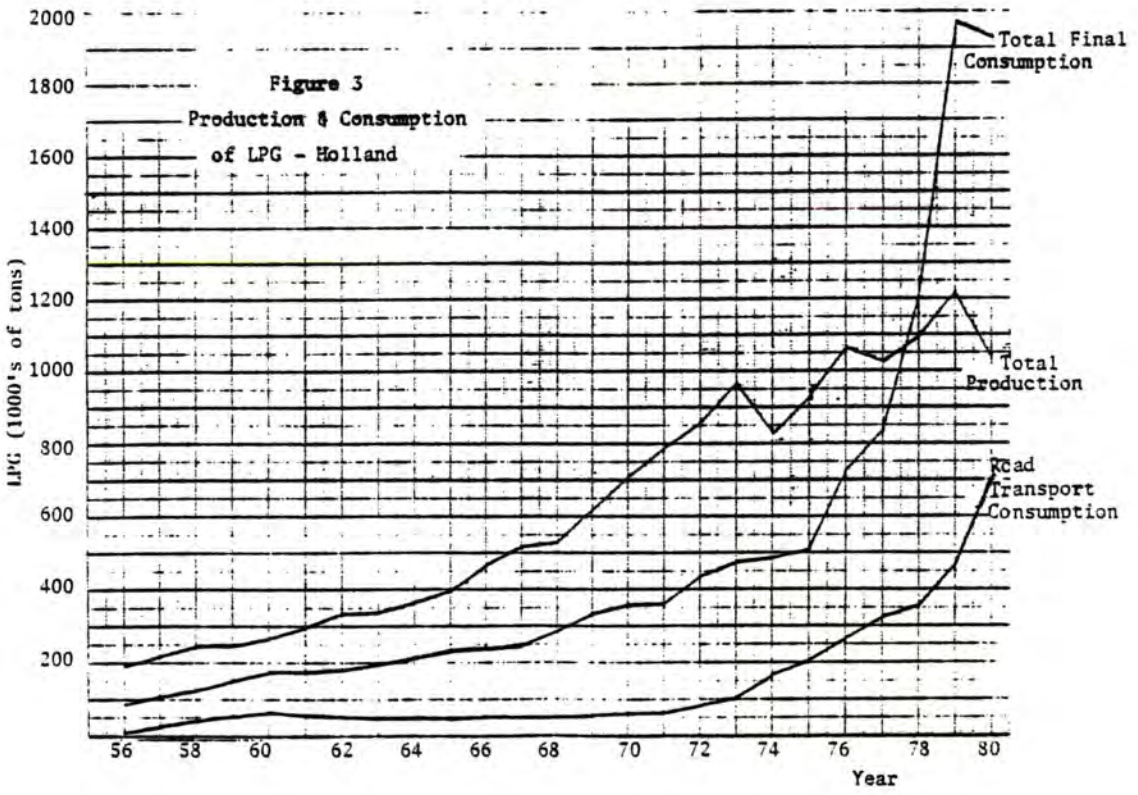
As a final consideration, it is useful to examine the growth of the Dutch LPG market in broader historical terms. The data presented in Table 2 and Figure 3 help to tell the story.

TABLE 2

LPG in The Netherlands:
Consumption, Production and International Trade, 1956-1980
(1000's of metric tons)

	(1) Road Transport Consumption		(2)		(3)	(4)
	Level	Annual % Change	Total Production	(1)/(2) x 100	Total Final Consumption	Exports (+) or Imports (-)
1956	10		190	5.3	86	104
1968	40	100.0	247	16.2	128	119
1960	63	25.5	267	23.6	175	92
1962	50	-10.9	332	15.1	182	150
1964	47	-3.0	362	13.0	215	147
1966	52	5.2	465	11.2	239	226
1968	48	-3.9	528	9.1	288	240
1969	53	10.4	619	8.6	332	287
1970	58	9.4	704	8.2	358	346
1971	60	3.4	785	7.6	359	426
1972	80	33.3	858	9.3	435	423
1973	103	28.8	966	10.7	475	491
1974	164	59.2	826	19.9	485	341
1975	203	23.8	929	21.9	511	418
1976	264	30.0	1068	24.7	723	345
1977	324	22.7	1027	31.5	836	191
1978	355	9.6	1096	32.4	1204	-108
1979	466	31.3	1213	38.4	1968	-755
1980	696	49.4	933	74.6	1934	-1001

Source: OECD, Energy Statistics.


Figure 3
Production & Consumption
of LPG - Holland
LPG (1000's of tons)
2000
1800
1600
1400
1200
1000
800
600
400
200
56
58
60
62
64
66
68
70
72
74
76
78
80
Year
Total Final Consumption
Total Production
Road Transport Consumption

By 1960 LPG was established as a road transport fuel in Holland. Sales were relatively low throughout the 1960's, with considerable annual fluctuation but no appreciable growth on average. By the beginning of the 1970's a new growth trend occurred, probably in response to excess supplies and market development on the part of the producers. In 1972 the rate of growth of automotive LPG demand increased dramatically and continued to be high until 1978. Another increase in the growth rate occurred in 1979-80.

Thus the dramatic growth trend evident in the bottom curve of Figure 3 started in response to local market developments, but these were quickly reinforced by the events in the autumn of 1973. Gasoline prices rose in response to OPEC actions by more than LPG prices. Growth began to slow down in 1978, but the second round of sharp oil price increases that began in 1979 presumably helped to reaccelerate the trend. The latter effect would be strong because, by 1979, higher oil prices had presumably become more fixed in the public mind and would influence long-term decisions more.

At the same time higher prices for oil products were affecting long-term decisions in other markets for LPG. In particular, the petrochemical industry began to use more liquefied gas. In 1975 the consumption of LPG as a chemical feedstock was 100,000 t. In 1980 it was 1,011,000 t. From 1979 to 1980 there was a 50% reduction in the industry's use of naptha. Total demand for LPG in Holland far outstripped domestic supply in 1978 and has remained above it. The automotive market alone accounted for 75% of total production in 1980. Imports from the Middle East and elsewhere have been making up the shortfall. There is some scope for import replacement by way of the development of Dutch gas and oil fields in the North Sea, but the impact of this is not now known.

This switch to a net import position has raised new questions in regard to the development of the road transport sector of the market. Not that there is any shortage of LPG to be imported. Everyone is anxious to reduce the flaring of associated natural gas. But growth in automotive LPG demand that is to be satisfied by imported supplies is quite a different matter from having an outlet for excess supplies from domestic production.

Import based growth is likely to be found undesirable by both the oil companies and the Dutch Government. For the oil companies that are now the sources of bulk LPG in Holland, the possibility of importing increasing amounts of LPG that will substitute for their own gasoline sales is not likely to be attractive. LPG is thought to have a higher profit margin than gasoline now, but this would not likely persist if excess capacity in gasoline production were accompanied by the need for expensive investment in receiving and storage facilities for LPG. There is, furthermore, a complicated joint production relation involved. More automotive LPG means less gasoline demand. A reduction in gasoline refining would also reduce the domestic supply of LPG, with the effect that still more imports would be needed.

The effect of lower oil prices is complicated. Coming after the sharp rise in prices, this will reduce further the likelihood that the LPG market will expand. A direct effect is the reduction in the gasoline-LPG price ratio, which lessens the incentive for the consumer who is considering an LPG conversion. More uncertain are the possible indirect effects through the petrochemical industry. Now that a portion of the industry is equipped to use LPG as a feedstock, the petrochemical demand for it is unlikely to fall back to the low levels that existed until the latter half of the last decade. But considerably more switching from naphtha to LPG had been forecast. This further

growth in petrochemical demand for LPG is no longer expected in the immediate future. When naphtha prices were high relative to LPG prices, plans for expansion for LPG import facilities in Holland began to appear. Now that the price ratio has fallen the planning activity has subsided; one large project for a new coastal depot that had progressed to a tangible stage was cancelled. If the planned increases in capacity had materialized, the overall LPG supply potential would have become more flexible. Presumably growth potential in the road sector would have been accounted for in the plans. By itself, the road sector is less likely to encourage large investments in new capacity.

Ironically, the plans referred to above played an important role in stimulating governmental action on the development of new regulations for the siting and transport of LPG. The prospect of tighter restrictions presumably added to the pressure on the firms involved to reconsider investment plans as the industry's environment changed.

Continued rapid expansion of road transport demand would present a problem for the Dutch government whether supplies come from domestic or foreign sources, though it is probably easier for them to consider dampening its growth now that it depends on imports. With further growth in LPG consumption the lost tax revenue, due to the lower effective tax rate on LPG, would eventually have to be recovered. An estimate of the total loss in tax revenue caused by current consumption levels, in the fiscal year 1980-81, was approximately $48 million. If moves are made to recover revenue, increasing the LPG tax will be a tempting method.

The government would also have to deal with the safety and environmental implications of a much larger LPG market if growth continues at present rates. It is difficult to say in which direction

this should push them. Informants complained that the risk analyses underway tend to consider LPG in too isolated a fashion. Some comparison with the risks of gasoline is involved, but it is limited. Some informants indicated that there is evidence that LPG is more dangerous at the stage of bulk transport. But there is probably not enough evidence available to make an overall judgment that accounts for all stages. More important is the inertia that is involved in something as well established as gasoline use. Given this, environmental pressures are more likely to focus on limiting the expansion of LPG than on achieving an optimal balance between gasoline and LPG use.

But it is possible that governmental action to moderate the penetration of LPG into the motor fuel market will be unnecessary. Rather the market may be close to some sort of equilibrium size demined by the microeconomics of LPG use. The average breakeven point beyond which conversion generates savings is currently believed to be in the 15,000-20,000 km range. If all the vehicles driven more than that were converted, the ceiling would be reached. In fact, the true ceiling is likely to correspond to annual driving somewhat above 20,000 km, due to the inertia, uncertainty, and lack of information to which many consumers are subject. Some informants suggested that there is still room for growth, particularly in the 20,000-30,000 km range. But it is unlikely to be very large. A rough estimate of the mean annual distance travelled by Dutch vehicles is 14,000 km. Statistics on the spread of the distribution were not available. But with 9% of the total vehicle population already converted, a sizeable portion of the total number of cars in the pool that might be converted surely has been already.

If this turns out not to be true and high growth rates continue in the immediate future, action on the part of the government,

LPG suppliers or both is likely. With a small number of large firms supplying the wholesale market, there is scope for manipulation of the LPG-gasoline price relation by private initiative. If that does not occur a change in the taxation of LPG would be the likely alternative.

CONCLUDING COMMENTS

The implications of the Dutch experience with LPG for the Canadian use of propane in road transport are both general and specific. The general lessons are rather obvious. Avoid the pitfall of waiting until the market has grown before introducing adequate safety and environmental regulations to control the use of propane on the roads. Face up to the fiscal implications of supporting the use of propane. If the policy is successful it will eventually create a tax deficiency and it is prudent to account for that in long-term planning.

In addition, and perhaps more important, there is a large amount of specific knowledge to be gleaned from the Dutch experience. If automotive propane use is to be expanded in Canada, and especially if it is to play a significant role in fuelling the private car, numerous details regarding its handling and sale, and the conversion of vehicles to use it, will have to be worked out. Knowing how the Dutch worked out these details, and how they are now adjusting them, is bound to be helpful to Canadian policymakers and to Canadians in the automotive propane industry.

REFERENCES

1. This paper is based on a longer report done for the Ontario Ministry of Transportation and Communications. Responsibility for its content is, of course, fully my own. Much of the information contained in it was collected in personal interviews

carried out in April 1982. While no attempt is made in the text that follows to reference individual informants, more information on sources can be provided in response to requests. I wish to thank the Dutch officials and representatives of the LPG industry, too numerous to list here, who gave generously and patiently of their time and Mr. R. Roy of the Canadian Embassy in The Hague, who arranged meetings for me.

2. Conversions from guilders to Canadian dollars were done at the rate 2.1 f/$.

PUBLISHED SOURCES USED

Drayton, G., The Market for LPG in the 1980's (London: Economist Intelligence Unit, 1981).

Fitton, K.B., The Automotive LPG Market in Europe, UN Economic Commission for Europe, Symposium on the LPG Situation in the ECE Region During 1980-1990, Dublin, October 1981.

Ontario Ministry of Transportation and Communications, Switching to Propane, A Guide for Fleet Operators, August 1981.

OECD, Energy Statistics, various years.

Smit, T. and L. Voute, Developments of Safety Regulations in the Netherlands, UNECE Symposium, op. cit.

Sonderkotter, F., LPG as an Automotive Fuel in the European Economic Community, UNECE Symposium, op. cit.

Williams, A. F. and W.L. Lom, Liquefied Petroleum Gases: A Guide to Properties, Applications and Usage of Propane and Butane (Chichester: Ellis Horwood Ltd).

Translations of excerpts from several Dutch government documents (details will be supplied on request).

TRANSPORTATION REQUIREMENTS TO 2000: A NORTHERN PERSPECTIVE

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ABSTRACT

This paper provides an historical overview of the development of the existing transportation systems in Canada's North in response to military, economic and social demands. It reviews government policies that will influence future transportation development, and examines the major developments which will influence transportation demand to the year 2000. The paper concludes with a discussion of the role of government and industry in providng infrastructure required in the future.

INTRODUCTION

A very close interdependency exists between transportation and economic development. While transportation is a necessary condition for economic development, the existence of a transportation system does not necessarily ensure that economic development will proceed. The situation in the Yukon today is a good example. For a remote region, the Yukon is served by a relatively good transportation system, which has

contributed to the development of a number of mines. However, in the current economic recession, despite an adequate transportation system, the mining industry in the territory is shut down. This in turn has brought about the temporary close down of the White Pass railway and a major reduction in the trucking sector.

In this paper I will examine the relationship between transportation and economic development in the light of major resource developments which are likely to occur North of 60° during the next 15 to 20 years. However, before looking into the future, I will briefly provide an historical overview of how and why the existing northern transportation system developed, a brief review of current government transportation policies in the North and then a forecast of major developments and their impact on transportation.

HISTORICAL OVERVIEW

The existing transportation systems have developed primarily to meet the demands of resource development, the military and government social and economic objectives.

The traditional form of transportation in the Canadian North, as in any pioneer region, has been the water routes. However, the long and cold winters which put these routes out of commission for eight or nine months

of the year have tended to cause the inadequacy of this form of transportation to offset its relative cheapness.

The first part of the Canadian north to experience intensive economic activity was the Yukon during the Klondike gold rush of 1898. The Yukon River became the main thoroughfare and at the height of the Gold Rush some 250 sternwheelers plied the Yukon River and its tributaries. The sternwheelers became part of history when in 1955 the S.S. Klondike II made her last run from Dawson to Whitehorse, becoming obsolete by an expanded road system.

To meet the transportation demands of the gold rush, the narrow gauge White Pass and Yukon Railroad was completed in 1900 and connected the Yukon River with tide-water at Skagway. It is interesting to note that this railway has operated continuously since then, at times with great financial difficulty, without government assistance until 1981 at which time the Federal and Yukon Governments provided $6 million in interest free loans to purchase capital equipment primarily locomotives. The current shutdown of the railway since October 1982 is the first extended closedown since its construction.

Economic activity in the Yukon diminished after the gold rush ended and no significant transportation infrastructure was added until World War II. The Alaska

Highway was constructed in 1942 as a war-time measure and airfields were built along the Northwest Staging Route. In 1943 and 1944, the Canol (Canadian American Norman Oil Line) road and pipeline from the oil field at Norman Wells was constructed to a refinery at Whitehorse, a distance of 950 kms. At the same time a gasoline pipeline was built from Skagway along the railway right of way to Whitehorse and from there to Watson Lake and Fairbanks. The pipelines and refinery were dismantled after the war with the exception of the Skagway-Whitehorse pipeline which is still in use to-day. The Yukon section of the Canol road has been maintained as a summer road.

In the 1950's, the Federal Government initiated a roads program to support social and economic development. The construction of the Klondike Highway from Whitehorse to the United Keno silver mine near Mayo and to Dawson brought an end to river traffic. The Robert Campbell Highway built in the 1960's brought on the opening of the Cyprus Anvil Mine in 1970.

The Dempster Highway from the intersection of the Klondike Highway near Dawson to Inuvik was started in 1959 as part of Mr. Diefenbaker's Northern Vision. Twenty years and $100 million later the Highway was opened to traffic. A summer road linking Carcross to Skagway primarily to support tourism and generally running parallel to the railroad was completed in 1980.

In the Yukon, all communities with the exception of Old Crow now have year round road surface access.

In the Northwest Territories, the water route remains the principal thoroughfare. The Hudson Bay Company operated paddle-wheeled steamers on the Mackenzie River to support its trading posts. The Bay's marine transportation division was subsequently acquired by the Northern Transporation Company Limited (NTCL) which started up in the 1930's in support of the uranium mine at Port Radium on the east end of Great Bear Lake. NTCL has become the main carrier on the Athabaska, Slave and Mackenzie River system and the Western Arctic. The Canol project was the first major test of the river system. However, because of the short season and restricted capacity of the river (Waterways being the head of navigation), a winter road had to be constructed and a series of airfields constructed from Waterways to Norman Wells. In less than two months in 1942 the U.S. Army Engineers built ten airfields along the water route. The extension of the Mackenzie Highway in 1949 linking Edmonton to Hay River gradually resulted in Hay River becoming the major transhipment point on the Mackenzie River system replacing Waterways.

The construction of the Great Slave Lake Railway in 1964 brought on the opening of the Pine Point mine. Under the Northern Roads Program, the highway network was extended to Yellowknife, Fort Smith and Fort Simpson.

The Liard Highway linking the territories to Fort Nelson is scheduled to be opened in 1983. These roads were constructed primarily in support of the Government's social objectives, to reduce isolation and improve the standard of living of northern residents.

The situation in the Keewatin and the Eastern Arctic is very different. All freight movements are by the marine and air modes. NTCL serves the Keewatin out of Churchill, while the Baffin Region and High Arctic areas are resupplied out of Montreal on the annual sealift co-ordinated by the Coast Guard.

The other major development which provided a significant stimulas to transportation was the construction of the DEW line in the mid 1950's. The DEW line left a tremendous legacy for northern operations. It provided a network of good gravel runways, superb communications facilities and good navigational aids, which were virtually non-existent prior to construction, and also opened the Arctic to the great potential of airfreighting. An extensive combination sealift and airlift was mounted to support site construction.

In contrast to the Yukon, which has a generally well developed surface transportation system, only the south-western section of the Mackenzie District has all year round surface access.

In summary, the major transportation systems in the territories to-day, roads, airports and railways have been constructed either in support of resource development, as a result of military requirements or in support of Government social and economic objectives.

TRANSPORTATION POLICIES

Having reviewed the past and before examining the major development which impact on northern transportation in the future, I will briefly review the transporation policies which will influence future developments.

Roads Policy

The Northern Roads Policy which was approved by Cabinet in 1965 and 1971, envisaged the development of a road network in the territories such that no potential resource development would be more than 200 miles from a major road. However, during the past ten years, inflation and fiscal restraint have prevented the attainment of this objective. The roads budget has been held constant at $19 million and will be held at this level, with an annual escalation in accordance with Treasury Board guidelines. In addition, under the Resource Roads Program funds are available whereby the Department cost shares with industry the construction of initial and permanent access roads to resource developments.

Because of fiscal restraint, there will not be a significant road building program in the immediate future. While some new roads may be built to provide community access, where this is feasible, any major new roads will be constructed primarily in support of regional economic development objectives.

Air Facilities Policy

In 1974 Cabinet approved a five year program to upgrade community airports to provide year round access, improve safety and to provide regular and reliable air service. Prior to this program, most communities did not have airstrips and were served by ice strips in winter and by water in summer. During the break-up and freeze-up periods extending up to six weeks in spring and fall, these communities were without air service for medical evacuations, mail, supplies etc. Delays in construction and fiscal restraint have delayed the program and an extension to the program is under review. Under the program, airports were classified as Arctic A, B and C. Major centres were classed as Arctic "A" and were entitled to a 5000 foot runway; Arctic "B" for communities of 500 population or a regional centre qualified for a 4000 foot runway and communities of 100 population had 3000 foot runways. This classification has proven to be too restrictive and under the revised policy runway length is to be determined by the role of the airport and the critical aircraft being used by the

local carrier. The Transport Canada National airports classification system has also been adopted, i.e. national, regional and local community airports.

The program, although behind the original planned schedule, has proven very successful. Communities now have year round access, and the air carriers are providing a much improved regular and reliable air service. It has provided local employment in airport operations and enables local residents to participate in employment outside the community through work rotation e.g. working in mines, hydrocarbon exploration etc.

The program is community oriented and does not construct airports in support of resource developments. The Cullaton Lake, Arvik and Lupin mines all constructed their own airports without government assistance.

Arctic Shipping Policy

Shippers have been free to select the carriers or ships of their choice without consideration of the degree of Canadian content other than under the Coasting trade, as long as the requirements of the Arctic Shipping Pollution Prevention Regulations are met. However, Government has been using friendly persuasion to get resource developers to give preference to Canadian flag ships and Canadian shipping companies when available, reliable and competitive. The Nanisivik mine located on

the north end of Baffin Island is renewing its shipping contract with Canarctic Shipping Company (a Government/ Industry consortium) for a further five year period. Cabinet, in approving development of Cominco's Arvik mine on Little Cornwallis Island, stipulated that 50% of the concentrates had to be shipped using the M.V. Arctic. In negotiating its shipping contracts, Cominco contracted 75% of its concentrates to Canadian Shipping, with the remaining 25% going to a Swedish shipping company.

Consideration has been given to the development of an Arctic Shipping policy which would require all shipments of resources out of the Arctic to be carried in Canadian flag, Canadian built ships. This requirement could subject the resource industries to using higher cost Canadian ships. This could have the effect of retarding resource development, particularly mining, in the Arctic and in effect would be a transfer payment from the resource industry to the Canadian shipping and ship building industries. Since the resource developers have been using Canadian Companies where competitive and reliable, I do not envisage the development of a restrictive Arctic shipping policy in the near future.

FUTURE DEVELOPMENTS

The historical overview has shown that while transportation infrastructure and services have

developed in part to meet the social needs of the North, the main impetus has come from the military and the mining industry. What of the future? Military operations of the future in the North will be primarily air transported operations. Consequently, I do not envisage any new significant infrastructure requirement to meet military needs. Existing roads, airports, and transportation services will be utilized. Some additional temporary airstrips may be constructed to meet specific military requirements.

On the social side, the upgrading of community airports will continue under the Arctic Air Facilities policy and some local roads and basic dock facilities will be constructed to meet the needs of the Communities. As demand grows, improved air services will continue to be provided by the regional and local air carriers.

The major demand for transportation during the next 15-20 years will be generated by the non-renewable resource industries. The growth of these industries will to some extent be dependent on Government policy objectives for the North. The pace of development will also depend on the pace of recovery of international economies which will in turn influence the demand for and price of minerals and hydrocarbons.

The following factors will influence the pace of resource development:

1) Federal Government policies designed to create a favourable climate for mineral development to meet national and regional economic and social development objectives;

2) the Federal Government goal of energy self-sufficiency by 1990;

3) demand, supply and price for minerals and hydrocarbons;

In examining the likely resource developments which will materialize, I will first look at the Yukon and then the Northwest Territories.

Yukon Transportation Requirements

Yukon transporation demand will be generated by the mining industry, the Alaska Highway Gas Pipeline and the Dempster Lateral Pipeline.

The centre of mining activity will be the MacMillan Pass area along the Canol Road and the Howards Pass area to the South of MacMillan Pass. Known deposits in the area have the potential of an annual output in excess of one million tons of lead, zinc, tungsten and barite

concentrates. The Canol Road upgrading will start in 1983 to support this potential development. Development of these deposits is contingent upon metal prices and demand. Output from this area, combined with the production of 400,000 tons from the Cyprus Anvil mine could justify an extension of the railway from Whitehorse to the vicinity of Faro.

The Yukon Railway Study carried out in 1975 studied a number of options for an extension of the White Pass railway from Whitehorse to Faro and concluded that an extension was viable with volumes exceeding one million tons.

Large deposits of iron ore and coal have been proven in the Bonnet Plume area 350 miles north of Whitehorse. The magnitude of these deposits would suggest a transportation system tailored to the specific needs of the development. However, in view of the current markets for iron ore and coal and the long lead time to bring these into production, I would not envisage these being developed before the year 2000.

The other major development in Yukon which will impact upon transportation is the Alaskan Highway Gas Pipeline. Start of construction has been delayed and commencement will depend on the demand for gas and financing of the project. Construction will place a heavy demand on the existing transportation systems.

For example, the Foothills Logistics Plan estimates that 642,000 tonnes of pipe, fuel, construction and other material will have to be moved for the Yukon section of the pipeline requiring 28,500 truck loads. While construction of the pipeline will place a large short term demand on the transportation system, no major long term addition to the systems will be required.

The Dempster Lateral is dependent on the building of the Alaska Highway Pipeline. If it proceeds, again, this would have only a short term impact.

Northwest Territories

As in the Yukon, non-renewable resource development will provide the major impetus to transportation development. Normal refurbishment of airports and the growth of air routes will continue in response to growth of communities and demands from the resource industries. The major demand for transportation over the next 15-20 years will come from the hydrocarbon industry, with a lower demand from the mining industry.

There are three major lead/zinc mines in the N.W.T. The Pine Point mine is expected to re-open in the near future. The Nanisivik Mine on Baffin Island which ships 140,000 tons of lead and zinc concentrates annually will run out of ore in about 5-6 years unless new reserves are developed, reducing the demand for shipping.

The Arvik Mine on Little Cornwallis commenced shipping concentrates in 1982. Six voyages carrying 150,000 tons of lead and zinc concentrates were successfully completed in a shipping season of three months. Output can be expected to be increased as market conditions improve resulting in an increase in shipping requirements. The mine has reserves extending its life well beyond 2000.

Cadillac Explorations is developing a lead, zinc, silver deposit north of the Nahanni Park. To support the mine, an all weather road from the mine to the Liard Highway will have to be constructed.

Borealis Exploration Ltd. has a large magnite iron ore deposit with estimated reserves of four billion tons on Melville Peninsula near Hall Beach. Development of the ore body is dependent upon market conditions. If developed it would create a demand for bulk ore carriers.

The region north of Yellowknife to Bathurst Inlet has high potential for minerals. While there are a number of lead, zinc, copper deposits in the area, these are not likely to be developed unless there is a significant increase in metal prices. A recent transporation study carried out by the Department of Indian Affairs and Northern Development concluded that even if the transporation infrastructure was in place (roads and/or railway) the transportation costs would be such as to

make the projects uneconomical. The least cost alternative was a road running north to Bathurst Inlet, stockpiling, and shipping during the three month shipping window.

The only metal mines which, under present market conditions, could be developed are those located near tide water and not faced with high inland transportation costs. With the exception of Cadillac Explorations it is highly improbable that any new major mines will come into production in the next 10 - 15 years, unless there is a significant shift in demand, supply and price for these minerals.

Major transportation demand will come from the hydrocarbon industry. One hydrocarbon development (Norman Wells) has been approved and is proceeding; the other potential developments are the Mackenzie Delta/Beaufort Sea and the High Arctic.

Norman Wells

The Norman Wells field development and the 560 mile, 12.75 inch diameter pipeline (868.6 km of 323.9 mm pipe) extending from Norman Wells to the Rainbow Pipeline at Zama, Alberta will be constructed using existing transporation infrastructure and services. Winter roads will be used for the winter construction period. Construction is scheduled to start in November 1983 and

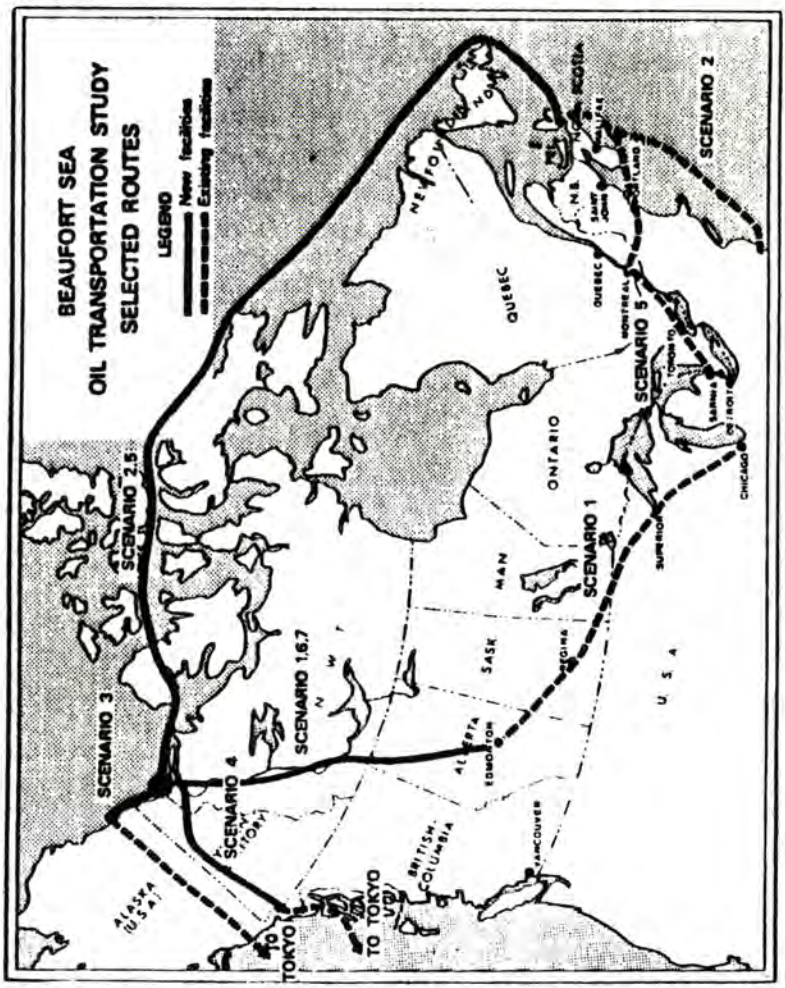
to be completed during the winter of 1984/85. Pipeline materials and construction camps, etc., will be barged from Hay River to stockpile locations during the summer preceding start of the winter construction period. Transportation demand has been estimated as 6779 truck loads of pipe, fuel and equipment. While this will place a heavy demand on the existing rail, truck and barge system, it is within capacity of the present system.

Beaufort Sea - Mackenzie Delta

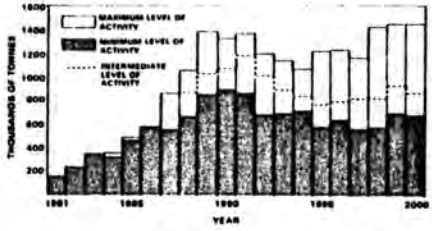
The Beaufort Sea - Mackenzie Delta Environmental Impact Statement in support of hydrocarbon development has been filed with the Beaufort Sea Environmental Assessment Review Panel. The Panel has noted a number of deficiencies in the Statement and has requested the Proponents (Dome, Esso and Gulf) to rectify these prior to commencement of Hearings. While no applications for the transportation of oil and gas from the region have been submitted, two transportation systems, tankers and pipelines, are being given serious consideration, and it is possible that eventually both will be employed for part or all of the transportation requirements.

Esso Resources appears to favour the pipeline route in that its reserves are located on land in the Delta and in shallow waters. Dome Petroleum because its discoveries are in deeper waters, prefers the tanker

route. The tanker mode has the advantage of adding additional tankers as reserves are developed, whereas a large diameter pipeline requires an adequate level of reserves to justify construction. A possible alternative to a large diameter pipeline, as a means of attaining some cash flow until sufficient reserves are proven, is an extension of the pipeline from Norman Wells.

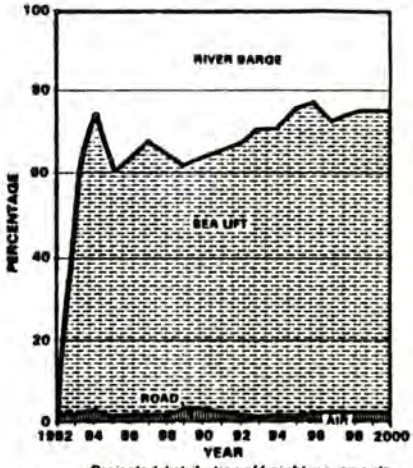


The movement of freight into the region will tax existing systems to their capacities. The following chart gives an indication of freight to be transported to the Region during the period to 2000. This does not include pipe and other materials required for the construction of a pipeline.



Projected quantity of freight to be transported to the Region per year during the period 1981 to 2000.

The following chart provides a modal distribution for the intermediate development plan. It is to be noted that the Proponents plan at this stage is to move the bulk of the freight requirements by sea around Point Barrow or the Northwest Passage. The present capacity of the river system (approximately 500,000 tons) could be expanded by adding additional equipment or by dredging the Mackenzie River. The Dempster Highway will require upgrading and a road link between Inuvik and Tuktoyaktuk will likely be constructed.



Projected distribution of freight movements by mode for the intermediate development plan.

Arctic Islands

Turning further east and north to the High Arctic, two proposals are being developed by industry for the movement of gas.

The Arctic Pilot Project (APP), sponsored by Petro-Canada, Nova, Dome Petroleum and Melville Shipping Limited is proposing to construct and operate a natural gas pipeline and LNG icebreaking tanker system to transport natural gas reserves from Melville Island. The APP envisages a 160 km, 56 cm diameter pipeline from Drake Point to Bridport Inlet, Melville Island, a barge mounted liquefaction plant, two 140,000 m^3 Arctic class 7 LNG icebreaking tankers. The National Energy Board hearings were adjourned on August 31, 1982 pending a clear indication by the proponents of the market for their natural gas. The proponents have recently asked the National Energy Board to resume hearings as they

hope to negotiate an agreement with European buyers before the end of 1983.

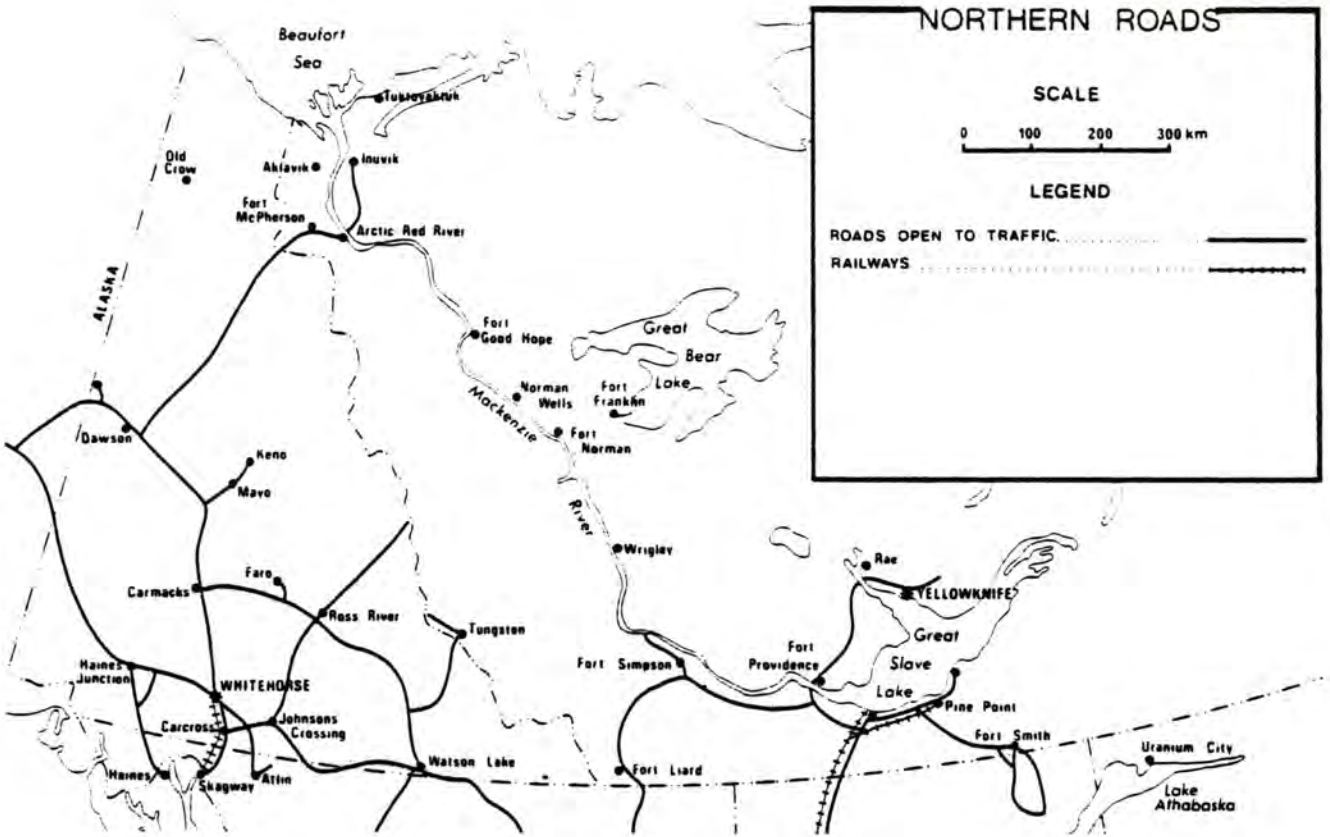
The other project for the movement of High Arctic gas is the Polar Gas Project. The initial proposal was for a gas pipeline running down the west coast of Hudson Bay and into southern Ontario. The most recent proposal from Polar Gas consists of a 32 inch diameter gas pipeline from the Mackenzie Delta south to existing lines in Alberta, with subsequent extension to the Beaufort Sea and the High Arctic Islands. It appears that High Arctic Gas by pipeline is unlikely to flow before 2000.

In summary, transportation developments in the Yukon will be primarily dependent upon the mineral industry with some short term demand from the Alaska Highway Gas Pipeline, and possibly the Dempster Lateral Gas Pipeline should these projects proceed. In the N.W.T., I do not envisage any significant mineral developments which will generate a significant new transportation demand. Major transportation demand will be generated by the Norman Wells field development and related pipeline to Zama, Alberta and the development of the Mackenzie Delta and Beaufort Sea oil and gas reserves.

One final point is the matter of cost of transportation infrastructure and who provides it. The Federal Government, I believe, will continue to provide and fund

the necessary infrastructure to meet socio-economic objectives in the North. Community airports, community access roads, and roads forming part of the territorial road networks, and dock facilities for community resupply, will continue to be constructed and maintained by Government. However, the cost of constructing and maintaining infrastructure required in support of resource development will likely have to be borne by industry or cost shared. I anticipate that there will be a greater degree of cost sharing or cost recovery in future. The costs of airports have been cost recovered for sometime through landing fees and the airport departure tax. The Marine Administration is considering a user charge for services provided by the Coast Guard, including charges for icebreaking services, navaids, etc.

The policy which appear to be emerging is basically along the following lines. Single resource developers particularly in isolated areas, e.g. Lupin Mine, Arvik Mine, will be required to bear the cost of the infrastructure required. In cases where potential exists for multiple developments (MacMillan Pass) or the development is of such a magnitude as to provide significant national or regional benefits, government will provide common use infrastructure either through a cost sharing or cost recovery basis.


NORTHERN ROADS
SCALE
0 100 200 300 km
LEGEND
ROADS OPEN TO TRAFFIC
RAILWAYS
Beaufort Sea
Tuktoyaktuk
Inuvik
Aklavik
Old Crow
Fort McPherson
Arctic Red River
ALASKA
Fort Good Hope
Great Bear Lake
Norman Wells
Fort Franklin
Mackenzie River
Fort Norman
Dawson
Keno
Mayo
Wrigley
Rae
YELLOWKNIFE
Great Slave Lake
Carmacks
Faro
Ross River
Tungsten
Fort Simpson
Fort Providence
Haines Junction
WHITEHORSE
Carcross
Johnsons Crossing
Pine Point
Fort Smith
Uranium City
Lake Athabaska
Haines
Skagway
Atlin
Watson Lake
Fort Liard

ROAD AND HIGHWAY COST FACTORS AND COMMUNITY NEEDS

HIGHWAY TRANSPORT NEEDS OF SMALL RURAL COMMUNITIES IN WESTERN CANADA

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ABSTRACT

A survey methodology is developed to evaluate the transport needs of small rural communities and the performance of the common carrier industry. Such a survey must consider the heterogeneous characteristics of both the users and suppliers of transport. Shipper/receivers in 30 small communities across British Columbia, Alberta and Saskatchewan were interviewed. They were found to be highly dependent on common carriers for LTL transportation service. Overall, common carrier performance in the LTL market was not significantly different between the provinces. However, a price/quality of service tradeoff is observed between Alberta and Saskatchewan. This appears to be caused by the rate regulation policy in Saskatchewan.

INTRODUCTION

Small rural communities (SRCs) are a significant part of the Canadian fabric. Their viability is the concern of both Federal and provincial policymakers. One dimension of this concern is the search for regulatory policies that promote the provision of adequate truck transportation service to SRCs. Truck transport is for most SRCs, the only physical link to other communities and to larger trading centres. Railroads have long abandoned the movement of small shipments and continue to retreat from locations served by light density branch lines. The quantity and the

quality of truck transportation in sparsely populated areas of Canada is thus an important factor in its continued development.

There is substantial controversy over the role and the performance of one form of trucking, for hire truck common carriers, in meeting SRC transport needs.[1] Some argue that common carriers are not important.* Others debate the merits of the regulatory environment in which common carriers operate. Several studies have addressed these issues in the Canadian context but there appears to be an overall dearth of empirical information. At the very least, both policymakers and carriers need to know the nature of SRC transport needs, whether they are being met by common carriers and how well. This paper reports on a study addressing these empirical questions. The goal of the research was to develop a comprehensive but workable survey methodology to assess the performance of highway transport service in SRCs. The methodology was applied to a cross-section of small communities in Western Canada. A by-product of the validation process is a tentative conclusion about the state of SRC transportation in Western Canada. A description of the methodology and its application follows in the next section. This is followed by an analysis of the quantitative and qualitative data collected. Emphasis is placed on the intraprovincial less than truckload (LTL) market. The final section contains the conclusions and implications arising from the research.

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*Henceforth, for hire truck common carriers will be referred to as "common carriers."

METHODOLOGY

The SRC transportation problem has been the subject of several studies in Canada[2,3,4,5] and numerous studies in the United States. Previous research has collectively increased our understanding of the SRC transport problem. However, there are important concerns about existing research that limits the applicability of previous findings to public policy decisionmaking in Canada. A goal of this research was to develop an appropriate methodology that minimizes these problems. Major characteristics of this methodology are summarized below.

1. Definitions of SRCs - The raison d'etre of the SRC transportation problem is that an acceptable level of transportation service may not be supplied to such communities based on the market determined profitability of the service. A study should isolate and study communities that are not only small, but relatively isolated from major trading centres as these factors contribute to the high cost of serving the SRC. Thirty communities in B.C., Alberta and Saskatchewan were selected for this study and are listed in Table 1. Eighteen of the communities had 1976 populations below 1000 and twelve had populations between 1000 and 5000. No community was closer than 50 miles to the primary trading centres of each province;and with one exception, all were at least 50 miles away from any secondary trading centre (e.g. community with a population exceeding 15000). The two largest communities selected for each province were at least 100 miles from a primary city. The study communities are thus both small and isolated.

2. Control of Regulatory Scenarios and Criteria for Evaluation - A major problem with many SRC studies is that conclusions about the effects of regulation are based on ill defined perceptions of regulation on the part of the respondents. Some studies have observed that many shippers are not aware of regulations, much less be in a position to assess the cost/benefits of regulatory policy. This problem is minimized by surveying attitudes and measuring performance of a cross-section of shipper receivers (S/Rs) located in differently regulated markets. If the degree of regulation is the only major difference in the environments of two different trucking markets, then differences in evaluated performance can be associated with differences in regulation. If nonregulatory differences do exist, one has to account for their effect on performance in order for the residual performance can be attributed to regulation. The economic laboratory exists in this research because Alberta trucking is unregulated, B.C. trucking is regulated with respect to entry control, and Saskatchewan is regulated with respect to entry and rates. Analysis should focus on intraprovincial performance since these regulatory generalizations do not apply to extraprovincial trucking. The performance in Alberta is thus a benchmark for measuring the impact of regulations existing in B.C. and in Saskatchewan.

3. Recognition of Transport Market Heterogeneity - Apart from the distinction between urban and small community shippers, most studies do not recognize that S/R respondents may have different transport requirements and there-

Table 1

Communities Surveyed in SRC Study

	Province		
	B.C.	ALTA.	SASK.
1	Golden	Slave Lake	Kindersley
2	Burns Lake	High Prairie	Hudson Bay
3	Fruitvale	Smokey Lake	Kelvington
4	Clearwater	Manning	Carrot River
5	Clinton	Sedgewick	Luseland
6	Canal Flats	Boyle	Watson
7	Kaslo	Hardesty	Cut Knife
8	Telwkwa	Gleichen	Quill Lake
9	Spences Bridge	Cowley	Arcola
10	Pemberton	Innisfree	Punnichy

fore view the performance of a particular transport alternative differently. At the very least, parcel, LTL and TL (Truckload) transport markets should be analyzed separately. The survey instrument was designed to identify which transport market the S/R belonged in and to what transport market its responses were relevant to.

4. Comprehensive Performance Measurement - Many studies have focused on only one dimension of transport performance, e.g. rates or service quality but not both. A low price is not necessarily indicative of good performance if the quality of service is also inferior. The survey instrument sought information on rates, service quality and overall

5. Subjective verses Hard Data - Most studies measure the perception of S/Rs. These subjective evaluations may be influenced by different expectations or differential quality of alternatives. For example, a S/R in B.C. may "expect" a level of performance that exceeds that expected in Alberta "because" the B.C. carriers "are" regulated. In Saskatchewan, S/Rs may be judging common carrier performance against the excellent service of the bus industry which is partly supported by the RTAP program. This study collects actual performance data for two dimensions of transport, rates and transit times. Hard data comparisons can be used to strengthen or shed doubt on subjective evaluations.

This study utilizes the cross-sectional approach to evaluate the relative performance of trucking service to small communities. The study was confined to the three Western Canadian provinces of British Columbia (B.C.), Alberta (Alta.), and Saskatchewan (Sask.). Each province regulates their intraprovincial (movement within their provincial borders) trucking industries differently. All three provinces are concerned about the quantity and quality of truck service to less populated communities but only Saskatchewan's transportation statutes contain explicit reference towards this policy area. Certain exemptions to regulation exist, particularly in Saskatchewan, but these generally do not affect the regulations pertaining to the movement of general freight.

These regulatory differences are one part of the economic laboratory. The other ingredient is the ability to

control for non-regulatory factors that affect the performance of trucking, e.g. create ceteris paribus conditions. This is accomplished initially by choosing communities with similar demographic and economic characteristics. Ten triplets of communities in each province were selected on the basis of population size, distance from population centres, and economic makeup. All communities have populations of less than 5000 and most under 1000 and none have any significant manufacturing base. A personal interview was used to collect relevant information from two types of sources in each community: a community representative and a set of shippers/receivers. The procedure for each community was to interview the community representative first in order to supplement the profile of businesses obtained previously from external sources. The interviewer then selected a sample of businesses to contact based on the following criteria: (1) select firms likely to require some form of intercity truck transportation, e.g. eliminate grain elevators, farms, etc., (2) select one firm only if several firms of the same type exist, e.g. select one grocery store out of four but interview more if one store is an independent and the other is a chain operation, (3) select firms so that every major business sector is represented, e.g. manufacturing, retailing, forestry, etc.

The survey instrument was a 26 question, 5 part questionnaire filled out by the interviewer at the time of the interview. The interviews were conducted during the summers of 1981 and 1982 and resulted in a total of 324 S/R interviews.

CHARACTERISTICS OF S/R RESPONDENTS AND TRAFFIC

The vast majority of the S/Rs surveyed were in the retail business (see Table 2). As noted above, the process of selecting firms for the field survey was based on a judgment sample. In general, retailing was overrepresented at the expense of the other sectors. The majority of the underrepresentation is on service establishments which were judged to be least likely to require any form of truck transportation. The majority of the respondents indicated annual sales less than $500,000 (see Table 3). However, a significant minority of firms had sales exceeding $500,000. Nonrespondents to the size question tended to be larger businesses. Transportation costs were generally less than five percent of the respondents' revenues (see Table 4). Transport costs are more significant in the B.C. sample and least significant in the Alberta sample.

The respondents were classified according to the type of freight (weight class) and the direction of movement. This resulted in 15 freight type/direction classifications shown in Table 5. Ninety-eight and seven tenths percent (98.7) of the S/Rs are receivers of freight (purely inbound or both inbound and outbound) and 17.3 percent are shippers of freight. The majority of the S/Rs were LTL and Parcel Shippers. The statistics in Table 5 do not reflect the percentage of freight flow in each category. However, the figures are consistent with what is generally perceived to be the direction and the type of freight movement in SRCs. A majority of the S/Rs, particularly in Alberta, indicated that at least 90 percent of its freight originates from

Table 2

Distribution of SRC S/R Respondents by Business Type (N=324)

Business Type	B.C.	ALTA.	SASK.	TOTAL
Retailing	86.0	90.7	85.0	87.0
Services	6.0	5.2	8.7	6.8
Manufacturing	4.0	1.0	3.1	2.8
Construction	2.0	2.1	3.1	2.5
Other	2.0	1.0	0	.9
TOTAL*	100%	100%	100%	100%

Table 3

Size of SRC S/R Respondents (N=212)

Annual Sales	B.C.	ALTA.	SASK.	TOTAL
<$100,000	21	14	18	18
$100,000 - $500,000	39	40	50	44
>$500,000	40	45	31	38
Total*	100%	100%	100%	100%

Table 4

Transportation Cost As A % of Total Revenue (N=253)

Class	B.C.	ALTA.	SASK.	TOTAL
Less than 2%	29.1	24.3	27.0	26.9
2 to 5%	32.9	64.9	49.0	48.6
6 to 10%	27.8	6.8	19.0	18.2
Greater than 10%	10.1	4.1	5.0	6.3
Total*	100%	100%	100%	100%

* Sum may not equal 100 due to rounding.

Table 5

Distribution of SRC S/R Respondents

by Shipper Type and Traffic Direction (N=317)

Shipper Type	B.C.	ALTA.	SASK.	TOTAL
Parcel				
Inbound	37.8	13.8	24.0	25.2
Outbound	1.0	-	-	.3
Both	3.1	2.1	6.4	4.1
Subtotal	41.9	15.9	30.4	29.6
LTL				
Inbound	30.6	39.4	28.0	32.2
Outbound	-	-	-	-
Both	2.0	1.1	2.4	1.9
Subtotal	32.6	40.5	30.4	34.1
TL				
Inbound	6.1	9.6	4.8	6.6
Outbound	2.0	-	-	.6
Both	1.0	3.2	.8	1.6
Subtotal	9.1	12.8	5.6	8.8
Parcel/LTL				
Inbound	8.2	16.0	12.8	12.3
Outbound	-	-	.8	.3
Both	3.1	6.4	9.6	6.6
Subtotal	11.3	22.4	23.2	19.2
Parcel/LTL/TL				
Inbound	1.0	8.5	8.8	6.3
Outbound	-	-	-	-
Both	1.3	-	.6	1.9
Subtotal	2.3	8.5	9.4	8.2
TOTAL	100%	100%	100%	100%

within the province of domicile (see Table 6). About one third of the respondents received 90 percent or more of its freight from either the province of domicile or an adjacent province (e.g. regional movement).

Table 6

Origin of Inbound Freight (N=323)

	BC	ALTA	SASK	TOTAL
Provincial	49.5	63.9	57.5	57.0
Regional	40.4	27.8	30.7	32.8
National/International	10.1	8.2	11.8	10.2
	100%	100%	100%	100%

THE IMPORTANCE OF FOR HIRE TRUCKING IN SRC TRANSPORTATION

SRCs are served by a variety of transportation suppliers but by every criteria available, the for hire common carrier is the dominant form of transport. Each respondent was asked to list the carriers utilized in order of contact frequency. For 64 percent of the respondents, for hire common carriers are used most frequently (see Table 7). The second most important carrier, bus transportation, was listed by only 14 percent of the respondents. In addition, when a form of transport other than common carriers was cited as the most frequently used carrier, a common carrier was usually listed as the second most frequently utilized carrier. In total, over 90 percent utilized common carriers is their primary, secondary or third transport alternative. The dependence on common carriers is even higher for LTL shippers (74 percent use a common carrier most frequently).

Table 7

Use of Common Carriers

Common Carrier is Used. . .	BC	ALTA	SASK	TOTAL
Most Frequently	56	67	68	64
Second Most Frequently	20	16	22	20
Third Most Frequently	9	8	4	7
TOTAL	85%	91%	94%	91%

THE TRANSPORT REQUIREMENTS OF LTL FREIGHT

The SRC transport market can be classified into three shipment types: parcel, LTL and TL. The transport requirements for each type of freight may differ so it is advantageous to consider each shipment type individually. The remainder of this analysis focuses specifically on the transportation of LTL freight which like the other shipment groups, is predominantly inbound movement.

The quality of LTL service provided by a carrier to a community has many dimensions. The study sought to focus upon those characteristics that were most important to the respondents in the sample. Each respondent was asked to rate a set of service characteristics as very important, important, not important or not applicable. In Table 8, the percentage of respondents which rated each characteristic as very important; or very important or important is shown. For this analysis we assume that the most important service factors are those which are rated as very important by at least 50 percent of the respondents or rated as very important or important by at least 75 percent of the respondents. Using this criteria, we observe the following

TABLE 8

Importance of Transportation Service Characteristics in LTL Carrier Selection

PROVINCE	B.C.		ALTA.		SASK.		TOTAL	
Response Service Characteristic	Very Important	Very Important or Important	Very Important	Very Important or Important	Very Important	Very Important or Important	Very Important	Very Important or Important
RATES*	49.3	78.6	72.0	92.7	49.5	78.9	56.3	83.1
SERVICE RELIABILITY*	60.0	84.0	81.5	96.3	65.1	91.7	68.7	91.0
ADHERENCE TO SCHEDULE*	24.7	71.5	57.3	96.3	54.1	86.2	46.6	85.0
SPEED OF DELIVERY*	63.2	89.5	72.3	96.4	64.2	92.6	66.4	92.9
SPEED OF PICKUP	17.3	42.6	13.3	24.1	27.5	54.1	20.2	41.5
HANDLING OF CLAIMS*	25.0	63.2	24.1	83.1	37.0	88.9	29.6	79.8
LIABILITY COVERAGE*	22.4	56.6	13.3	68.7	26.6	77.1	21.3	68.7
TRACING	18.4	60.5	12.2	65.9	21.1	68.8	17.6	47.9
DAMAGE CONTROL*	45.3	74.6	57.8	81.9	47.7	86.2	50.2	81.7
SINGLE LINE SERVICE	22.7	56.0	19.5	50.0	13.8	51.4	18.0	52.2
LOCATION OF TERMINALS	8.2	34.2	6.2	22.2	4.6	22.0	6.1	25.5
NO. OF DESTINATIONS	8.0	25.3	6.2	30.9	4.6	32.1	6.0	29.8
AVAILABILITY OF RATE INFO.	10.7	42.7	6.2	60.5	6.4	53.2	7.5	52.4
AVAILABILITY OF EQUIP.	20.0	45.3	13.8	63.8	13.1	55.2	15.3	55.0

* Characteristic rated by at least 50% of respondents as very important or rated by at least 75% of respondents as very important or important in one or more provinces.

factors as important in one or more provinces: (1) Rates, (2) Service Reliability, (3) Speed of Delivery, (4) Handling of Claims, (5) Damage Control, (6) Adherence to Schedule, (7) Liability Coverage. Finally, we observe that Availability of Rate Information is relatively more important to Alberta shippers but much less to shippers in other provinces. This is consistent with the fact that rates are not required to be filed in Alberta. The study shall focus on the seven characteristics consistently rated as important in one or more provinces by the criteria stated above.

PERCEPTIONS OF SERVICE PERFORMANCE

Respondents in each province were asked to evaluate a variety of service characteristics for the common carrier most frequently used for LTL freight. In Table 9, the evaluation of the LTL service by all S/Rs is shown. The seven service dimensions were identified as important measures of performance in at least one province. The percentages are calculated on a base that omits respondents who checked the characteristic as not applicable. The Chi Square (χ^2) and significance (SIG.) columns indicate the relationship between the respective row province and Alberta.

There are a number of bases for ranking service performance between provinces. Scanning the "Excellent" column, one can observe that Alberta's performance is rated highest in 4 out of 7 characteristics. B.C. is highest rated in 3 characteristics; Saskatchewan none. Scanning the "excellent" and the "Quite Good" columns and summing

TABLE 9

Evaluation of LTL Transportation Service of Most Frequently Used For-Hire Carrier by All S/Rs*

Character-istic	Province	Excellent	Quite Good	Adequate	Minimally Acceptable	Unsatis-factory	N	χ^2	SIG
Rates	B.C.	7.5	17.9	31.3	10.4	32.8	67	8.86	.06
	ALTA.	14.7	27.9	26.5	16.2	14.7	68		
	SASK.	13.9	25.3	21.5	22.8	16.5	79	1.36	.85
Service Reliability	B.C.	20.5	39.7	23.1	7.7	9.0	78	10.80	.03
	ALTA.	25.6	57.7	11.5	2.6	2.6	78		
	SASK.	9.9	36.0	31.5	8.1	14.4	111	28.73	.00
Adherence to Schedule	B.C.	29.8	40.4	12.3	12.3	5.3	57	10.57	.03
	ALTA.	19.5	59.7	13.0	1.3	6.5	77		
	SASK.	16.8	40.0	28.4	7.4	7.4	95	11.68	.02
Speed of Delivery	B.C.	17.9	35.9	20.5	11.5	14.1	78	13.28	.01
	ALTA.	23.1	53.8	16.7	1.3	5.1	78		
	SASK.	10.2	34.3	35.2	10.2	10.2	108	21.58	.00
Handling of Claims	B.C.	18.8	27.1	12.5	18.8	22.9	48	13.83	.00
	ALTA.	25.9	48.3	13.8	8.6	3.4	58		
	SASK.	9.6	33.7	13.3	9.6	33.7	83	22.09	.00
Liability Coverage	B.C.	23.5	29.4	26.5	5.9	14.7	34	8.00	.09
	ALTA.	20.0	56.4	16.4	3.6	3.6	55		
	SASK.	15.8	36.8	22.8	7.0	17.5	57	8.82	.07
Damage Control	B.C.	21.4	35.7	14.3	14.3	14.3	56	3.37	.49
	ALTA.	18.6	50.0	11.4	12.9	7.1	70		
	SASK.	10.4	42.7	16.7	9.4	20.8	96	8.67	.07

* Ratings refer to services of specific for-hire carrier most frequently used if identified or group of carriers furnishing LTL truck service.

the two, one can observe that Alberta's performance is now rated highest in all 7 characteristics. If we use the criteria of "adequate" or better, again all 9 characteristics favor Alberta. Finally, if we assume the validity of the ordered rating scheme, we observe (from the χ^2 and SIG columns) that Alberta's service is significantly superior (at $\alpha = .05$) to both British Columbia's and Saskatchewan's service with respect to Service Reliability, Adherence to Schedule, Speed of Delivery and Handling of Claims. The largest area of dissatisfaction is with B.C. rates (32.8% unsatisfactory) and Saskatchewan's Handling of Claims (33.7 percent unsatisfactory).

The relative performance is altered somewhat when only the ratings of LTL S/Rs are considered. Specifically, in only one area, Handling of Claims is Alberta's performance significantly better than in the other provinces as measured by the statistical Chi Square test. Note that Saskachewan's rate evaluation also improves significantly to the point that its ratings exceed Alberta's in this dimension.

RATE PERFORMANCE

One portion of the interview requested the respondent to make available representative freight bills or other documentation of actual freight movements. The total rate, origin or destination (depending on whether the shipment was inbound or outbound), weight, and other information was collected. Three hundred and eighty five cases met two criteria; the shipments weighed at least 50 pounds but less than 10001 pounds and the origin or destination was within one province. The provincial limitation preserved regula-

TABLE 10

Evaluation of LTL Transportation Service of Most Frequently Used For-Hire Carrier by LTL S/Rs*

Character-istic	Province	Excellent	Quite Good	Adequate	Minimally Acceptable	Unsatis-factory	N	χ^2	SIG
Rates	B.C.	8.7	13.0	17.4	17.4	43.5	23	7.75	.10
	ALTA.	16.7	30.0	30.0	6.7	16.7	30		
	SASK.	25.9	40.7	7.4	18.5	7.4	27	7.42	.11
Service Reliability	B.C.	20.7	44.8	20.7	6.9	6.9	29	1.75	.78
	ALTA.	26.5	52.9	11.8	5.9	2.9	34		
	SASK.	16.2	37.8	29.7	5.4	10.8	37	6.05	.20
Adherence to Schedule	B.C.	28.6	47.6	14.3	9.5	0.0	21	5.08	.28
	ALTA.	30.3	45.5	15.0	0.0	9.1	33		
	SASK.	26.5	35.3	23.5	5.9	8.8	34	3.06	.55
Speed of Delivery	B.C.	20.7	34.5	13.8	20.7	10.3	29	5.91	.21
	ALTA.	29.4	47.1	14.7	2.9	5.9	34		
	SASK.	18.9	35.1	29.7	8.1	8.1	37	4.17	.38
Handling of Claims	B.C.	15.8	21.1	5.3	36.8	21.1	19	10.12	.04
	ALTA.	28.6	42.9	14.3	10.7	3.6	28		
	SASK.	17.2	37.9	10.3	3.4	31.0	29	8.26	.08
Liability Coverage	B.C.	23.1	23.1	23.1	15.4	15.4	13	5.00	.29
	ALTA.	19.2	53.8	19.2	3.8	3.8	26		
	SASK.	31.6	42.1	10.5	5.3	10.5	19	2.31	.68
Damage Control	B.C.	18.2	31.8	18.2	18.2	13.6	22	1.24	.87
	ALTA.	16.7	46.7	13.3	13.3	10.0	30		
	SASK.	20.0	42.9	17.1	8.6	11.4	35	.67	.95

* Ratings refer to services of specific for-hire carrier most frequently used if identified or group of carriers furnishing LTL truck service.

tory homogeneity within each province since provincial regulations for shipments moving across provincial boundaries are not necessarily identical to the regulations applicable to freight moving within the province. The weight boundaries limit the sample to the LTL freight market. The data was fitted to the following logarithmic model in order to estimate the effect of regulation.

(1) $\log TR = a + b_1 \log W + b_2 \log H + d_i D_i$

where

TR = Total Rate Paid for Shipment,
W = Weight of Shipment,
H = Distance of Shipment,
D_1 = 1 if B.C., 0 otherwise,
D_2 = 1 if Sask, 0 otherwise.

The value of d_i represents the effect of regulations of the respective province relative to unregulated Alberta. The model was calibrated twice, once pooling British Columbia with Alberta and once pooling Saskatchewan with Alberta and using the appropriate D_i in each case.

The B.C./ALTA. model results were: N = 178 R^2 = .7433

(2) $\log TR = .0484 + .5855 \log W + .3973 \log H + .0484 D_1$
$\quad\quad\quad

Since d_3 0, the ratio of Alberta rates to Saskatchewan rates is Ratio = $\frac{1}{\exp(d_3)} = \frac{1}{\exp(-.03077)} = 1.36$

On the average, Alberta rates are 36% higher than comparable Saskatchewan truck rates to small communities. These statistical results indicate that the actual rate level is generally lower for Saskatchewan shippers of freight in small communities than in Alberta or British Columbia.

TRANSIT TIME PERFORMANCE

The respondents also estimated the transit times (measured in discrete days) to and from the locations identified on their representative freight bills. An empirical measure of transit time performance is thus available for comparison to the S/R rating of Speed of Delivery. To maintain comparability, again only intraprovincial, LTL freight bills were selected for this part of the analysis. The average transit times for the selected shipments were 1.91, 1.82 and 2.32 days for B.C., Alberta and Saskatchewan respectively. Transit times in Saskatchewan are over 25 percent longer. However, this may be due to the haul distribution within each province. To shed light in that factor, the distribution of transit times were cross tabulated by province controlling for distance of haul (see Table 11). With no consideration of distance traveled, the percentage of shipments delivered in one day is highest in Alberta. Overall, transit times are statistically lower in Alberta (Panel a). However, this varies across distance brackets. Under 150 miles, the percentage of Alberta shipments delivered in one day is again the highest but the average transit time is not statistically better than those in B.C.

Table 11

Transit Time Performance by Province and Length of Haul

Haul	Province	AVG. TRANSIT TIME (DAYS) 1	2	3	4	5	6	7	10	N	X^2	SIG.	AVG. DIST.
a. all miles	B.C.	62.9	11.3	16.1	3.2	1.6	3.2	-	1.6	62	23.71	.00	
	ALTA.	75.8	9.9	3.3	-	-	-	11.0	-	91			
	SASK.	54.8	21.0	9.7	2.4	.8	.8	7.3	3.2	124	18.08	.01	
b. >150 miles	B.C.	83.3	5.6	5.6	-	-	5.6	-	-	18	4.09	.25	104
	ALTA.	97.0	-	3.0	-	-	-	-	-	33			106
	SASK.	73.5	10.2	10.2	2.0	-	2.0	-	2.0	49	8.09	.15	103
c. 150-300 miles	B.C.	90.0	10.0	-	-	-	-	-	-	10	.47	.79	187
	ALTA.	90.9	6.1	-	-	-	-	3.0	-	33			172
	SASK.	55.2	13.8	24.1	-	3.4	-	-	3.4	29	14.73	.01	207
d. <300 miles	B.C.	44.1	14.7	26.5	5.9	2.9	2.9	-	2.9	34	20.81	.00	540
	ALTA.	28.0	28.0	8.0	-	-	-	36.0	-	25			582
	SASK.	34.8	37.0	-	4.3	-	-	19.6	-	46	8.19	.14	424

or Saskatchewan. Between 150 and 300 miles, B.C. and Alberta transit time performance is virtually identical and both are far superior to Saskatchewan's performance. However, the average distance of these Saskatchewan shipments was 20 percent higher than in Alberta. In contrast, both Saskatchewan and B.C. appear to perform better than Alberta in moving shipments exceeding 300 miles. In this case, Alberta shipments traveled much further than Saskatchewan freight.

These objective measures may be compared with the subjective ratings of Speed of Delivery. Recall that a larger percentage of Alberta LTL S/Rs rated Speed of Delivery as Excellent or Quite Good than was the case in B.C. or Saskatchewan. When all shippers (e.g. including parcel shippers who ship some LTL freight) were considered, this relasionship was also statistically significant. The subjective ratings are consistent with the overall comparison of actual transit times but inconsistent with more homogeneous distance brackets. Only in the medium distance market are shippers getting below average transit times in Saskatchewan, and Alberta shippers are getting the poorest service in the long distance markets.

OVERALL PERFORMANCE

The respondents were also asked to evaluate the overall service (all factors combined) provided by its primary for hire carrier and by all carriers providing LTL service. These responses are summarized in Tables 12 and 13. As in the earlier analysis, the evaluations by all S/Rs indicate that the total package of service in Alberta is superior to

Table 12

Evaluation of LTL Transportation Service of Most Frequently Used For-Hire Carrier

Shipper Group	Province	Excellent	Quite Good	Adequate	Minimally Acceptable	Unsatis-factory	N	χ^2	SIG
all S/Rs	B.C.	26.4	33.3	26.4	6.9	6.9	72	10.07	.04
	ALTA.	20.3	58.2	13.9	3.8	3.8	79	18.55	.00
	SASK.	11.6	36.6	26.8	14.3	10.7	112	18.55	.00
LTL S/Rs	B.C.	22.2	40.7	22.2	3.7	11.1	27	3.06	.55
	ALTA.	26.5	52.9	8.8	5.9	5.9	34		
	SASK.	18.9	40.5	21.6	10.8	8.1	37	3.54	.47

Table 13

Evaluation of Overall LTL Transportation Service

Shipper Group	Province	Excellent	Quite Good	Adequate	Minimally Acceptable	Unsatis-factory	N	χ^2	SIG
all S/Rs	B.C.	10.4	41.6	35.1	9.1	3.9	77	10.47	.03
	ALTA.	13.9	59.5	24.1	2.5	0.0	79		
	SASK.	3.7	49.5	29.4	14.7	2.8	109	16.59	.00
LTL S/Rs	B.C.	10.7	64.3	10.7	10.7	3.6	28	5.39	.23
	ALTA.	14.3	54.3	28.6	2.9	0.0	35		
	SASK.	5.6	58.3	25.0	8.3	2.8	36	3.42	.49

that provided in British Columbia or Saskatchewan and this superiority is statistically significant. However, the LTL S/Rs rated the overall performance of LTL transportation just about equally between the provinces.

SUMMARY AND ANALYSIS

The preceding comparisons indicate that there is a significant difference in the evaluations of LTL service made by LTL S/Rs and by all S/Rs. The latter group includes in addition to the former, S/Rs who have significant need for Parcel and TL service. A question arises over the weight given to the latter type of S/R respondent in an overall evaluation of LTL service. First, non LTL S/Rs may have marginal need for LTL service, although it may be the case that a large Parcel S/R may have LTL transport needs far exceeding the total LTL needs of a small LTL shipper. The choice is clearly whether one wants to assess the performance given to the greatest number of shipper/receivers or to a specific transport market. If the choice is the latter, then equal weighting could overstate the relevance of marginal S/Rs in the LTL market. Secondly, the quality of service available for meeting Parcel and TL needs may influence the rating of LTL service. For example, a S/R could perceive LTL service to be slow compared to TL service unless there is recognition of the frequent need to consolidate the former type of shipment. In order to minimize these potential bias, greater reliance is placed on the evaluations of the LTL S/R group.

The results of the rate, transit time and service comparisons can thus be summaried as follows: (1) There is

statistically very little difference between most of the service evaluations of LTL transport service across the three provinces. Only in the area of Claims Handling do B.C. and Saskatchewan carriers appear to be performing significantly worse. On the other hand, there appears to be some superiority in Rate performance in Saskatchewan relative to Alberta and B.C.. Problem areas in B.C. are Rates and Claim Handling. In Saskatchewan, the worse problem area is Claims Handling. Alberta S/Rs are least sastified with Rates. (2) The actual price of small community trucking service is lowest in Saskatchewan and higher in in both Alberta and British Columbia. (3) Analysis of actual transit times reveals that the relative performance between provinces varies with the distance considered. This suggests that the relatively poor speed of delivery perceived by LTL S/Rs is a function of the distribution of freight among various distance (lenghth of haul) markets. Specifically, if one considered only the long distance intraprovincial market, transit times are expected to be shorter in B.C. and Saskatchewan. (4) Overall, the quality of truck service and rates provided to small communities is not very different between Alberta, British Columbia or Saskatchewan. The combination of comparisons would suggest that while the type of regulations existing in Saskatchewan has benefited the small community shipper in terms of lower direct costs, it has been at the expense of slightly reduced service quality. The overall evaluation, however, indicates that the tradeoff is acceptable to the Saskatchewan LTL shippers.

CONCLUSION

The purpose of this study was to develop a research approach to evaluate the quality of trucking services to small communities and the impact of regulation. The different regulatory environments of the three Western Canadian provinces provide the economic laboratory to control for regulation. The study is unique in that a benchmark for evaluation exists, controls for shipper heterogeneity and other demographic factors are used, and both rates and quality of service are evaluated and objective performance measures are used. The study finds that Saskatchewan's operating environment, containing both rate and entry controls, has resulted in lower rates but slightly worse service in the movement of LTL freight to and from small communities relative to unregulated Alberta. Some minor but no substantial differences exist between the performance in British Columbia and Alberta. The areas of least satisfaction appear to be Rates in B.C. and Alberta and Claims Handling in B.C. and Saskatchewan.

The empirical findings are of course tentative. The survey sample consisted of respondents from a set of 30 communities selected to maximize homogeneity in small community characteristics. A larger sample of communities could be surveyed in order to validate that these results are representative of the LTL truck rate and service levels to all small communities in Western Canada. The Parcel transport market is found to be relatively large and should be analyzed in a comparable manner.

REFERENCES

1. Hirshhorn, R., Trucking Regulation in Canada: A Review of the Issues, Working Paper 26, Economic Council of Canada, 1981, Chapter VII.

2. McRae, J.J. and D.M. Prescott, The Structure of Rates in the Canadian For-Hire Trucking Industry: A Further Analysis, prepared for the Regulatory Reference, Economic Council of Canada (mimeo), 1979.

3. Ontario Ministry of Transportation and Communications, Trucking Services to Small Communities, Toronto, 1982.

4. Select Committee of the Legislative Assembly, Reviewing Intra-Provincial Trucking Regulations, Alberta, 1977.

5. Sparks, G.A., N.D. Clarke, and L.C. Watson, Freight Transportation Requirements for Sparsely Populated Regions in Rural Saskatchewan, Transportation Centre, University of Saskatchewan, undated.

INCREASING ALLOWABLE GROSS VEHICLE WEIGHTS ON SECONDARY HIGHWAYS[1]

by

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Abstract

Considerable attention has been directed toward the use of larger and heavier trucks in Canada as a means of increasing the productivity and efficiency of the trucking industry. This paper identifies and quantifies the potential benefits associated with increasing the allowable gross vehicle weights on the secondary highway system in Saskatchewan from 33,600 kg to 50,000 kg. Significant benefits in terms of reduced transports costs and increased fuel efficiency are possible through the use of the larger vehicles. These benefits tend to be associated with a relatively small number of major commodity movements.

Introduction

In recent years considerable attention has been directed toward the use of larger and heavier trucks as a means of increasing the productivity and efficiency of the trucking industry. The energy crisis of the early 1970's initiated the interest in using larger trucks in that fuel efficiency increases significantly with increased vehicle size.

In recognition of the potential benefits available from permitting larger and heavier trucks to operate over our highways, the federal government and the provincial governments of Alberta, Saskatchewan and Manitoba established highway strengthening agreements in 1974. These agreements increased the allowable axle and gross vehicle weights on a standardized basis for designated portions of the highway network in western Canada. These portions of the highway network within Saskatchewan, generally referred to as the primary highway system, are illustrated in Figure 1.

While the 1974 highway strengthening program introduced increased axle and gross vehicle weights on a uniform basis for movements between major centers in Saskatchewan and throughout western Canada, it at the same time introduced a two tiered axle and gross vehicle weight system within each of the provinces. That is, the increased axle and gross vehicle weights were only permitted on the "primary highways" while maintaining the lower axle and gross vehicle weights on all other provincial highways and rural roads.

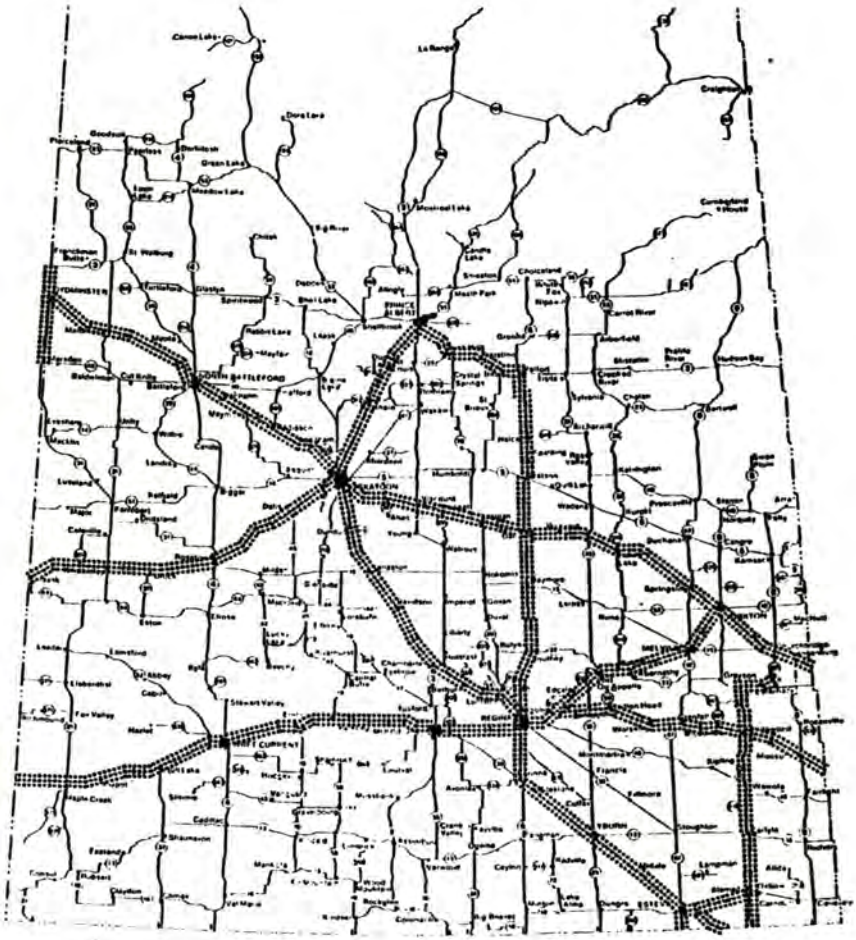
The increased allowable axle and gross vehicle weights permitted on the primary highway system resulted in improving the productivity and increasing the overall efficiency of portions of the trucking industry. In general terms, those portions of the industry involved in moving dense commodities between origins and destinations located on or near the primary highway system[2] reaped the

FIGURE 1

PRIMARY HIGHWAY SYSTEM

TOTAL km 3177.3 (EXCLUDES INTERSECTING ROADS, STUB–CONNECTORS, P.C.A. ACCESS *, HIGHWAYS INSIDE CORPORATE LIMITS)

FEBRUARY 1, 1983



* POTASH CORPORATION OF AMERICA

benefits of increased allowable axle and gross vehicle weights.

On the other hand, those commodities which "cubed-out" because of their low densities or moved between origins and destinations wherein the truck had to operate on other than the primary highway system for some portion of the trip were restricted so as not to be able to reap the benefits associated with increased allowable axle and gross vehicle weights permitted under the highway strengthening agreement.

The end result was that many of the major movements in western Canada were excluded from reaping the benefits of the highway strengthening program and in some cases, inequitable transport costs resulted in which the smaller rural centers were at a significant disadvantage to the larger urban centers. The above might be illustrated by the following examples.

The trucking industry in Saskatchewan is responsible for essentially all of the distribution of fuel from refineries and pipeline terminals in Regina and Saskatoon. Fuel does not "cube-out", therefore it is a commodity which could potentially reap the benefits of moving at the increased axle and gross vehicle weights. In fact, portions of the total fuel did move at the increased allowable weights following the implementation of the highway strengthening agreements. However a portion, in particular that which moved to destinations in rural Saskatchewan which were located off of the primary highway

system was unable to benefit because such movements were restricted from using the increased allowable weights. As a result, most fuel consumed in major centers in Saskatchewan reaped the benefits of increased allowable weights, whereas much of the fuel used in rural Saskatchewan was unable to benefit.

Another example is the movement of fertilizer from plants in Alberta and British Columbia directly to farms in Saskatchewan. Fertilizer moving by truck from Cominco's plant in Trail, B.C. to a farm in Saskatchewan located 20 km off the primary highway system would have the payload restricted on the 900 km trip by the weight regulations applicable to the 20 km section of non-primary highway. This type of restriction can translate into substantial differences in transport costs and energy consumed per tonne of payload.

To illustrate, commercial carrier charges per trip from Tail, B.C. to Saskatchewan would be approximately $1100 for a 20 tonne payload operating at a gross vehicle weight of 33,600 kg (i.e. $55 per tonne), versus about $1265 for a 32 tonne payload at a gross vehicle weight of 50,000 kg (i.e. $40 per tonne) for a saving in transport cost of about 27%. In terms of energy, a 1800 km round trip would be expected to consume about 30% less total fuel per tonne of payload at the higher gross vehicle weight.[3]

The above and other situations wherein major movements were unable to reap the benefits of the 1974

highway strengthening program were identified and/or brought to the attention of the Saskatchewan Department of Highways and Transportation following the implementation of the highway strengthening program. Many cases were brought to the attention of the Department of Highways and Transportation via requests to extend the primary highway system as designated in 1974 to include a larger portion of the highway network.

During the ongoing review process associated with requests for extensions to the primary highway system, two things became obvious. These were:

1) most "secondary" highways in Saskatchewan are not structurally capable of handling the increased axle loads which were permitted on the primary highway system, and

2) there were seemingly a large number of significant movements which were not able to reap the benefits of the highway strengthening program because of a requirement to travel on some part of the secondary highway system for a portion of the trip.

During the discussions related to the possible extension of the primary highway system, it was suggested that a compromise solution may be available wherein most of the benefits associated with the increased weights on the primary system could be obtained on the secondary system without increasing the structural requirements of these highways. This proposed compromise involved increasing the allowable gross vehicle weights on the

secondary system to approach that allowed on the primary highway system while maintaining the existing lower axle weights. Such a change would in effect allow combination units (i.e. A and B trains) to operate on the secondary highway system utilizing an increased gross vehicle weight while maintaining the previous allowable axle weights. In the opinion of highway engineers, increasing the allowable gross vehicle weights would have little or no impact upon the structural requirements of the secondary highways as long as the allowable axle weights were not increased and the total tonnes of commodity did not increase (i.e. traffic did not divert from rail to road).

Increasing the maximum allowable gross vehicle weight permitted on the secondary highway system from 33,600 kg to 50,000 kg while maintaining the existing allowable axle weights would allow maximum payloads to increase from 20-23 tonnes to 32-34 tonnes, or about 60%. Experience has indicated that the increase in operating costs resulting from increasing the gross vehicle weight from 33,600 kg to 50,000 kg are in the order of 15% with fuel consumption increases being about 10%. In short, shifting from a 5 axle semi operating at 33,600 kg to a combination unit operating at 50,000 kg (with the same allowable axle weights), the traffic which would take three loads with a semi could be transported in two loads with the combination vehicle. The end result being that transport costs could be reduced by about 23% and total fuel consumed by about 27%.

The proposed "compromise" of allowing combination vehicles to operate over the secondary highway system presented some potentially significant savings at little or no cost to the highway system. In the opinion of the Department of Highways and Transportation, this was a situation that clearly required a closer look. The Department initiated a study of the matter in 1981, one of the objectives of which was to:

> "identify and quantify the potential benefits associated with increasing the maximum allowable gross vehicle weight permitted on the secondary highway system from the existing 33,600 kg to 50,000 kg while maintaining the previous maximum allowable axle weights permitted on the secondary highway system".

Study Methodology

In initiating the study, it was recognized that it would be impossible within the scope of the resources available to identify and quantify all commodity movements. It was however deemed possible and acceptable for the purpose of this analysis to identify and generally quantify and describe the major movements within the province, and from these generally identify and quantify movements which might benefit from the proposed change. Thus, the general approach taken was one of to:

1) identify the major commodity movements within the province,

2) identify major shippers and carriers associated with the movements of the commodities identified in (1),

3) through contact with major shippers and carriers, develop a quantified description of each major commodity movements, and

4) through comments from major shippers and carriers, determine the commodity movements which could potentially be affected by the proposed changes in gross vehicle weights and attempt to quantify the magnitude of the benefits.

A note of caution is in order. The total effect including the data collection, the analysis and the preparation and presentation of the report involved about 35 mandays of effort, and thus must be viewed as a Q & D (quick and dirty) type of analysis.

As will become apparent later, although a Q & D approach was used, the results fulfilled the objectives of the undertaking in that the analysis indicated the direction which should be taken and the general magnitude of the benefits to be expected. Further, it must be recognized that the information presented in the following sections was gathered through discussions with a large number of individuals on an informal basis. While every effort was made to validate the information and make it as complete as possible, it is impossible to ensure the completeness or the accuracy of the information. This obviously imposes some rather strict limitations on the uses to which the information can be put. It does not

however unduly restrict its use for our purposes in that its use herein is simply to provide an overview and order-of-magnitude appreciation for the implications of the proposed changes. It is not nor was it intended to be a comprehensive description of commodity movements in Saskatchewan.

The Major Commodity Movements

A nummber of commodity flow studies have been undertaken in past years. One of the most recent and most comprehensive was undertaken in 1978 by Transport Canada and the Provincial Departments of Highways and Transportation of Manitoba, Saskatchewan and Alberta.[4]

Table 1 presents the detailed commodity classification and the distribution of truck trips by general commodity hauled for the six locations surveyed in Saskatchewan during the 1978 study.

Utilizing Table 1 as a guide, major shippers and carriers associated with the commodities were identified and contacted. Quantified descriptions of each major commodity movement were prepared. A summary of these quantified descriptions are presented in Table 2.

From Table 2 it is noted that the major benefactors of the proposed change in allowable gross vehicle weights on the non-primary highway system would include petroleum products, bulk liquids and chemicals, dry bulk chemicals, forest products and grains. The estimated magnitudes of the benefits associated with each of these movements are

Table 1

Commodity Classification[1]

Commodity	% of Total Trips
General Freight	19.2%
Foodstuffs (Non Perishable)	2.9%
Foodstuffs (Perishable)	8.4%
Heavy Machinery	11.3%
Metal Products	6.1%
Petroleum Products	9.7%
Bulk Liquids & Chemicals	4.2%
Bulk Dry Chemicals & Minerals	13.5%
Forest Products	4.7%
Livestock	2.9%
Construction Materials	5.9%
Acid Feed & Feed Products	3.1%
Trailer - Mobile Homes	1.4%
Household Goods	3.3%

1 Source - Western Canada Truck Origin - Destination Survey, Transport Canada

TABLE 2

SUMMARY OF COMMODITY MOVEMENTS

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
General Freight 19%	Inter-provincial	Between major cities over primary highway system. 100-200 trailers per day.	$ 18 x 10^6	—	$ 18 x 10^6	None	—
	Intra-provincial	Major Saskatchewan centers to rural centers over non-primary system. Approximately 80 small carriers.	—	$ 5 x 10^6	$ 5 x 10^6	20% of the loads could potentially save something however assume none do because of need to use combination venicles. Some special situations.	—
Foodstuffs Non-Perishable 2.3%	Food Preparations (box, bottle, can bag)	Between major centers over the primary highway system. 5-10 trailers/day.	$ 900,000	—	$ 900,000	Implications a function of LTL traffic plus a move to combination vehicles. Assume no benefits.	—
	Non-Alcoholic Beverage	Major centers to smaller centers within 50-100 km radius				Little benefit - assume none	
	Alcoholic Beverage (Beer, wine, liquors)	Major warehouse in Regina receives and distributes all shipments of liquor and wines. Receives TL and ships TL and LTL provincially. Beer moves from breweries to warehouses in TL lots and provincially by LTL				Benefits possible but likely small because carriers unlikely to have combinations units.	
	Tobacco Products	Between major cities			?	No implications	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Foodstuffs Perishable 8.4%	Meat and meat products	Major Canadian cities over the primary system.	$ 3.2 x 10^6	—	$ 3.2 x10^6	Implications a function of LTL traffic and availability of combination vehicles.	
	Fish and seafood	Northern Saskatchewan to Manitoba, Eastern Canada, U.S.A. 225 loads per year	$ 450,000	—	$ 450,000	Moving at 50,000 kgs versus 33,600 kgs could reduce costs by about 23%. Operating combination vehicles over northern roads may be a problem.	$ 100,000 90,000 litres
	Dairy products (non-bulk)	Major centers to retail outlets in smaller centers.			?		
	Bakery products	Major centers to smaller centers and between major centers.			?		
	Fresh and frozen fruit and vegetables	Ontario, B.C. and southern U.S.A. to Saskatchewan			?	Would allow combination units to operate over highays to U.S.A. and thus provide potential benefits.	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Dry Bulk Chemicals 13%	Fertilizer	600,000 tonnes/year move from Alberta to Saskatchewan. 90% or 540,000 tonnes are granular; 60,000 tonnes are liquid & anhydrous ammonia. 60-70% (350,000 tonne of the 540,000 tonne) moves by truck, the rest by rail.	$ 2.2 x 10^6	$ 7.8 x 10^6	$ 10 x 10^6	75% of the 350,000 tonnes moving by truck, or 260,000 tonnes moves at 33,600 kgs. Fertilizer moving to destinations located off the primary highway system could benefit by about 23% in cost and 20% in fuel consumption.	$ 1.8 x 10^6 1.6 x 10^6 litres of fuel
	Sulphur	Alberta oil and gas fields to Rabbit Lake	—	$ 2 x 10^6	$ 2 x 10^6	Possible benefits amounting to 23% on transport costs if combination vehicles can be used on northern roads	$ 460,000 414,000 litres of fuel
	Potash	Potash mines in Sask. to the U.S.A. and Manitoba	$ 1.5 x 10^6	$ 1.3 x 10^6	$ 2.8 x 10^6	Some benefits, exact magnitude unknown however small when compared to fertilizer and fuel	
	Cement	Cement plants to redi-mix plants and construction sites located throughout the province	$ 1.5 x 10^6	$ 1.3 x 10^6	$ 2.8 x 10^6	Benefits in the order of 23% would accrue to the 120,000 tonnes per year moved over the non-primary system	$ 300,000 270,000 litres of fuel
	Gypsum	—				—	
	Ores and Ore Concentrates	Uranium mines in northern Saskatchewan to Saskatoon and extra-provincially					
	Coal	—				—	
	Alum	—				—	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Dry Bulk Chemicals (continued)	Sand & Gravel	Urban fringe to urban area. Gravel pits to construction sites.				Could be substantial benefits on longer hauls.	
Bulk Liquids and Chemicals 4.2%	Acids and Caustic Soda	Alberta to locations in Saskatchewan. Saskatoon provincial & to U.S.A.			$ 1-2 x 10^6	Benefits from use of combination vehicles appear attainable. Subject to equipment availability.	$ 230,000 - 460,000 207,000 - 414,000 litres of fuel
	Alcohols	—				—	
	Lime	Exshaw, Alberta to			$ 2.5 x 10^6	Benefits from use of combination vehicles appear attainable if combination units can be used on northern roads	$ 580,000 522,000 litres of fuel
	Anhydrous Ammonia	Alberta to distribution centers to farms			$ 1.5 x 10^6	Benefits from use of combination vehicles appear attainable if combination unit can be used.	$ 350,000 315,000 litres of fuel
	Chlorine	Saskatoon Chemicals to P.A. Pulp				—	
	Paints and Solvents	Minor movements				Little or no benefit	
	Water	Minor movements				Combination vehicles unlikely to be used	
	Non-Petroleum Oils and Fats	Canola oil moves by rail				No benefits	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Bulk Liquids and Chemicals (continued)	Milk (bulk)	Farms to major centers				No benefits	
	Liquified Gas	From manufacturers to distribution centers and bulk customers. From distribution centers provincially.				Questionable as to whether products would move in combination vehicles.	
Petroleum Products 9.7%	Petroleum Crude	Wells to batteries & refineries moving on lease, municipal and provincial highways				Little or no benefit because unlikely to take advantage offered by combination vehicles.	
	Natural Gas and Propane	Moose Jaw - Provincially				Could potentially benefit however size of storage facilities at distribution centers likely a problem initially. Combination units unlikely to be used in distribution to customers.	
	Gasoline and Diesel Fuel	Saskatoon - Regina	$ 3 x 10^6	$ 17 x 10^6	$ 25 x 10^6	Combination vehicles would be permitted on the non-primary highway with 23% decrease in costs and 27% decrease in total fuel consumed.	$ 3.9 x 10^6/yr. 3.8 x 10^6/yr. litres of fuel
	Asphalt and Road Oils	Refineries to construction sites	$ 1.5 x 10^6	$ 4.4 x 10^6	$ 5.9 x 10^6	Combination vehicles would be permitted on the non-primary highway with 23% decrease in cost and 27% decrease in total fuel consumed	$ 1 x 10^6 900,000 litres of fuel

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Petroleum Products (continued)	Liquid Gas, Oxyacetylene, Plastic and Rubber	Between major centers and extra-provincial				Little or no apparent benefit	
Heavy Machinery 11.3%	Construction and maintenance equipment	To and from construction projects			?	Reduce number of permits	
	Oil industry equipment and machinery	Northeast, southeast and south regions of province				Reduce number of permits	
	Automobile and truck chassis	Provincially from major centers				No implication	
	Auto parts and accessories	Between major centers and from major centers to smaller centers				Little or no benefit	
	Industrial machinery	Major centers provincially				Reduce number of permits	
	Agricultural machinery and equipment	Major centers provincially				Reduce number of permits	
Metal Products 6.1%	Scrap metal	Origins all over Western Canada and North Central U.S.A.				Little or no benefit because of indivisable lengths of autos not condusive to use of combination vehicles	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Metal Products (continued)	Iron and Steel Products Steel Coils	Regina to Edmonton 240,000 tonnnes/yr.				None	
	Pipe	Regina to Alberta				None	
Forest Products 4.7%	Logs					—	
	Woodchips	Sawmills to Prince Albert				The use of combination units would permit reductions in transport costs of about 23% to accrue	$ 230,000 207,000 litres of fuel
	Firewood	Northern forested areas to urban areas				—	
	Planks and Boards	Northern forested areas to southern Saskatchewan and extra-provincially	?	$ 1-2 x 10^6		23% benefits for the lumber moving out of Saskatchewan's north	$ 230,000 - 460,000 207,000 - 414,000 litres of fuel
	Posts and Poles	Glaslyn and Prince Albert to south of province	$ .5-1 x 10^6	—	$.5-1 x 10^6	23% potential benefits for posts and poles moving out of Glaslyn	?
	Plywood and Aspenite	Hudson Bay to southern Sask.		$ 1-1.5 x 10^6	$1-1.5x10^6$	23% potential benfits for plywood and aspenite moving out of Hudson Bay	$ 230,000 - 345,000 207,000 - 310,000 litres of fuel
	Cardboard, Newsprint, etc.					—	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Livestock 2.9%	Cattle	Farms to stockyards. Stockyards to feed-lots and slaughter houses.				Benefits limited by operational constraints	
	Swine	Farm to assembly yard. Assembly yards to market. Currently movements from assembly yards to market occur at 33,600 kgs and 37,500 kgs	$ 400,000	$ 290,000	$ 690,000	The use of combination units appears feasible. Their use would result in 23% decrease in transport costs	$ 66,700 60,000 litres of fuel
	Poultry	—				—	
Construction Materials 5.9%	Bricks and Blocks	Bricks move from Estevan provincially. Blocks move in and around major centers.	$ 180,000	$ 120,000	$ 300,000	Long haul movement of bricks could potentially benefit. Blocks do not typically move long distances.	$ 27,600 25,000 litres of fuel
	Cement (bags)	—				Bagged cement could potentially move on combination units thus reducing transport costs by about 30%	?
	Sod and Trees	Fringe area to urban area				No implications	

TABLE 2
(continued)

GENERAL COMMODITY CLASS	SPECIFIC COMMODITIES	O - D PATTERNS	ESTIMATED ANNUAL $ VALUE OF MOVEMENT			IMPLICATIONS OF INCREASING ALLOWABLE GROSS ON NON-PRIMARY SYSTEM	
			PRIMARY	NON-PRIMARY	TOTAL	COMMENTS	EST. SAVING
Construction Materials (continued)	Roofing Products	Alberta to building supply outlets provincially and to construction sites				Asphalt shingles could potentially benefit by about 30%	
	Flooring	Manufacturers to major distributors				Little implication to LTL nature of shipments on non-primary highway system	
	Gypsum Products (drywall)	Drywall plants in Saskatoon provincially and extra-provincially	$ 1.5-3.0 x 10^5		$ 1.5-3.0x10^6	Little implication because most drywall moves to major centers	
	Insulation	—					
	Prefab Houses	—					
Grains 3.1%		Farms to elevators, inland terminals, rapeseed plants, feedlots, flour mills, etc.		$5-10x$10^6$	$5-10x$10^6$	Major benefits potentially amounting to between $1-2 million/year	$ 1-2 x 10^6 .9-1.8 x 10^6 litres of fuel
Trailers, Mobile Homes 1.4%						None	
Household Goods 3.3%						None	

summarized in Table 3. As can be noted from Table 3, the benefits are estimated to be in the order of $11 x 10^6 per year.

There are a number of issues that deserve comment at this time. First, the methodology used in identifying the magnitude of benefits related to the proposed changes in allowable gross vehicle weights might appear to be weak. Some credibility might be added to these estimates by developing independent estimates using other data.

Cost Savings

Early in the paper the cost savings associated with moving from a maximum allowable gross vehicle weight of 33,600 kg to that of 50,000 kg were estimated to be about 23%, based upon the fact that it costs about 15% more to operate at 50,000 kg relative to 33,600 kg, and that traffic that took three loads to be transported at 33,600 kg could be transported in two loads at 50,000 kg. These estimating procedures might appear a bit simplistic to some. Their general validity can be confirmed by operating data.

Based upon statistics provided by a major carrier who transported 15,092 loads at 33,600 kg and 4764 loads at 50,000 kg in 1980, it cost 5.02¢/tonne km at 33,600 kg and 3.73¢/tonne km at 50,000 kg for a reduction of 26% for that moved at 50,000 kg relative to that at 33,600 kg. It is of interest that our simplistic estimates compared 23% versus 26%; close enough for our purposes. While the

Table 3

Summary of Potential Major Benefits

Movement	% of Total Truck Trips	Magnitude of Benefits for Proposed Changes Non Primary System
General Freight	19.2%	Special cases
Dry Bulk Chemicals	13.56%	$ 2.6 x 10^6/year
Bulk Liquids and Chemicals	4.2%	$ 1.3 x 10^6/year
Petroleum Products	9.7%	$ 4.9 x 10^6/year
Forest Products	4.7%	$ 1.0 x 10^6/year
Grains	3.1%	$ 1.0 x 2.0 x 10^6 per year
TOTAL		$ 10.8 - $11.8 X 10^6/year

above lends some credibility to the percentage savings, the question of total dollar savings remains to be validated.

If trucks hauling petroleum products represent 9.7% of total truck traffic and it is possible to save 4.9×10^6 per year by moving to 50,000 kg on the secondary highway system, then if one assumes that all traffic handled by trucks could benefit similarly, the total potential benefits would be estimated at $4.9 \times 10^6 \div 9.7\% = 50.5 \times 10^6$ per year. This is obviously an "up-side" estimate in that not all traffic "grosses-out" nor is all traffic condusive to the use of combination vehicles.

Petroleum products, bulk liquids and chemicals, dry bulk chemicals, forest products and grains however could be expected to benefit from an increase in allowable gross vehicle weights. This traffic represents about 35% of the total truck traffic. Thus if only the above commodities were to move at 50,000 kg, the total potential benefits would be about 17.7×10^6 ($35\% \times 50.5 \times 10^6$). The fact that 11×10^6 per year were identified via the commodity to commodity analysis would suggest that the benefits have been estimated to the correct order of magnitude.

It would thus appear reasonable to conclude that an increase in the allowable gross vehicle weight on the secondary highway system from 33,600 kg to 50,000 kg would result in reducing the over-the-road costs of truck transportation in Saskatchewan by something in the order

of $11 x 10^6 per year. This represents a reduction of approximately 3% in total over-the-road truck transport costs.[5]

This might have been alternatively estimated by assuming that the 35% of the total truck traffic namely that involved in hauling petroleum products, bulk liquids and chemicals, dry bulk chemicals, forest products and grains could capitalize upon the proposed change in gross vehicle weight on the non-primary highway system. If this change resulted in operating cost reductions in an individual movement by 23% as previously estimated, then total operating costs would be expected to be reduced by 35% x 23% = 8%. Again, while these estimates developed by independent techniques are different, they do give an indication of the order of magnitude of the potential benefits.

It is of interest to compare the potential benefits from the proposed change to those resulting from the 1974 highway strengthening agreement. This comparison would help to put the proposed change into some perspective.

While it was impossible within the constraints on this effort to evaluate the benefits of the 1974 agreement, data available related to the response of those involved in the transportation of gasoline and diesel to the 1974 program give some indication of industry response.

Statistics available indicate that 61% of the total gasoline and diesel fuel in 1980 was delivered at a

maximum gross vehicle weight of 33,600 kgs, with 8% at 37,500 kgs, and 31% at 50,000 kgs. If the relative cost savings are assumed to be 12% and 60% for hauling at 37,500 kgs and 50,000 kgs relative to 33,600 kgs, then the total reduction on the cost of delivering gasoline and diesel fuel resulting from the 1974 agreement would have been about 19%.[6]. This compared with an estimated 20%[7] associated with the proposed change to the allowable gross vehicle weight on the secondary highway system. In short, for the movement of gasoline and diesel fuel, the proposed change to the secondary highway system would have implications comparable to those of the 1974 highway strengthening agreement.

In extending the above to the movement of other commodities, it becomes apparent that the proposed change to the allowable gross vehicle weight on the secondary highway system would have significantly greater implications to bulk liquids and chemicals, dry bulk chemicals, forest products and grains than did the 1974 highway strengthening agreement because a portion of most trips associated with these commodities is on the secondary highway system, and thus gross vehicle weights are restricted to 33,600 kg whereas under the proposed increase for the secondary highway system these commodities stand to reap significant benefits.

In short, the proposed changes to the allowable gross vehicle weights on the secondary highway system would appear to hold benefits for the movement of

commodities in excess of those attained from the 1974 highway strengthening agreement. Put another way, increasing the allowable gross vehicle weight on the secondary highway system to 50,000 kg will remove a constraint for a large portion of the total truck trips, with the result that major segments of the trucking industry will for the first time be able to take advantage of the increased gross vehicle weight permitted under the 1974 highway strengthening agreement.

Fuel Savings

Estimates of dollar savings in operating costs were developed above. Estimates of fuel savings are also of interest. These might be estimated in a number of ways. Probably the quickest way, given that we have already estimated dollar value savings, is to use the fact that fuel costs represent approximately 30% of operating costs. Thus for every $1 x 10^6 saved in operating costs, $300,000 or assuming a price of 33¢/litre, 900,000 litres of fuel would be saved. Thus total dollar savings of $11 x 10^6 for the proposed increases in allowable gross vehicle weight on the secondary highway system would translate into fuel savings of 9.9 x 10^6 litres per year. These represent savings of 3.4% relative to the total fuel consumed by over-the-road truck operatings in Saskatchewan.[8]

Conclusions

Increasing the allowable gross vehicle weight on the secondary highway system to 50,000 kgs and thus allowing combination vehicles to operate on these roads could be expected to result in annual savings in transportion in Saskatchewan in the order of $10 million. If allowable axle weights are not increased, these savings are attainable with little increase in costs in terms of roadway requirements.[9]

Footnotes

1. This paper is a summary of a report entitled: An Analysis of Industry's Perspective of Increasing Allowable Vehicle Weights on Provincial Highway prepared for the Saskatchewan Department of Highways and Transportation, April 1981.
2. Trucks operating at primary highway axle and gross vehicle weights are permitted to operate to or from origins and destinations located within 8 kms of the primary highway system.
3. This is based on average fuel consumptions of 46.08l/100 km and 50.89l/100 km for the vehicles operating at 33,600 kg (payload 20 tonnes) and 50,000 kg (payload 32 tonnes) respectively. These fuel consumption rates are applicable to fleet averages for one way loaded, return empty, and obtained from a major carrier with an exceptionally good management information system.

4. Western Canada Truck Origin-Destination Survey, 1978, Volume I and II, Transport Canada, TP 1711 and TP 1712.
5. 291.9 x 10^6 litres of clear diesel were used in Saskatchewan in 1980. The bulk (95%) of this being consumed by over-the-road truck transportation. If it is assumed that fuel cost 33 ¢/litre and fuel costs represent 30% of total over-the-road costs, then total over-the-road trucking costs would be equal to $321 x 10^6 per year. (291.9 x 10^6 litres x 33¢/litres = $96.33 x 10^6/year for fuel 30% = $321 x 10^6/year; $11 x 10^6 $321 x 10^6 = 3.4%).
6. 61% of traffic had no benefit, 8% had 12% (1%) and 31% had 60% (18%) for a total of 19%.
7. Total cost of gasoline and diesel deliveries $25 x 10^6/year. Estimated savings associated with the proposed change to the non-primary highway system equals $ 4.9 x 10^6 or 20%.
8. 9.9 x 10^6 291 x 10^6 = 3.4%.
9. Allowable gross vehicle weights were increased on Saskatchewan secondary highways to 49,000 kgs on March 1, 1983.

HIGHWAY COST RECOVERY AND INTERCITY TRUCKING

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ABSTRACT

Government expenditures and revenues for road transport, and the portion attributable to intercity trucking, are discussed. Estimates of public financial support are provided for the national road system and for Ontario's provincial highway system. Expenditures and revenues attributable to intercity trucking were estimated for Ontario provincial roads using results from U.S. studies, and for a section of highway 401 using an adjusted method that includes the effects of trucks on highway capacity utilization. Revenues from trucks are insufficient to cover attributed costs, though the portion of cost recovered is higher for highway 401 (where traffic density is higher than average) than for the provincial road system as a whole.

INTRODUCTION

Canadians are served by almost one million kilometres of roads, of which 300,000 kilometres are paved. The value of the existing paved road system, as measured by new construction costs (including planning and land

1 The views expressed are those of the author and not necessarily those of CIGGT or its sponsors.

acquisition) is on the order of $150 billion. The cost to reconstruct the existing system approaches $100 billion. These figures emphasize the substantial value of the existing highway system, the future public liability for support of that system, and the importance of maintenance and traffic control measures that will avoid excessive road deterioration.

In the United States, studies by both federal and state agencies indicate that highways and associated structures are deteriorating faster than they are being repaired and that revenues from highway users are failing to keep up with increasing costs for highway construction and maintenance. Heavy trucks are identified as a major source of highway costs, largely as a result of the effects of heavy axle loads on pavement deterioration. Competing modes of transport, in particular U.S. railways, have complained that non-compensatory user charges provide truck operators an unfair advantage.

A variety of issues arise from the above concerns. Table 1 provides examples in relation to highway finance and economics. Highway-related issues fall into the following broad categories:

(a) physical management of the highway system
(b) financial management of the highway system
(c) economic management of the transportation system.

In Canada, relatively less attention has been paid to the financial and economic aspects. The purpose of this paper is to contribute to discussion of these issues, focussing on two specific questions: the extent of public financial support for highway transport and the

TABLE 1: ILLUSTRATION OF HIGHWAY FINANCING ISSUES

General:

(1) To what extent, if any, should government be involved in the provision and/or upkeep of the highway system?

(2) In what way should government strike a balance between the provision of highways as a public service and the treatment of the highway system as a self-supporting enterprise?

(3) To what extent should highway user charges serve transportation and non-transportation objectives, including the balance between efficiency and equity considerations?

(4) How should revenues from highway users (fees, fuel taxes) be reconciled with inflating costs, by increasing user charges or reducing levels of service?

Cost Allocation and User Charge Design:

(5) Should the existing system be regarded as something that has already been paid for, and therefore free, or should user charges reflect an opportunity value of the system in place, even though no expenditures are made, say, for new right-of-way?

(6) Should the allocation of costs among vehicle classes reflect the historical rationale for construction of highways? For example, should the initial costs of a highway built originally for automobiles be assigned entirely to that vehicle class?

(7) Should costs be apportioned among vehicle classes solely according to costs variable with traffic, or including costs fixed with regard to traffic level?

Related:

(8) Should the national highway system continue to expand, stabilize at its present network, or become consolidated into a smaller and perhaps more cost-effective system?

(9) What investment pattern would emerge if both railways and trucking companies paid the full costs of their travel?

Source: Adapted from D.B. Lee, Methods for Allocating Highway Costs, U.S. Department of Transportation, April 1981.

portion of that support attributable to intercity trucking.[2]

PUBLIC SUPPORT FOR HIGHWAY TRANSPORT

In 1979, public expenditures on road construction and maintenance by all levels of government in Canada totalled $5.45 billion, distributed as follows:

federal government	$0.30 billion
provincial government	3.16 billion
local government	1.99 billion

The above figures include $210 million transferred from federal to provincial governments and $580 million transferred from provincial to local governments.

Government revenues from road motor vehicles were $3.34 billion, including:

federal excise taxes on fuel	$ 420.3 million
provincial fuel taxes	1,782.2 million
motor vehicle fees, licences, etc.	1,135.6 million

On the above basis, public support for highway transport was $2.11 billion. It is not clear, however, that this estimate fairly represents the true public liability for highway transport, for the following reasons.

(1) In most provinces, consumers contribute to general government revenues through sales taxes. Since sales tax is not added to tax already applied to motor fuels, it may be more reasonable to treat only that portion of fuel tax over and above the general sales tax as road-related revenue. This approach would

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2 This paper is based on research conducted at the Canadian Institute of Guided Ground Transport, and reported in P.M. Bunting, Highway Costs and Revenues Attributable to Intercity Trucking, CIGGT Reports 82-9 and 82-10 (Working Papers).

reduce road-related revenues by $620 million.[3]

(2) In 1979, the federal government spent $1.36 billion to maintain domestic oil prices below world levels -- a subsidy that most benefits petroleum-intensive uses. Since road users consume a large proportion of oil (45 per cent), it may be appropriate to treat the benefit to these users ($590 million) as a specific road transport subsidy.

(3) The expenditures shown include items not clearly related to road transport (e.g. sidewalks), but exclude a range of expenditures incurred in support of road transport (identified later in this paper).

(4) A single-year estimate of net cash outflow does not necessarily reflect longer-term public commitments to maintain or expand the road system.

These limitations are less important where the emphasis is on (financial) balancing of the immediate inflows and outflows of road-related funds. However, they are more important where judgments are to be made affecting the economic balance between competing modes of transport.

Estimates of road infrastructure costs and revenues are contained in a recent Transport Canada study.[4] Some road costs were deleted (e.g. portions attributed to property access) and other costs added (land, police and justice, cost of capital). Revenues were adjusted to match cost and revenue items (e.g. fines for highway infractions were included). No reduction was made in the

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3 The adjustment has been applied to total fuel sales. However, for commercial trucking fuel use, the cost of which appears in the price of consumer products which are usually subject to sales tax, it may be more appropriate to treat all fuel tax as road related.

4 Transport Canada, Strategic Planning, Transport Costs and Revenues in Canada, 1969-1979, Report TP3737E, July 1982.

provincial fuel tax for the general tax portion and, while the oil subsidy associated with transportation was estimated, it was not included with infrastructure costs. The cost analysis was displayed as annual expenditures (cash flow), annual costs using historical book value accounting, and inflation-adjusted costs. The resulting estimates of the difference between infrastructure costs and revenues for 1979 ranged from $1.99 billion (based on actual expenditures and revenues) to $4.35 billion (based on inflation-adjusted book-value costs).

Inflation-adjusted costs are more likely to indicate the future public liability for road transport. However, all three methods of cost analysis are based on historical expenditure patterns, which may not be continued into the future.

While the Transport Canada estimates represent an important step toward a consistent and useful comparison of modal cost recovery, it is not clear that all relevant costs of the road system have been included. For road transport (as distinct from roads alone), public costs include:

(1) Government costs (federal, provincial, municipal):

    (a) highway construction and maintenance expenditures *

    (b) costs incurred in support of, or related to, highway transport; for example:
        (i) police and justice *
        (ii) fire
        (iii) industry standards regulation *
        (iv) industry loan guarantees or direct subsidies

(v) foregone or deferred taxes arising from special incentives (e.g. accelerated depreciation)
(vi) other foregone taxes or revenues (e.g. property tax on right-of-way)
(vii) land acquisition *
(viii) research and development *
(ix) general government support (administration, capital funds, costs, etc.).

(c) costs affected by highway transport (e.g. health care expenditures affected by motor vehicle accidents, pollution, etc.) *

(2) Social costs of transport:

(a) congestion costs, such as increasing operating costs and delays

(b) environmental costs -- air and water pollution, noise, etc.

(c) accidents -- fatalities, non-fatal injuries, property damage, etc.

Costs for items in the above list denoted by an asterisk have been estimated for the Ontario provincial highway system. The results, shown in Table 2, include road expenditures incurred by the Ontario MTC and by other departments. Costs associated with the MTC include allocations for related departmental administration and research and development. Capital items (e.g. road construction) are expensed under this approach, and hence no provision has been made for depreciation or interest charges. However, an allowance has been included for interest on working capital.

The costs contained in Table 2 also include an allowance for deferred expenditures, based on MTC estimates of future highway funding requirements. These

TABLE 2: COSTS ATTRIBUTABLE TO THE ONTARIO PROVINCIAL HIGHWAY SYSTEM (1979/80)

Provincial Government Expenditures	
Ontario Ministry of Transportation and Communications:	
Provincial Roads Program	$449.4 million
Related MTC Costs	47.1
Other Road Outlays:	
Northern Roads	54.3
Resource Access	5.1
Police and Justice	104.0
Other Items	15.2
Imputed Interest on Working Capital	40.5
Allowances per year for Deferred Expenditures (Provincial Roads Program only)	89.9
Allocation of Deficit on Ontario Health Insurance Plan (accidents)	80.7
Total	$886.1 million

requirements are higher, in constant dollar terms, than funds expended in the late 1970's. Figure 1 shows road expenditures (construction and maintenance) for Ontario, where the real (constant dollar) value of highway funding has fallen, and for Alberta, where increases in funding have kept pace with, or exceeded, inflation.

Whether expenditures in Ontario reflect a maturing road system or deferral of needed improvements and repairs is not clear; to answer the question definitively would require analysis of the physical condition and capacity of the existing highway system. To the extent that U.S. experience is indicative of North American conditions, deferral is a significant factor. However, it has been argued[5] that Canadian roads are built to

5 For example, by the Ontario Trucking Association in "Ontario Trucking Group Urges Study Be Redone," Globe and Mail, March 21, 1983.

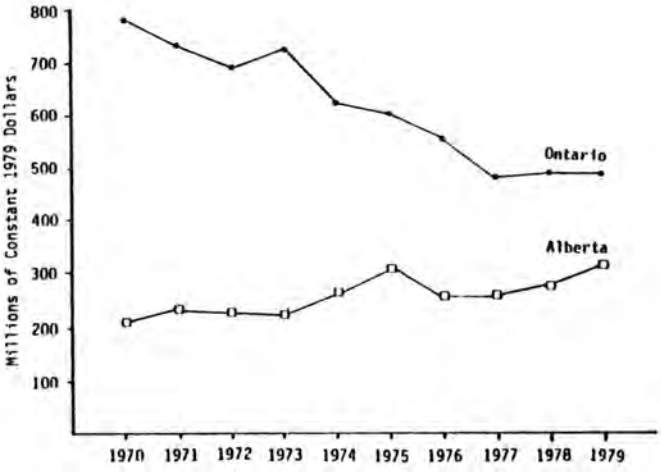


Figure 1 Ontario and Alberta Provincial Road Expenditures, 1970-1979, in Constant Dollars (excluding transfers to local government)

better standards than are U.S. roads and hence do not deteriorate as rapidly.

Provincial revenues from motor fuel taxes and fees for licensing and vehicle registration ($1,089 million in 1979/80) appear sufficient to cover the costs shown in Table 2. However, only a portion of the revenues ($370-451 million) is attributable to traffic on the provincial highway system. In Table 3, part of the revenues is treated as general sales tax and part as an allocation to traffic on roads under municipal jurisdiction. On this basis, the provincial highway system showed a deficit in 1979/80 of $435-516 million. This estimate does not include the federal subsidy to oil prices or federal contributions to provincial road construction; these items would increase the estimated deficit by approximately $35 million.

TABLE 3: ONTARIO PROVINCIAL HIGHWAY REVENUES (1979/80)

Gross Revenues:		
Road Fuel Taxes	$ 734.6 million(a)	
Fees, Licences, etc.	352.0 million(a)	$1,086.6 million(a)
Deduct:		
Foregone General Sales Taxes		$ 253.5 million(b)
Revenue Attributed to Local Authorities:		
Estimate 'A'		381.7 million(c)
or Estimate 'B'		462.8 million(d)
Net Revenue Attributable to Provincial Highways:		
Estimate 'A'		$ 451.4 million
Estimate 'B'		370.3 million

(a) Source: Statistics Canada, Catalog 68-207, 1979.
(b) Total road fuel sales (Statistics Canada, Catalog 53-218) at 24 cents per litre.
(c) Transfers to municipalities (Statistics Canada, Catalog 68-211).
(d) Fuel Tax Revenue attributed in proportion to urban fuel use (estimated as 63 per cent, based on 55 per cent of vehicle-miles in urban areas at 40 per cent higher fuel consumption rate per mile); no attribution of fee or licence revenue.

COSTS AND REVENUES ATTRIBUTABLE TO INTERCITY TRUCKING

The costs shown in Table 2 are taken as an approximation of intercity highway costs. In Ontario, expenditures under the provincial roads program are primarily for intercity highways. However, in a more rigorous analysis, adjustments would be desirable for local traffic that uses provincial highways and for intercity traffic that uses municipal roads.

The share of costs attributable to trucks has been based on the results of several recent U.S. studies, as summarized in Table 4. Although truck traffic is typically less than ten per cent of total vehicle miles,

these studies allocate from thirty to fifty per cent of highway costs to trucks. These cost allocations are higher than earlier estimates (e.g. the 1968 figures for Ontario shown in Table 4), reflecting a shift in expendi-

TABLE 4: COMPARISON OF COST ALLOCATIONS -- U.S. AND CANADIAN STUDIES

	Per Cent Allocated to Light Vehicles	Per Cent Allocated to Heavy Vehicles
Ontario, 1968(a) (urban and non-urban)	72.9	27.1
Oregon(b) Urban and Non-Urban Preservation Level of Expense (1981-82 estimates)	50.9	49.1
Washington(c) (1978-81 desirable budget; includes county, city costs)	71.4	28.6
1982 U.S. Highway Cost Study(d) (federal-aid system)		
. recommended approach:		
1977	64.0	36.0
1985	57.6	42.4
. updated incremental(e)		
1977	71.9	28.1
1985	70.4	29.6

(a) Derived from results in Haritos, Z., Rational Road Pricing Policies in Canada, Canadian Transport Commission, 1973.

(b) Oregon Department of Transportation, Motor Vehicle Cost Responsibility Study, 1980, Final Report, March 1981.

(c) D. Neuzil, "Allocating Highway Program Costs to Washington State Highway Users," in Price and Subsidy in Intercity Transportation and Issues of Benefits and Costs, Transportation Research Record 635, Transportation Research Board, Washington, D.C., 1972.

(d) U.S. Department of Transportation, Federal Highway Administration, Final Report on the Federal Highway Cost Allocation Study, May 1982.

(e) Similar to procedures used in earlier cost allocation studies.

tures toward highway maintenance, which is significantly affected by heavy axle loadings and increased truck traffic.

Provincial highway costs attributable to trucks are estimated at $326 million (fiscal year 1979/80), including 40 per cent of costs directly related to road construction and maintenance and 30 per cent of remaining costs. Revenues attributable to truck operations on provincial highways, including a motor fuel tax (net of general sales tax), carrier licence fees and vehicle registration fees, are estimated to be $91 million. Despite the approximate nature of the analysis, the deficit, $235 million, or about nine cents per truck-kilometre, is sufficiently large to justify further attention.

Highway cost allocation studies typically use an incremental analysis of pavements, by which the cost of a 'basic' roadway sufficient for small, lightweight vehicles (autos, pickups, etc.) is allocated to all users and the additional, incremental costs required to serve larger, heavier vehicles are allocated directly to those vehicles. The non-incremental or 'residual' costs are often allocated to road-user classes according to vehicle-miles.

If longer-term costs are of interest, it would be more reasonable to use highway capacity utilization as the basis for allocating residual costs. This would better reflect the role that capacity utilization plays in justifications for replacing highways (at existing or

changed structural standards), and for expansion or contraction of the road network. Table 5 shows estimates of highway capacity for two-lane and four-lane highways, and for low and high proportions of truck traffic. On highway 401 east of Toronto (rolling terrain), trucks

TABLE 5: HIGHWAY CAPACITY AND TRUCK TRAFFIC
(vehicles/hour)

	Average Highway Speed (AHS)			
	Two-Lane Highways(a)		Four-Lane Divided Highways(b)	
	80 km/h	100 km/h	100 km/h	120 km/h
Level of service(c)	'C'	'C'	'C'	'C'
Flat terrain:				
20 per cent trucks	541	768	1,588	2,300
1 per cent trucks	693	985	1,887	2,733
Truck share of capacity(d)	38%	38%	33%	33%
Rolling terrain:				
20 per cent trucks	392	557	1,191	1,725
1 per cent trucks	676	961	1,850	2,680
Truck share of capacity(d)	54%	54%	49%	49%

(a) Passing sight distance (PSD), 40 per cent; 3.5 m lanes; 2 m shoulders.
(b) Peak-hour factor, 83; 3.5 m lanes; 2 m shoulders.
(c) Two-lane highways, C = 65-69 km/h (80 AHS); 65-79 km/h (100 AHS); four-lane highways, C = 75-90 km/h (100 AHS); 75-90 km/h (120 AHS).
(d) Proportion of capacity at one per cent trucks unavailable for non-truck traffic when truck traffic is 20 per cent of total volume (= 1 - (capacity at 20%)(0.8)/capacity at 1%).

Source: Service Volumes for Two-Lane Highway and Four-Lane Divided Highways, Ontario Ministry of Transportation and Communications

account for roughly 20-30 per cent of total traffic. At full utilization, at which point capacity must be increased or level of service decreased, at least half of the 401's capacity would be absorbed by truck traffic.[6]

This 'capacity-share' approach to residual cost allocation has been applied to an analysis of 1980/81 costs for highway 401 between Toronto and the Ontario/Quebec border. Costs included were the same as those represented in the analysis of provincial highway costs, but allocations were developed in more detail and adjustments were made to the incremental analysis to reflect the above-average truck traffic density. Costs attributed to trucks amounted to about $30 million (58 per cent of total costs), while revenues were estimated at $18 million. Although the method used allocates a larger proportion of cost to trucks than would be the case if system-average allocations were used, the resulting deficit per truck-kilometre (two cents) is lower than the provincial highway average. The lower deficit arises from lower costs per truck-kilometre, which most likely reflect economies of scale in highway construction and maintenance.

Although the costs for highway 401 include an allowance for deferred expenditures, the analysis does not clearly reflect future costs. To illustrate, existing expenditures for construction and major repairs (includ-

6 The capacities shown in Table 5 are based on methods appearing in the Highway Capacity Manual. These methods have been questioned on the grounds that actual traffic often exceeds estimated capacity. It is not clear whether different methods of capacity estimation would increase or decrease the truck share.

ing deferral) were replaced by an estimate of equivalent annual 'life cycle' costs, assuming reconstruction of highway 401, with service life of twenty years, and intermediate resurfacing after seven and fourteen years. Highway costs increased significantly (from $51 million to $84 million) and the proportion allocated to trucks also increased (to 69 per cent), because a much larger portion of costs was identified with pavement deterioration. (The resulting deficit per truck-kilometre increased to eight cents.) In part, the rise in cost is due to the inclusion of the cost of invested capital, a factor that was not represented in analysis of historical expenditures.

Whether highway 401 will in future require reconstruction is not clear without specific information on its current and projected physical condition. However, the life-cycle estimate does point to an important limitation of cost analyses based on historical expenditures.

DISCUSSION

The preceding analysis implies that national estimates of road system deficits -- on the order of $2-4 billion per year -- may understate the true public liability for road transport because not all related public costs are included and historical expenditures may understate future public liability for road replacement and upkeep. Several questions might be raised,

including:

(1) Can the public afford the future costs of maintaining the present road system?

(2) Who should pay for road costs?

(3) Does the road subsidy have an undesirable effect on economic performance?

The answer to the first question is probably inescapable. If Canada does not keep up its road system, at least for the foreseeable future, a vital transport link will be lost at great cost to Canadian economic and social life. If other modes develop their capabilities, and if attitudes to personal mobility change, some contraction of the Canadian road network may be possible. However, this kind of evolution is unlikely to have a major effect on road expenditures over the next twenty years. Moreover, it is unclear whether a less-extensive or lower-quality road system is in the national interest. A high-quality road system may well be a necessary condition to the development of a 'high technology' future for Canada.

The answer to the second question is much less clear. Some regard transportation facilities as public goods that should be owned and/or paid for by government, and made available to the public either free or according to ability to pay. I do not intend to engage in theoretical debate on this point, except to suggest that the long-term behaviour of transportation infrastructure costs seems to have little to do with the economist's notion of a pure public good. A more compelling argument is that too broad an application of universal accessibi-

lity philosophies to economic activity -- of which transportation is a large part -- could pose a serious threat to Canada's fiscal security.

The analysis appearing in this paper presupposes a 'private enterprise' standard or benchmark in the pricing of transportation facilities, including the constraint that the total of revenues from all users should cover total associated costs and a 'reasonable' return on investment. This does not mean that government should not engage in financial support of transport activity or in price regulation. It does mean that government intervention is seen as a deviation from a standard (not as a given condition) and is justified against specific social or economic objectives.

Highways have evolved as a general responsibility of government, with expenditures not necessarily tied to any specific obligations of road users to pay for roads or to provide unprofitable services. The justification of expenditures is usually based on technical statements of need. User charges and taxes are established independently, essentially with some attention to their political acceptability. This disconnection between highway expenditures and revenues has not been helped by government accounting procedures which pass some, but not all, expenditures through specific highway accounts, and pass most of related revenues through general accounts.

The absence of a 'highway enterprise' view of highway cost recovery is undoubtedly part of the reason that revenues from Canadian road users during the last decade

have fallen behind highway expenditures. Moreover, given historical arrangements and institutional priorities, there has been little incentive to 'design' road user charges to match either cost responsibility or value of service from specific types of users.

The third question, the effect on economic efficiency of government support of highway transport, includes four related effects:

(1) At a time when overall government deficits are large and growing, deficits on highways increase the pressure for fiscal restraint. This decreases government's ability to respond to economic threats (unemployment) and opportunities (research and development).

(2) Subsidies to highway transport (indeed to any form of economic activity) can lead to oversupply of highway service (public and private) compared to less subsidized or unsubsidized goods and services.

(3) Subsidies to specific highway users, if not matched by subsidies to competing modes of comparable amount and application, can lead to (economically) inefficient use of the modes concerned.

(4) General highway subsidies remove the incentive to road users to minimize <u>total transport</u> costs. Thus, subject to regulatory constraints, users will select vehicles to minimize vehicle operating costs and/or maximize service, without regard to the effects on highway costs. Generally, the result is higher total costs than necessary, with the extra absorbed by government.

Given the extent of the road subsidy, its potential for unbalancing modal shares of traffic, and the possible contribution to general inflation, a thorough review is needed of federal, provincial and municipal expenditures and commitments related to highway transport.

Such a review should include expanded coverage of highway transport expenditures and revenues, consolidation of available information on highway condition and traffic characteristics, and improvements in methods for allocation of costs to road users, making use of available engineering information concerning vehicle/road interactions and highway capacity. At the same time, further progress is needed in defining and examining key highway financing issues and the economic environment in which they arise, in order to establish the context within which highway investment and cost recovery decisions will be made.