

ECONOMICS AND FINANCING OF HIGHWAY  
TRANSPORTATION IN CANADA

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## TABLE OF CONTENTS

	Page
LIST OF FIGURES	v
LIST OF TABLES	vi
ABSTRACT	vii
ACKNOWLEDGEMENTS	viii
1. INTRODUCTION	1
2. HISTORIC AND LEGAL BACKGROUND	3
2.1 Transportation Policies	4
2.2 Truck Regulations	8
2.3 Public Subsidy to Transportation	9
2.4 Equitability	11
2.5 Highway Design Philosophy	11
2.6 Design Standards	12
3. HIGHWAY ECONOMICS	14
3.1 General	14
3.2 Supply and Demand	14
3.3 Competition between Road and Rail Transportation	16
4. HIGHWAY FINANCE	26
4.1 Revenues and Expenditures in General	26
4.2 Revenues from Road User Taxes	28
4.3 Various Road User Taxes	30
4.4 Fixed and Variable Road User Taxes	32

	Page
4.5 Highway Costs	33
4.6 Investment Rate	35
5. TOLL HIGHWAYS	38
5.1 Toll Facility Concepts	38
6. HIGHWAY TAX ASSIGNMENT	43
6.1 Major Interest Groups Responsibility	43
6.2 Vehicle Class Responsibility	46
6.3 Proposal for Assigning Highway Costs	48
7. CLASSIFICATION OF HIGHWAYS	51
7.1 Objectives of Classification	51
7.2 A classification Procedure	52
7.3 Administration of the Various Systems	54
8. PLANNING FOR HIGHWAYS	58
8.1 The Short Term Plan	58
8.2 The Long Term Plan	59
8.3 The Planning Methods	60
9. RECENT AND FUTURE DEVELOPMENTS	65
9.1 The Environmental Aspects	65
9.2 The Urban Problem	67
9.3 An Autoless Core	69
9.4 Future Intercity Highways	71
10. CONCLUSIONS	74
REFERENCES	78

## LIST OF FIGURES

FIGURE		Page
1.	SUPPLY AND DEMAND	17
2.	RELATIVE AVERAGE TOTAL COSTS FOR TRUCKS AND RAILWAYS	21
3.	WEIGHT EFFECT ON COSTS FOR TRUCKS AND RAILWAYS	23
4.	COSTS RELATED TO SPEED	25

## LIST OF TABLES

TABLE NO.		Page
1	HIGHWAY ROAD MILEAGE BY TYPE IN CANADA	5
2	MOTOR VEHICLE REGISTRATION BY TYPE	6
3	DISTRIBUTION OF HIGHWAY EXPENDITURES	27
4	REVENUES FROM THE REGISTRATION AND OPERATION OF MOTOR VEHICLES	29
5	CONSTRUCTION, MAINTENANCE, AND ADMINISTRATION EXPENDITURES ON HIGHWAYS	36
6	ADVANTAGES OF TOLL ROADS	41
7	DISADVANTAGES OF TOLL ROADS	42
8	USERS AND TAXATION OF THE VARIOUS HIGHWAY SYSTEMS	55
9	PLANNING STUDIES	61
10	STUDY PURPOSES	62

## ABSTRACT

The purpose of the study was to gain an understanding of an important governmental function which aims at providing high quality ground transportation facilities. This service not only allows for the development of different areas of the country but constitutes a vast communication system.

The first step of the study was to trace the historical progress of transportation in Canada by making reference to various legislations and regulations. The economic allocation of resources for the maintenance, improvements, and expansions to the highway network was related to the means of raising the necessary revenues through various taxes and fees.

Essential elements of highway classification and planning were discussed. An insight into some of the future proposed transportation developments was provided.

Conclusions with respect to transportation policy, finances of highways, and research and development were formulated.

## ACKNOWLEDGEMENTS

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## INTRODUCTION

The Canadian way of life has been greatly influenced by the invention of the internal combustion engine which was adapted to private and public means of transportation. Car ownership fastly became an essential part of private life and commercial transportation by means of buses and trucks provided flexibility and accessibility.

Of course, the flexibility of motor transportation is greatly dependent on the availability of highways which require some allocation of the country's limited resources. This calls for sound governmental decision making and planning with regards to priorities, location, design standards, and operation of a complex net of highways throughout the nation. The way in which the national resources are allocated can be analyzed by studying how various projects are financed. Considering highway projects, it is logical to assign the costs among the consumers of the service by means of taxation schemes such as registration fees, motor fuel, motor carrier, and other forms of taxes. Many taxation principles must be considered such as benefit received, ability to pay, in order to distribute equitably the costs among the citizens.

Transportation in its broader sense has greatly



contributed to the development of Canada. The interior and western areas showed rapid economic development after the construction of railroads and canal systems. More generally speaking, it can be said that transportation most significantly affects industrial and commercial development by permitting specialization of production, i.e. enabling different regions to specialize in the production of goods and services for which they are most economically suited. Low cost transportation therefore allows for large scale production based on local natural and geographical resources which in turn implies that goods are produced at minimum cost for greater social welfare of the nation.

Motor vehicle transportation not only supplements air carriers, railroads, water carriers, pipelines through local delivery, but by virtue of the speed, flexibility, convenience, and size of the operating units, provides economical transportation for shipping relatively long distances cargoes which would otherwise be less than carloads for the railways. Of course, highway transportation is only part of the overall transportation system and the consideration of developing the nation's roads and streets should be envisaged with a thorough study of all trends, influences, problems, relationships, and requirements of the entire transportation industry.

## HISTORIC AND LEGAL BACKGROUND

Motor vehicle, after a slow start, has become a substantial competitor in the commercial transportation industry of the nation. In the second half of the nineteenth century, railroad services expanded rapidly and roads were relegated to the minor role of providing feeder service to rail terminals. However, the trend changed when the first motor car made its appearance in 1893 to increase in number to 220 cars ten years later. Registration increased further from approximately 10,000 in 1910 to over 400,000 in 1920.

By 1930, over 1,200,000 vehicles were registered in the nation and the road inventory was as follows: approximately 4,000 miles of paved highways and over 80,000 miles of surfaced highways in a rural system exceeding 390,000 miles. Highway construction was greatly retarded by the depression of the 1930's and the Federal Government came in the picture in 1931 by undertaking the construction of the Trans-Canada Highway primarily for the purpose of alleviating unemployment. Highway construction was virtually halted once again by the outbreak of World War II. Under the Trans-Canada Highway Act of 1949 the Federal Government agreed to pay one-half of the total cost of the construction of a designated highway stretching across

the breath of the nation and through each province.

Despite enormously increased postwar expenditures, it has hardly been possible to overcome accumulated deficiencies and provide a highway system adequate for the accelerated registration and increased motor vehicle use during the past twenty years.

A more recent picture may be obtained by comparing the figures of Table No. 1 and Table No. 2.<sup>1</sup> For the period 1965-1969, it is interesting to note that an increase of nearly 24 percent of motor vehicle registrations was accompanied by an increase of only 15 percent in highway mileage. This of course is an indication of greater traffic volumes on existing highways with the related problems of congestion and accidents.

## 2.1 Transportation Policies

If the economic aim of the nation is to obtain a high degree of satisfaction from available resources, traffic should not be diverted away from the economical carrier by subsidizing its competitor. This calls for prudent governmental regulations.

The powers of jurisdiction over transportation in Canada were originally defined in the British North American Act of 1867. Section 92 of this Act states: "In each Province the Legislature may exclusively make laws in relation to ... Local Works and Undertakings other than such as are of the following classes:

TABLE NO. 1  
HIGHWAY ROAD MILEAGE BY TYPE IN CANADA

Year	1965 Miles	1966 Miles	1967 Miles	1968 Miles	1969 Miles
Paved	71,791	66,901	66,346	72,507	109,234
Gravel	250,489	254,388	261,942	267,273	286,864
Earth	126,098	123,553	121,273	136,823	122,089
Total	448,378	444,742	449,561	476,603	518,187

TABLE NO. 2

MOTOR VEHICLE REGISTRATION BY TYPE

Year	Passenger Cars	Commercial Vehicles	Buses	Motor-Cycles	Total
1965	5,279,373	1,319,198	26,240	73,967	6,698,778
1966	5,480,724	1,413,929	32,674	107,934	7,035,261
1967	5,876,691	1,457,152	35,710	125,650	7,495,203
1968	6,159,573	1,548,603	38,614	140,287	7,887,077
1969	6,433,283	1,642,760	39,755	138,362	8,254,160
1970	6,602,196	1,694,865	41,118	157,402	8,495,581

- (a) Lines of Steam or other Ships, Railways, Canals, Telegraphs, and other Works and Undertakings connecting the Province with any other or others of the Provinces, or extending beyond the limits of the Province.
- (b) Lines of Steam Ships between the Province and any British or Foreign Country.
- (c) Such Works, as, although wholly situated within the Province, are before or after their Execution declared by the Parliament of Canada to be for the general advantage of Canada as for the advantage of two or more of the Provinces."

Under the provisions of this section the Federal Government has assumed control over the Railways, Waterways and later Airlines and Pipelines. The development of roads and streets has been, and continues to be, the sole responsibility of the individual Provinces and Municipalities concerned which have to coordinate, control, and plan a complex highway system composed of a great number of parts.

The jurisdiction over the interprovincial and international highway transportation was elucidated when Parliament passed "The Motor Vehicle Transport Act" in June, 1954, thus delegating to all Provinces, at their option, the authority to apply to interprovincial and international highway transport the same regulations respecting certificates of public convenience and necessity, and rates as they apply to undertakings operating

entirely within the Province.<sup>2</sup>

## 2.2 Truck Regulations

The regulation of the Motor Trucking Industry is a provincial concern. Provincial regulations may be divided into three general categories: (1) Safety: vehicle design, equipment requirements, operator licencing, and traffic rules; (2) Highway use: vehicle size and weight regulations; (3) Economics: relating to the rates and service regulations of different carriers.

Interprovincial and international differences in size and weight regulations undoubtedly have economic effects since they may represent barriers to motor carrier traffic. Most provinces require proof of "Public Convenience and Necessity" when applying for operating licences. The reason for this requirement appears clearly when one studies the transportation industry. In providing rail, water, pipeline, or air transportation service, the minimum capital investment is generally so large in relation to the potential volume of traffic and anticipated revenues, that entrance into the industry, and hence competition, is effectively discouraged. Here, regulation may be necessary to prevent price discrimination or unreliable, unsafe, or inadequate service.

In the trucking sector, a relatively low capital investment is required to provide a service, this is why provinces have restricted entry into the industry by requiring proof of public convenience and necessity. Professor A.W. Currie of

the University of Toronto has summarized the benefits of such a requirement:

Certification forestalls wild cutting and ensures a reasonably high standard of service along the route concerned. Prior to regulation new truckers entered the business at will, slashed tolls to get freight, paid inadequate wages, worked themselves and their men inordinately long hours, and maintained their trucks, so badly that they endangered other highway users. Some truckers gave service only when they felt like it, took only the business that paid them best, and could not make good in case of accident, or loss or damage of property.<sup>3</sup>

Such regulation is advocated and supported by the organized trucking industry. It must however be kept in mind that undue restrictions to the entry might limit competition and prevent the economic allocation of resources by permitting price discriminations and too high rates. Rates must reflect all economic costs involved in the operations. Effective rate and entry regulations must therefore prevent both the monopolistic situation as well as the unsafe, too competitive, free-entry situation.

The coordination and integration of transportation services should be promoted. All carriers should be given uniform, equal, and impartial consideration. The regulation and supervision of the motor trucking industry being a provincial responsibility, it is a handicap in the formulation of a national policy.

### 2.3. Public Subsidy to Transportation

#### 2.3.1 Water transportation

The provision and improvements to waterways, canals, harbors, navigational aids, have been made at Government



expense. These grants constitute a substantial subsidization of both inland and ocean water transportation.

### 2.3.2 Railway transportation

Substantial loans were given to various railways by the Federal Government; all levels of Government aided the railways in obtaining funds by guaranteeing their bond issues. Many Municipalities granted permanent tax concessions on railroad property as an inducement to pass through their centres. The first grants for the development of Canadian railways were awarded for the construction of the Grand Trunk Railway in 1856. These various type of subsidies accelerated railway construction and favored the development of remote areas thus allowing for unity and economic growth of Canada.

### 2.3.3 Highway transportation

It cannot be said that direct public aid per se has been given to highway motor transportation. However, highways are constructed and maintained by the Provinces, of course some revenues are obtained from operation taxes, licence fees, and motor fuel taxes, but if these revenues are insufficient to pay for the facilities, funds must be obtained from the other governmental financial sources which is in fact a subsidy.

### 2.3.4 Air transportation

Various forms of public aid are applied to air transportation. Some are grants to airplane clubs; the provision of navigational aids, airports, and various services

to commercial air transportation

### 2.3.5 Pipeline transportation

It appears that private funds have financed the construction and maintenance of oil and natural gas pipelines in Canada.

### 2.4 Equitability

It is evident that various transportation modes are in competition with regards to getting the "clientèle" of both passengers and freight. Any kind of governmental subsidy must be evaluated with this competition situation in mind in order to permit the allocation of resources in the most economical way.

Highway transportation must therefore be considered as a part of a greater overall transportation system. Roads and streets being a service must be estimated and these costs assigned to the users in an equitable way so that truck and bus transportation do carry their fair share of the expenditures. The development and expansion of the truck and bus industry must be allowed in those areas where economically they are the most suitable carriers.

### 2.5 Highway Design Philosophy

Demands of consumers for the highway system must be evaluated for in advance so that the determination of optimum geometric design standards is possible and in line with speed, safety, comfort, and the ability of the road users to provide funds for the increasing costs of superior facilities.

An important trend in usage of higher performance vehicles can be traced. The average vehicle speeds keep on increasing, the size and weight of vehicles have also increased which creates demand for greater structural strength and better geometric design standards of the road and street system. It must be remembered that the design life of a highway is much longer than that of the vehicle using it and therefore the vehicular qualities are improved much more often than those of the highways provided. It appears therefore essential, that formal planning and research be instituted to allow joint progress between the highway and automotive engineers. In turn, the regulations of size, weight, speed, equipment, and safety must be both flexible and adequate to permit the realization of all economic potentials of vehicles by not hindering technical development.

## 2.6 Design Standards

Considering the structural capacity of highways, the trend toward the increasing use of heavier trucks as a means of improving the efficiency of commercial motor transportation has called for substantial additional expenditures for highway pavements. An economic trade-off must be obtained between limitations on vehicle weight and pavement structural quality.

With regards to geometric standards, most two lane primary highways have the following characteristics: 22-24 foot pavements, 8-10 foot shoulders, 600 foot non-passing

sight distance, grades of 3 to 6 percent, and curvatures of 3 to 6 degrees. It is to be noticed however that satisfaction of these basic standards is not the only requirement to judge a highway with respect to safety. Other considerations such as uncontrolled intersections, soft shoulders, bridges, contribute greatly to the degree of safety of a highway.

## HIGHWAY ECONOMICS

3.1 General

In a market economy such as ours, different transportation agencies compete for the business. Highway investment indirectly promoted the development of the commercial motor transportation industry. It must also be remembered that the other major land carriers - the railways are also subsidized in other forms by various governments.

In general, the allocation of freight and passenger traffic among these competing carriers is mainly determined by the rates established by each, other considerations being service, flexibility, and dependability. In order to maximize returns, the most economical allocation of traffic among these carriers is essential, therefore the rates must reflect all costs involved in providing the service.

Highway expenditures are caused by both the number and the size and weight of commercial motor vehicles. Therefore, the road and street costs occasioned by the various commercial vehicles should be allocated to each so that these costs may affect their rates.

3.2 Supply and Demand

In our economic system, prices represent the

equilibrium condition between supply and demand. Assuming purely competitive conditions, i.e. profits being negligible, prices will reflect costs. Since we are dealing here with governmental undertakings, we can state that the various highway administrative bodies are non-profit organizations.

Therefore, each consumer of the highway service should be charged a price equal to the cost of the service provided. Being faced with this price, the consumer will demand a certain amount of service. The collective demands of all users, which may be translated into the funds collected through various taxes, will determine the investment to be made in the highway system.

It appears that the expenditures on the transportation system are drawn from the limited available national resources. Therefore highway expenditures are competing for the resources of the nation with other individual or collective expenditures such as welfare, medical insurance, housing, education, etc. Thus, charging road users, according to the costs occasioned, will be the determining factor in establishing an economic limit on the total resources of the nation to be devoted to the provision of roads and streets.

Let us reconsider in more detail the case of supply and demand. The supply of highway service is determined by the condition and design capacity of the system which of course is a function of the expenditures made for the maintenance and improvement of such system. In the same

way that traffic volumes are function of geometric design standards and traffic aid facilities (traffic signs, signals, pavement markings, etc.), the allowable vehicle weights are function of structural strength i.e. pavement and subgrade quality and thickness. It can be inferred that the greater the amount of vehicle-miles travelled in a certain amount of time, the greater the cost for the provision of the highways.

We can represent this situation graphically as shown in Figure 1, Curve S represents the supply function and Curve D represents the demand function. At the point of intersection of the two curves, i.e. the equilibrium position, the price is Y cents per vehicle-mile and the total vehicle-miles that can be safely accommodated by the highway system is X vehicle-miles per time period. It can be noted that Curve D has a very steep slope which means that demand is almost unaltered on account of the fact that private car owners are not affected to a great degree by changes in the costs per vehicle-mile, i.e. the demand is relatively constant. For example, increases in registration fees or fuel tax will have practically no effect on the amount of travel.

### 3.3. Competition between Road and Rail Transportation

#### 3.3.1 The advantages of trucks

The first Canadian railways faced competition from coachmen and also from inland water carriers. Later on, trucks started to take away some of the business formerly engaged in by the railways. In the 1940's the expansion

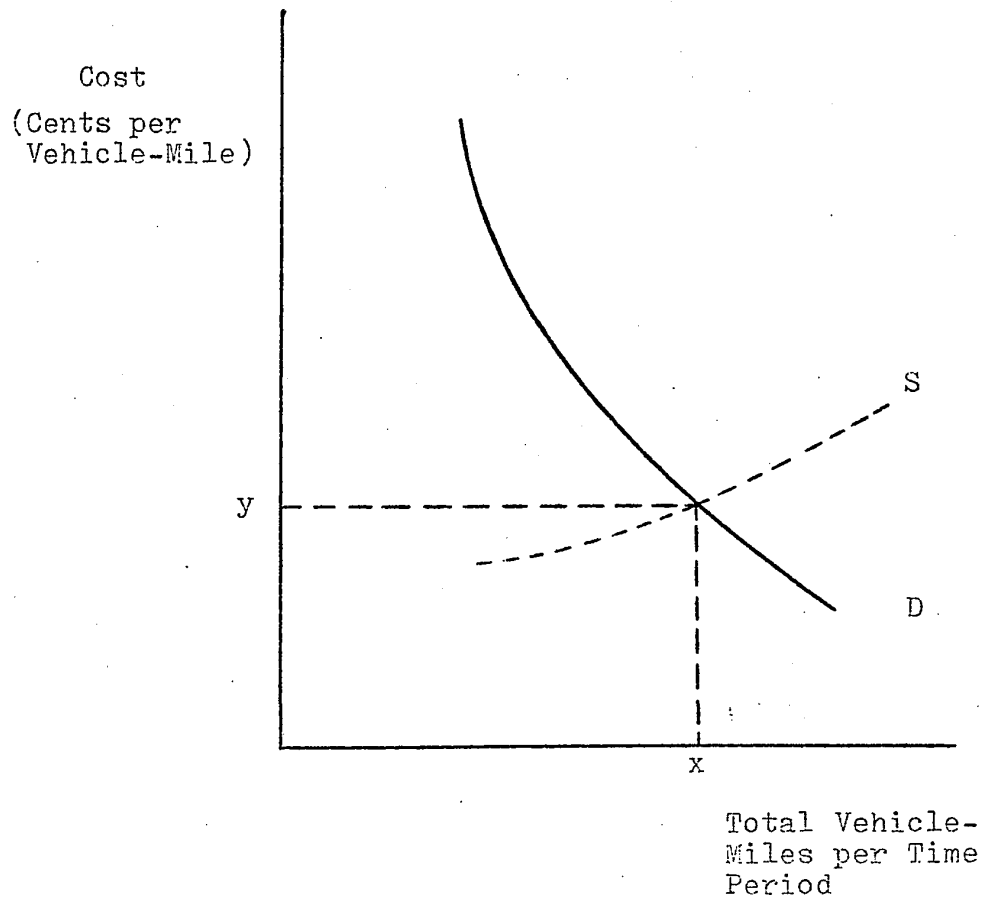


FIG. 1 - SUPPLY AND DEMAND



of the trucking industry was retarded by wartime restrictions and postwar shortages. By 1950, the highway carriers started to become more significant competitors. The competition between railways and motor carriers had three main effects: reduction of rail rates, decrease of demand for rail transportation, and indication of the service qualities required. The competition therefore is no longer strictly on a rate basis but also on the kind of service offered.

The primary cause of the growth of the trucking industry is of course technological. The short life of highway equipment allows to scrap obsolete models and use strictly the latest and best equipment. Railway equipment, on the other hand, lasts much longer and therefore the rate at which improved facilities are put into usage is much smaller than in the case of the trucking industry.

Trucks also have the advantage of being able to provide a door-to-door service.<sup>4</sup> In this regard, railways are much less flexible and extra costs are incurred by the transferring of freight between trucks, railway warehouses, and freight cars at both origin and destination. Normally, for short distances, trucks avoid these extra expenses of handling.

With the door-to-door service, the users of the trucking service do not need to haul freight to and from the carrier's freight shed. Therefore, goods being transferred fewer times between vehicles and warehouses have less chance of being damaged, with the other advantages of

time and handling savings.

The truck being a self-contained and small unit of transportation, it is possible to give more frequent service and at times more convenient to the purchaser of the trucking service. The trucks also offer a more personalized service.

### 3.3.2 Relative rates by trucks and railways

On a small sized shipment for short distances, trucks will certainly have lower costs than railways, while the reverse situation will hold for bulky goods that are transported over long distances.

Experts of the Royal Commission on Canada's Economic Prospects (the Gordon Commission) have estimated that for intercity traffic in 1954 costs per vehicle-mile were 50 cents for trucks up to 2.5 tons capacity, 36 cents for trucks between 10 and 15 tons, and 41 cents for trucks over 15 tons. They also arrived at the cost to move one ton of freight for one mile, trucks had a cost of 5 or 6 cents while rail had one of 1.5 cents.<sup>5</sup> It is to be noted here that the figures were arrived at using an averaging process and therefore comparisons are difficult to establish since costs by rail or truck vary to a great extent depending on length of haul, size, and weight of load. Another influencing factor comes into effect when a truck carries a load in one direction, the rates are normally cut on the return trip in order to attract business.

It can be stated that the transportation costs will

be influenced by three components: distance, weight (including density), and speed. Let us consider these factors as they affect the truck and railway rates.

A) The distance factor

Due to the low friction resistance of steel wheels on steel rails, the power required to pull a train does not increase significantly as the load of the train increases. Therefore as the load and the distance increase the rail costs in cents per ton-mile decrease sharply. The friction resistance of rubber tires to concrete increases the power requirements in proportion to distance, however the terminal expenses are much less than for railways. The relative average total costs (ATC) for trucks and railways may be represented by Figure 2.<sup>6</sup> The segment OX in Figure 2 represents the point where railways become more economical than trucks. Of course, it is difficult to state that for distance up to a given number of miles, trucks are more economical. OX must be divided by the load weight in order to arrive at the actual miles. A United States Senate Committee on Small Business has stated:

In different situations there may be a considerable variation in the distance beyond which the railroads will be found to be the low-cost carriers. In southern territory in 1950 rail carriers were found to be the low-cost carriers for distances in excess of 50 miles; in Illinois territory and Western truckline territory, rail carriers were found in 1951 and 1953 to be the low-cost carriers for distances in excess of 75 miles.<sup>7</sup>

Due to technological advances in the trucking equipment and improved highway designs, the distances where trucks are the economical carriers have surely increased in

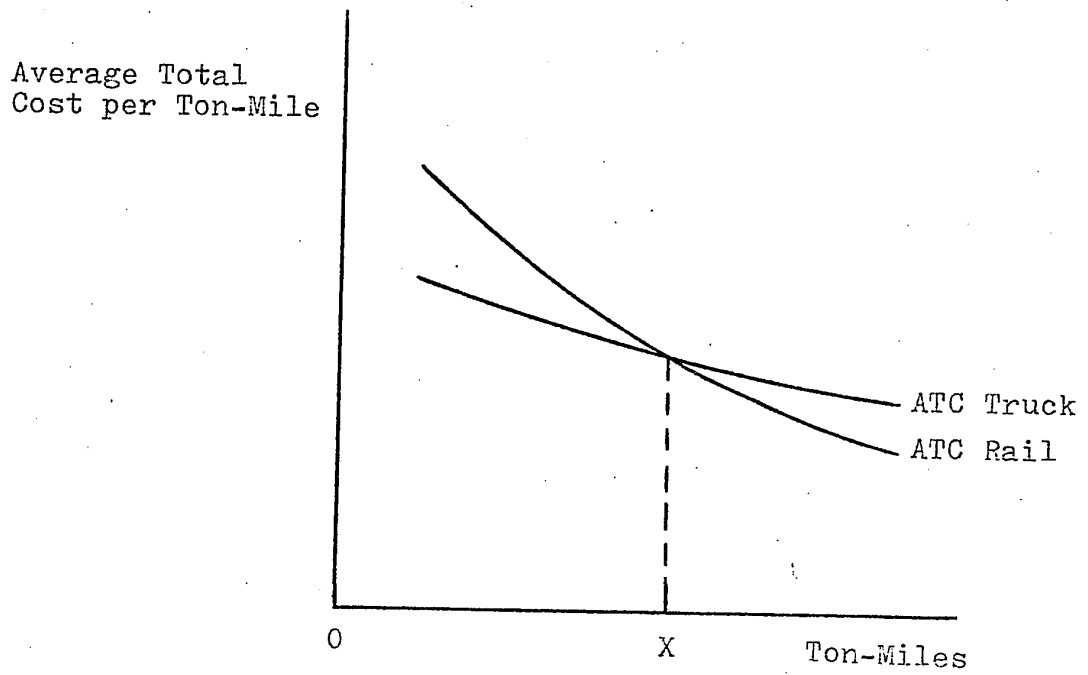


FIG. 2 - RELATIVE AVERAGE TOTAL COSTS FOR TRUCKS AND RAILWAYS

recent years.

B) The weight and density factors

Obviously, the costs of transportation per ton-mile vary inversely with density up to the weight capacity of the truck or railcar.

We can note the same general behavior of costs with respect to density for both railways and trucks. The extent of such decreasing costs, however, is much greater for railways than for trucks. The main factor explaining this situation is that the weight and cubical capacity of a normal railcar is anywhere from two to four times that of a normal truck.<sup>8</sup> The greater capacity of railcars allow lower rates with volume increases than is possible for trucks. Figure 3 illustrates that with respect to weight, rail transport has continuously declining costs and at some point beyond truck capacity, rail costs per ton-mile are lower than truck costs.<sup>9</sup> For illustrative purposes, the diagram assumes a 50 ton railcar capacity and a 20 ton truck capacity.

C) The speed factor

Increased speed requires the consumption of more motive power per unit of distance. This applies to trucks as well as locomotives.

It is also a fact that increased speed provides savings. Among the savings, we may enumerate time and wage savings as well as capital savings since over the long run, less equipment will be necessary to perform any given amount

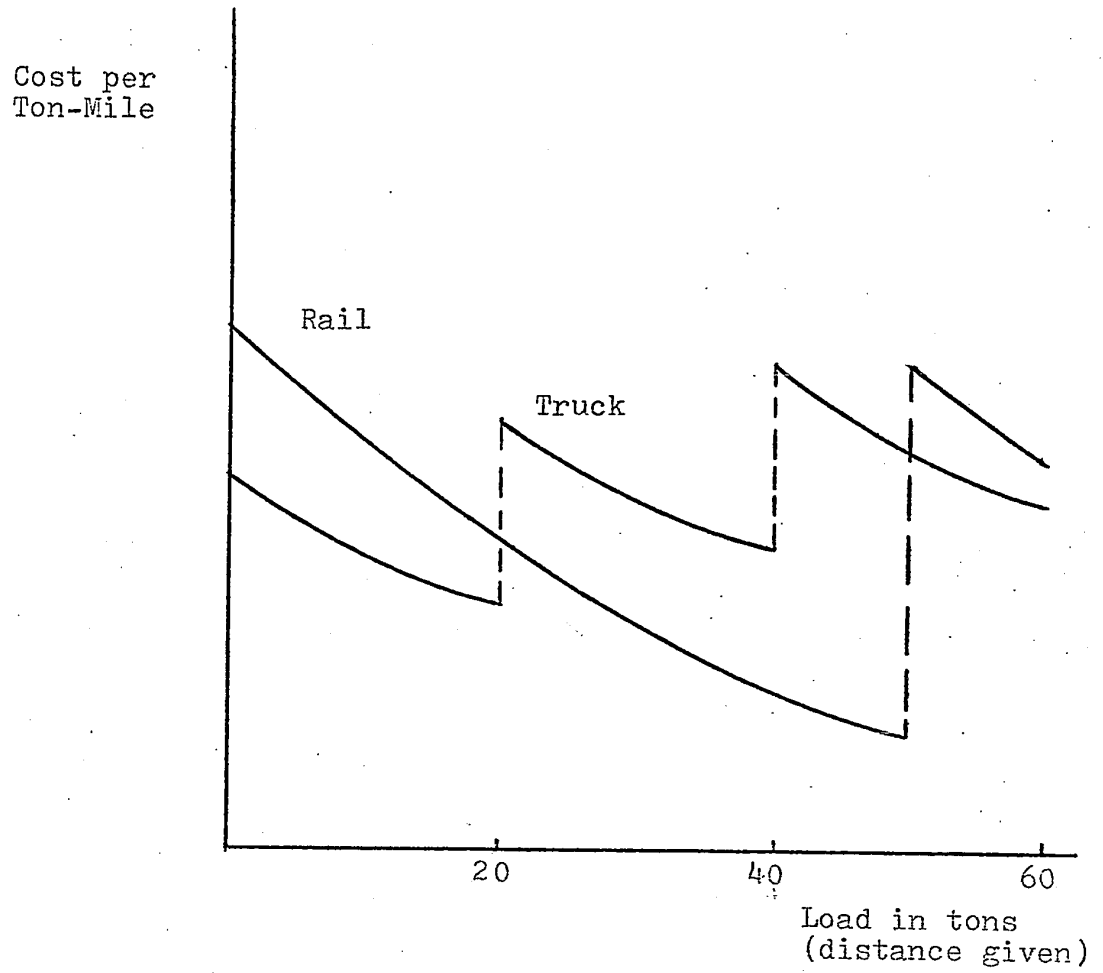


FIG. 3 - WEIGHT EFFECT ON COSTS FOR TRUCKS AND RAILWAYS

of business in a given period of time.

Herbert Ashton has related cost with speed as shown in Figure 4.<sup>10</sup> We can note that given a load and a distance, travelling at speed X will produce minimum costs.

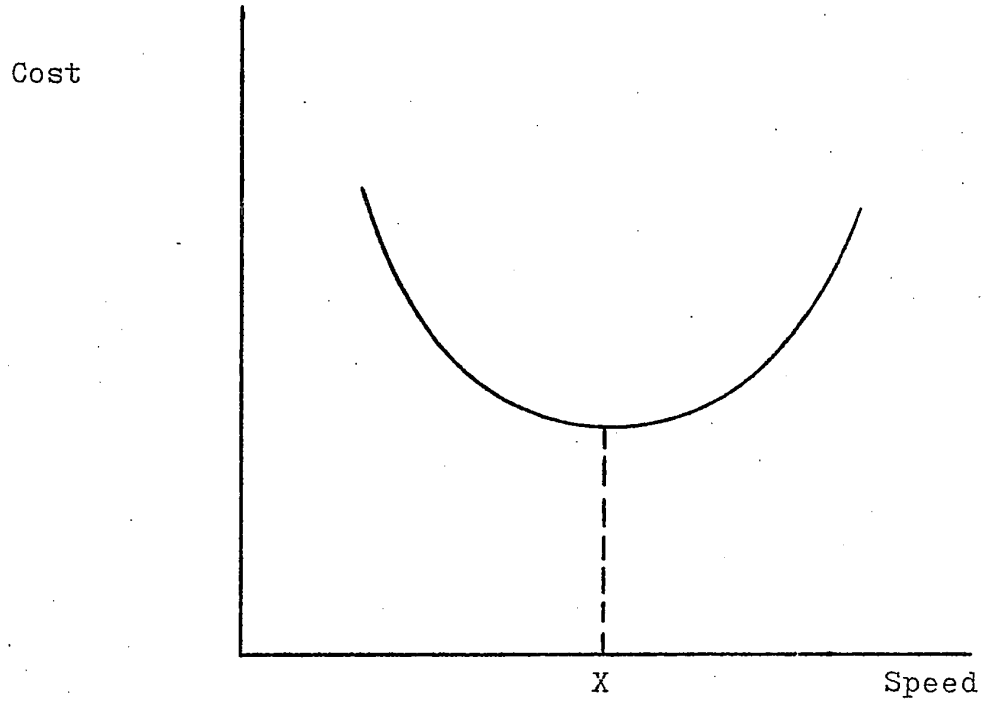


FIG. 4 - COSTS RELATED TO SPEED



## HIGHWAY FINANCE

4.1 Revenues and Expenditures in General

Approximately 90 percent of all funds spent on highways are supplied by the Provincial Governments, while the rest comes in about equal parts from the Federal and the Municipal Governments. The distribution of highway expenditures for the period 1965-1970 is shown at Table No. 3.<sup>1</sup>

Most Provinces make low interest loans available to Municipalities for public works undertakings among which are street construction and maintenance. In general, the road and street systems of Canada are financed from the following five revenue sources:

- (a) Road user taxes.
- (b) Tolls.
- (c) Municipal revenues from the taxation of local property.
- (d) General provincial revenues.
- (e) General federal revenues.

In most Provinces, the receipts of all taxes are paid into the general fund at both the provincial and municipal level, and the budgets of the highways and street departments are annually determined independently by the

TABLE NO. 3  
DISTRIBUTION OF HIGHWAY EXPENDITURES

	1965 \$'000	1966 \$'000	1967 \$'000	1968 \$'000	1969 \$'000	1970 \$'000
Federal	144,733	179,402	152,267	152,404	133,957	1,161,945
Provincial	1,006,231	1,101,055	1,064,755	1,048,515	1,057,729	
Municipal	98,388	106,752	122,728	125,671	133,588	795,113
Other	6,717	5,434	11,091	11,179	5,401	-
Total	4,256,068	1,392,643	1,350,841	1,337,769	1,330,965	1,957,058

appropriate level of government.

In every Province the expenditures on roads and streets exceed the road user taxes, therefore these receipts could easily be assigned as dedicated funds. A point of debate arises here and it could be formulated as a matter of justice to the tax payers: should funds be spent on the highway system only to the point where expenditures are equal to revenues from road user taxes? The answer is a political and social one, the fact that highway expenditures always outweigh highway revenues may be justified by the social benefits obtained by each member of the society even though he does not own a vehicle. An example in point is the sick person who is being transported to a hospital under emergency conditions, can a price be put on his life which may be saved by the simple fact that adequate highways allowed him to receive treatment on time. It is hard to evaluate all social benefits provided by vehicular transportation facilities but on the other hand it is just that some of the costs be borne by society at large.

#### 4.2 Revenues from Road User Taxes

Road user taxes are all such tax revenues generated as a result of vehicular travel. These are vehicle registration fees, public service vehicle licence fees, motor fuel taxes, operator licence fees, and revenues from fines for infraction of motor vehicle laws. Table No. 4 shows the level and the relative importance of the various sources of revenue.<sup>1</sup> As indicated, motor fuel taxes constitute by

TABLE NO. 4  
 REVENUES FROM THE REGISTRATION AND  
 OPERATION OF MOTOR VEHICLES

Year	Passenger Automobiles Licences	Truck, Bus Trailer and Other Vehicle Licences	Motor- cycle Licences	Chauffeur Driver and Dealer Licences	Public Service Vehicle Tax	Motive Fuel Tax	Total *
1965	\$ 106,021,801	\$ 101,760,278	\$ 484,711	\$ 16,013,614	\$ 8,001,229	\$ 671,972,144	\$ 917,703,749
1966	109,547,522	110,632,285	612,473	12,059,703	9,035,371	733,711,023	990,099,252
1967	115,303,718	118,352,634	724,504	18,670,290	9,309,014	781,812,992	1,060,522,985
1968	155,612,891	132,156,829	930,085	13,436,278	9,749,315	935,287,591	1,277,984,919
1969	172,470,313	145,294,690	871,437	21,761,241	10,772,150	1,010,522,305	1,394,906,611

\*Includes other items not shown such as transfer of motor vehicles, garage and services station licences, and fines for infractions of motor vehicle laws.

far the most important contribution to the total revenues.

The Federal Government assesses a series of indirect taxes as a means of raising general revenue. Some of these are excise and sales taxes which have a bearing upon the purchase, maintenance and operation of motor vehicles. For example custom tariffs have been placed on imported vehicles and vehicle parts.

#### 4.3. Various Road User Taxes

##### 4.3.1 Licencing

Motor vehicle licences were first used in Canada by the Province of Ontario in 1904. By 1914 motor vehicle registration was compulsory in all Provinces. However, as a revenue producing source, the issuing of such licences did not become significant until after 1920.<sup>11</sup>

##### 4.3.2 Motor fuel

The Province of Alberta introduced a gasoline tax of two cents per gallon in 1922.<sup>12</sup> By 1928 all Provinces had imposed gasoline taxes. In 1930 the total revenue from gasoline taxes in Canada exceeded the revenue from motor vehicle registration fees for the first time. Since that year motor fuel tax has been the greater revenue producer of the two sources.

Gasoline under the provincial acts include all petroleum oils used as fuel for internal combustion engines. Thus diesel fuel and liquid propane gas, which are being used in increasing amounts by heavy commercial vehicles, are taxed at the same rate as gasoline.

#### 4.3.3 Registration fees

In all Provinces, registration fee schedules are progressive with weight.<sup>13</sup> Distinct schedules are often applicable to buses, trucks, trailers, oil tank trucks, local delivery vehicles, for hire, private, and farm vehicles. In no Province is a single schedule of fees applicable.

It is interesting to note that different Provinces have different tax rates. For example, a Province may have a low gasoline tax accompanied by relatively high registration fees with the result that the total road user taxes may be the same as in a Province where the reverse situation is in effect. Commercial vehicles operating in more than one Province are required to purchase the registration and operating licences of each jurisdiction.

With the present taxation schemes, the larger commercial vehicles are able to promote the higher licence fees over a greater annual mileage and so reduce the burden of taxes assessed per unit of distance travelled. Taxation on a vehicle-mile basis and by type of vehicle would probably be the most valid since it would allow for differences in the purposes and in the extent of the use of the highways. Of course some functional relationship would exist between the assessment per vehicle-mile and the vehicle weight. However, the administrative costs involved in implementing such a system would probably be prohibitive.

#### 4.4 Fixed and Variable Road User Taxes

We can separate the different highway taxes into fixed and variable costs as far as the highway user is concerned. Vehicle registration fees and licence fees constitute fixed costs while motor fuel taxes, fines for traffic violations, and weight-or passenger-distance taxes would be variable costs. In order to charge more to those who use the facilities to a greater extent, it would seem reasonable to put greater emphasis on variable rather than on fixed taxes.

It must be realized that motor fuel consumption is not proportional to vehicle size and weight, variable taxes based entirely upon fuel consumption as is now the case cannot be adjusted to vehicle weight. A good tax structure would therefore have a weight-distance component since the heavier vehicles are the cause necessitating greater structural strength. However, the practicality of such a weight-mileage tax is something to be determined in further studies taking into consideration the enforcement and administrative costs involved in collecting such a tax.

In the present tax structure, the collections are a result of fuel taxes and licence fees. The licence fees vary according to vehicle use and in a sense, this is an expeditious way of avoiding complex administrative and enforcement systems, since the use categories are not necessarily reflecting the level of use of the highway system. It is however a justifiable attempt towards tax

neutrality considering the constraints.

#### 4.5 Highway Costs

The component costs of providing a highway network may be divided into the following categories:

- (a) Capital investment: covering the costs of new constructions and improvements.
- (b) Service to the debt: interest cost that must be paid on the borrowed funds.
- (c) Administration: costs of operation and maintenance of the highway network, this also includes traffic control and enforcement costs.

Considering the expenditures necessary to maintain and upkeep the highway system, let us consider two approaches used in determining the revenue requirements. In the annual cost approach, the capital investments of any one year are chargeable over the entire life of the project. Thus, an annual amortization charge to spread the construction expenditures over the serviceable life, is included in the Annual Cost determination. In addition, administration costs, which are the running expenses, are included. Over and above these two, an annual interest charge is added.<sup>14</sup>

Assuming straight line depreciation, the Annual Cost of the whole or part of the system may be determined by the following:

$$\text{Annual Cost} = \frac{I-S}{M} + \left(\frac{I+S}{2}\right)r + A$$



Where: I = initial capital investment  
 S = salvage value at the end of the design  
 life  
 M = design life in years  
 r = interest rate on the unamortized  
 amount of the capital investment  
 A = annual administrative costs

The second approach used to determine the cost of the highway system is the Annual Expenditure. In this method, a long term program is formulated and highway improvements are scheduled in advance for a long enough period so that the capital investments are about equal in each year. The major difference with the first approach is that capital investments become current costs.

Of course, the construction of major facilities may require vast amounts of initial investment and therefore borrowing becomes an essential way of financing with the consequence of having to pay both amortization and interest costs annually. It may be of general advantage to society as a whole, in the sense of a boost to the economy, that premature or accelerated highway construction programs be initiated with financing obtained through bond issues. In this case, it is reasonably just to say that the interest on the bond issues should be paid by society at large since it is the general public who receives advantages while the retirement of the debt should be paid by the road users who would have eventually necessitated the facilities.

In the same way, spendings on regional development roads based on the economic potential of the regions should be borne by the general funds of Government for the same reason that regional expansion loans to developing areas are financed by Government.

It is interesting to note as indicated in Table No. 5 that for the period 1966-1969,<sup>1</sup> the total highway expenditures have decreased even though total vehicle registration has increased (Table No. 2) as well as total road user revenues (Table No. 4). Table No. 5 also indicates the relative importance of construction, maintenance, and administration expenditures.

#### 4.6 Investment Rate

A satisfactory rate of investment can only be based on plans and cost estimates for the future, considering as an influencing factor changes in the technology of transportation. This is possible only if comprehensive engineering appraisals are made of the needs for the various roads and streets systems. Most Provinces are engaged in the process of making highway needs study.

It is essential that the appropriate level of investment, i.e. the level that will allow construction, operation, and maintenance of a satisfactory road and street system, be determined. Most highways being designed with a life expectancy of from 20 to 30 years, adequate plans of future replacement must be developed. Different techniques may be used, as we will see in the following chapters, to

TABLE NO. 5

CONSTRUCTION, MAINTENANCE, AND ADMINISTRATION  
EXPENDITURES ON HIGHWAYS

	1965 \$'000	1966 \$'000	1967 \$'000	1968 \$'000	1969 \$'000	1970 \$'000
Construction	884,394	983,688	908,399	892,541	862,857	1,147,353
Maintenance	307,553	333,430	360,129	363,578	382,676	809,705
Administration	64,121	75,525	82,313	81,650	85,432	
Total	1,256,068	1,392,643	1,350,841	1,337,769	1,330,965	1,957,058

determine future requirements and prepare plans for  
implementation of projects.

## TOLL HIGHWAYS

Toll collections is but another means devised to finance highway projects. It is especially favored when current incomes are insufficient to provide a necessary facility. However, since the implementation of toll charges has an effect on industries dependent on highways such as commercial motor transportation, this method of financing must be economically analyzed by comparisons with alternate modes of financing.<sup>15</sup>

### 5.1 Toll Facility Concepts

After the location of a toll highway has been selected, detailed traffic studies are made to determine the feasibility of the project. Such studies as origin-destination, volume forecasts, vehicle operating costs, and travel time are carried out not only for the hypothetical toll facility but also for the alternative free facilities.

Comparisons are made between costs of travel on the toll versus costs of travel on the free facility. These costs include fuel, oil, tires, maintenance, time losses or savings, and tolls. The amount of traffic diverted to the toll facility will depend to a great extent on the

comparison of the alternate travel costs.<sup>16</sup> From the traffic estimates and the toll charges, the annual revenues for the facility may be approximately determined. In turn, these anticipated revenues are compared with the annual costs of the project and in this way the feasibility of the project can be arrived at. The ratio of revenues to costs will serve to determine the conditions (interest rate, for example) of the bond issues since it is an indication of the degree of risk. In a similar manner, the absolute levels of revenues and costs will determine the amount of construction capital that may be obtained through bond issues.

It is evident that toll highways are competing with free highways for traffic and, therefore, the success or rate of return of a toll facility will depend to some degree on the suppression of capital improvements on alternate highways. However the needs of the population dictate that adequate funds be provided for the upkeep of adjacent free highways.

At first glance, the existence of toll roads is questionable since road user charges could be increased to meet the financial requirements of improved highways. This is evidenced by the fact that both private cars and trucks are willing to pay tolls over and above the normal user taxes. Credit financing can always be used to get in a relatively short time the money necessary to implement a project.

This brings us to consider the advantages and dis-

advantages of toll roads as enumerated in Table No. 6 and in Table No. 7. It appears that in most cases, other than toll means of financing can be used to produce the same results, i.e. the same highway standards. However, toll financing can be considered in situation where the credit position of the government is weak since the method would then allow the construction of an entire highway in a short time.

TABLE NO. 6  
ADVANTAGES OF TOLL ROADS

1. The actual highway users are charged in proportion to use.
2. Foreign vehicles are charged in proportion to use.
3. This method of financing provides an opportunity for investment of private capital.
4. The most expedient way of providing specific highways at the earliest possible time.
5. This method allows the credit of the government to be used for other purposes.
6. Toll roads become free roads at the end of the amortization period.



TABLE NO. 7  
DISADVANTAGES OF TOLL ROADS

1. Toll roads are suited only to rural locations and are in no sense a complete solution to the highway problem.
2. Toll roads cost more because of the provision of toll plazas, the administrative expenses, and the maintenance expenses due to concentration of labor and equipment along one road.
3. They create some duplication as adjacent free roads must be maintained.
4. There is double taxation on the vehicles using the facility.
5. There is an element of risk since the project feasibility is based on anticipated traffic.
6. The pricing methods are not associated with the costs occasioned.

## HIGHWAY TAX ASSIGNMENT

The tax burden created by constructing, maintaining, and operating roads and streets must be assigned among the three groups of consumers of the service provided by roads and streets: the property directly served, the general public, and the motor vehicle users. A review of the various theories developed to deal with cost allocation will be presented. Firstly, the responsibility of each of the three major interest groups must be established, then the share of the tax burden assigned to motor-vehicle users must be allocated among the different classes of vehicles.

6.1. Major Interest Groups Responsibility<sup>17</sup>

6.1.1 The Added-Expenditure Theory

This theory supports the idea that the motor vehicle users should be held responsible for all road and street expenditures in excess of the scale of expenditures prevailing during the time prior to the advent of motor vehicles. This approach is somewhat old and presents many weaknesses. It is difficult to establish when motor vehicles began to significantly influence highway costs. Early records of expenditures are inaccurate. Social habits and greater urbanization would have created a need for

development of highways and streets even if motor vehicles would have been invented later.

#### 6.1.2 The Relative Use Theory

Here, an attempt is made to determine the proportion of usage to provide land service, community service, and service to the motor vehicle user. The total tax responsibility is allocated in proportion to the type of service provided which is determined by the trip patterns, i.e. origin-destination of the users.

#### 6.1.3 The Predominant Use Theory

This approach is a simplification of the Relative Use Theory in that 100 percent of the cost of Primary Highways is assigned to motor vehicle users, while this group does not pay any of the cost of local roads and residential streets. This method does not provide a specific solution for the problem of allocating the costs of roads and streets with mixed use characteristics.

#### 6.1.4 The Standard Cost Theory

In this approach, a unit of transportation which is the ton-mile is used. The total gross ton-miles of transportation on the main highways are calculated. This quantity is divided into the average annual cost of the primary system to give the standard cost rate. This rate is then applied to the estimated total average annual ton-miles on all roads and streets to give the gross revenue to be collected from the road users. The weaknesses of

this method are that it assumes that 100 percent of the cost of the primary system is to be paid by motor vehicle users and that it uses the ton-mile as the unit of transportation.

#### 6.1.5 The Earnings-Credit Theory

The method assumes that 100 percent of the cost of the primary system is to be charged to the motor vehicle users. A cost per vehicle-mile is calculated from the total cost of this system and the total travel upon it. This unit cost is applied to the total travel on all roads and streets to determine a gross revenue. This revenue is taken as a percentage of the cost of providing the entire highway system and this determines the share assignable to the motor vehicle users. Next, the method assumes that 100 percent of the cost of local roads and streets is to be charged to the local taxpayer. A property tax rate per mile of road is calculated and applied to roads and streets to determine another share of the expenditures. The results of the two calculations are averaged to obtain the final percentage of the highway costs to be assigned to the motor vehicle users.

#### 6.1.6 The Differential Benefits Theory

This method considers mileage and time savings resulting from road improvements. The calculation of the benefits obtained by the various sizes and types of motor vehicles is distributed to the different road and street

systems on a ton-mile basis. The benefit analysis is also used to assign the improvements financial burden to the vehicle users, the property owners, and the general public.

#### 6.1.7 The Basic Access Highway Responsibility Theory

This approach assumes that a basic highway should be provided to ensure access to property. The cost of this minimum standard road or street should be the responsibility of property owners and the general public. The additional cost of any road or street constructed to higher standards should be the responsibility of the vehicle users. Of course, there is an arbitrary decision to be made in the selection of the access highway.

### 6.2. Vehicle Class Responsibility <sup>17</sup>

#### 6.2.1 The Gross Ton-Mile Method

This approach is based on the distribution of the vehicle tax responsibility according to the ton-mile unit. The ton-miles are obtained by multiplying the distance travelled in a period by the average operating gross weight. The annual gross ton-miles transported on a highway system are divided into the annual cost assigned to all vehicles. This rate is then applied to groups of similar vehicles to determine the annual user tax to be collected. It must be kept in mind that the ton-mile unit is probably not a very good measure of the value of the service provided.

### 6.2.2 The Operating Cost Method

This approach assumes that the highway costs assignable to motor vehicles should be allocated according to a measure of the value of the service. It is thought that the vehicle operating costs including fuel, maintenance, depreciation, etc. rise continuously with vehicle size and thus is an appropriate measure of the service value received.

### 6.2.3 The Differential Benefits Method

This method assumes that mileage or time savings due to highway improvements are a good measure of the value of the service received. It has been shown that these savings are directly related to the savings in operating costs of vehicles of different sizes. In this sense, this theory produces about the same results as the Operating Cost Method.

### 6.2.4 The Time-Space Method

This approach assumes that a vehicle uses the space it covers and therefore the measure of value should be the product of the space occupied by the time spent on the highways. A progressive scale is calculated for the various vehicles considering the annual mileage, the average speed, and the vehicle size. This scale is then used to determine the relative share of each type of vehicles. This method produces a very low cost assignment to the heavier vehicles which necessitate the extra costs

of stronger pavements. For this reason, it has been discounted.

#### 6.2.5 The Differential Costs Method

This approach is also called the Incremental Theory and is based on the fact that vehicles of different dimensions and weights differ in their requirements for highway facilities. The problem therefore consists of determining the increases in the costs of construction, and maintenance occasioned by an ascending scale of vehicle sizes and weights. Of course, considerable engineering judgment must be exercised in assigning the increments of pavement thicknesses, maintenance costs, and other features to various vehicles.

#### 6.3 Proposal for Assigning Highway Costs

The best base for allocating tax responsibility is the "cost occasioned" concept. This philosophy ensures tax neutrality in the commercial transportation industry and helps in establishing an economic limit on the total resources of the nation to be devoted to the provision of roads and streets. What is the determining factor here is that superior and more costly facilities are needed to accommodate heavier and greater volumes of vehicles. These increases in expenditures should therefore be paid by motor vehicle users.

The two major interest groups requiring the road and street facilities are the motor vehicle users and the

property owners. However, the general public should be responsible for public property facilities and development roads since the fiscal benefits derived from an improved economy will serve the overall interests of the nation. It is contended that all the costs of the local roads and streets built to a basic standard should be allocated to property owners since they require the facilities to gain access to their property. However, any additional costs caused by better standards to cope with greater volumes and vehicle weights should be passed on to the vehicle users. It is conceivable that, without through traffic, the primary and secondary highway systems would be constructed to the same standards as the local roads. The additional costs of the primary and secondary systems resulting from improved facilities are therefore the responsibility of vehicle users. This is similar to the Added-Expenditure Theory with the exception that the present day local roads and streets are taken as bases.

The Differential Costs Method is a vehicle class cost allocation method based upon a cost occasioned concept. An essential requirement for the use of this method is a good classification of vehicles which are relatively homogeneous with respect to annual mileage, weight, and loading characteristics. The various vehicle types are: passenger cars, city and suburban buses, inter-city buses, trucks, tractor-trucks, trailers, and semi-trailers. The total annual travel of each vehicle group must then be distributed among the various road and street



systems. A way of doing this is by classified motor vehicle volume counts on all road and street systems for a given year. The annual expenditures for each system are then allocated to the various vehicle groups proportionately to their usage and their incremental requirements for structural strength.

Once the total annual cost responsibility for each vehicle class, and hence for each vehicle, has been determined, appropriate taxes must be imposed to collect the required sums of money. One way of doing this is to use a maximum motor fuel tax rate that will be limited by the lowest annual fees assessed any group of vehicles. The remainder of the revenues may be collected by a graduated licence fee. The graduated licence fee could be replaced more adequately by a graduated weight-distance tax which will reflect variations in travel within the vehicle classification groups and will become a variable cost of operations.

## CLASSIFICATION OF HIGHWAYS

7.1 Objectives of Classification

Roads and highways have different functions, some serve as communication links between cities, others serve to provide access to private property. Since various parts of the highway network serve the interests of various population groupings, it is logical to assign the administrative responsibilities according to these interests. A classification plan is the only way by which laws, fiscal programs, and administration can be properly conceptualized and applied.

It is therefore possible to formulate the objectives of a classification plan:

- (a) Group roads and streets into classes reflecting the interests of the various population groupings.
- (b) Distinguish between roads with different use characteristics.
- (c) Provide classes of roads which may be taxed uniformly.
- (d) Avoid overlapping administration.
- (e) Group roads into similar standards classes in order to assign priorities.

- (f) Group roads into a minimum number of systems avoiding classification of a single road in more than one system, thus eliminating duplication in engineering or administrative effort.<sup>18</sup>

The present classification systems in the various Provinces serve primarily to designate administrative authority.<sup>19</sup> However, the classification schemes of various Provinces have been rendered cumbersome and complex because of subclassifications which have been set up as legislative expedients for certain financial aid programs or as methods of imposing size and weight restrictions on commercial vehicles.<sup>20</sup>

The adoption of a functional road and street classification plan constitutes the first step to obtain solutions to the problems created by the motor transportation industry. Specific criteria, as uniform as possible from one Province to the other, should be followed in classifying the roads to the appropriate system. The classification scheme should be made flexible enough to allow reclassification when improvements and developments alter the use of the facilities affected.

## 7.2 A Classification Procedure

Both the rural roads and the urban streets may be classified into four systems respectively. The rural roads may be assessed as follows:

- (a) Primary Highways.

- (b) Secondary Highways.
- (c) Local Roads.
- (d) Development Roads.

The urban streets should be assigned to one of the following:

- (a) Primary Highway Extensions.
- (b) Secondary Highway Extensions.
- (c) Major Urban Thoroughfares.
- (d) Local Streets.

These various systems should possess the following use characteristics:

Primary Highways : roads of great importance, connecting large cities and carrying essentially through traffic.

Secondary Highways : roads connecting smaller cities, having also the function of carrying traffic from the local system to the primary system.

Local Roads : these roads provide access to rural properties.

Development Roads : these roads serve to exploit the economic potentials of a region, such as mining, forest, tourism, water resources.

Primary Highway Extensions: these streets carry large volumes of intercity and through traffic.

Secondary Highway Extensions: when streets serve both functions of providing local property access as well as accommodating substantial volumes of through traffic.

Major Urban Thoroughfares: when streets connect major business districts with all sections of the municipality. They serve great volumes of intra-city traffic.

Local Streets : the function of this system is to provide access to local property.

Of course, it may be difficult in some cases to assign a given road or street to a specific system since the element of human judgment is always present. However, useful guides that may be used are the traffic volumes and the relative importance of rural or urban travel.

### 7.3 Administration of the Various Systems

By implementing and using a classification procedure as presented above, it is obvious that some areas of responsibility for planning, programming, and operation of the various systems must be defined and assigned to various levels of Government. Table No. 8 may serve as an indication of who uses the services and consequently who should pay for them as well as indicating who collects the money.

It is obvious that in many cases, two levels of Government are involved in collecting the revenues from the highway users, this does not imply that there should be double jurisdiction over the administration, planning, and operation

TABLE NO. 8  
USERS AND TAXATION OF THE VARIOUS HIGHWAY SYSTEMS

	System	Users of the Service	Taxation	Government Collecting
Rural	Primary Highways	Motor Vehicle Users	Road User Taxes	Provincial
	Secondary Highways	Motor Vehicle Users Property Owners	Road User Taxes Property Taxes	Provincial Municipal
	Local Roads	Property Owners	Property Taxes	Municipal
	Development Roads	Industry General Public	Industrial Taxes General Taxes	Provincial and Federal
Urban	Primary Highway Extensions	Motor Vehicle Users	Road User Taxes	Provincial
	Secondary Highway Extensions	Motor Vehicle Users Property Owners	Road User Taxes Property Taxes	Provincial Municipal
	Major Urban Thoroughfares	Motor Vehicle Users Property Owners	Road User Taxes Property Taxes	Provincial Municipal
	Local Streets	Property Owners	Property Taxes	Municipal

of the systems. For example, large metropolitan regions such as Montreal or Toronto must integrate into their General Development Plan, the plan for road and street construction with due regard to its influence on other sectors of municipal responsibility such as industrial, commercial, residential, and recreational development.

To take another example, the construction and maintenance of Development Roads can in many cases be of national interest. However, due to the nonexistence of a Federal Highway Department, it is clear that the responsibility must be switched to the Provinces. Accordingly, federal grants must be made to the Provincial Governments in order to develop the regional economic potentials. It therefore appears that although inter-governmental financial cooperation is needed, the administrative authority should be unique.

At present, there appears to be wide discrepancies in the ways each Province deals with the classification of its highways. The adoption of a uniform classification method would bring about great benefits. It would permit the compilation of accurate road and street statistics on a national basis. It would enable the techniques and results of provincial highway needs studies to be used in other Provinces as well as make possible comparisons between Provinces. It would allow provincial authorities to exchange more accurate and understandable information as well as give federal authorities a clearer picture of

the entire road and street system and its needs by permitting evaluation with regards to the other sectors of the Transportation Industry.

A point to be noted here is that attempts are being made to standardize the classification procedures across the different Provinces. The Roads and Transportation Association of Canada has published a section on road classification in its book titled: "Geometric Design Standards for Canadian Roads and Streets".<sup>32</sup> The classification system described in this chapter is in many points similar to that presented in the above mentioned book.

It must be kept in mind that in a classification system, arbitrary decisions must be taken to define the various classes and therefore there can be differences of opinion. However, the purpose of the classification and its importance is what must be made clear to all those involved in highway or street construction: the land planner, the highway planner, and the design engineer. A good understanding of the purposes will allow for the acceptance and use of a uniform classification procedure.



## PLANNING FOR HIGHWAYS

Considering the necessity of the highway transportation network, the demands of the users of this network, and the limited national resources; it is obvious that sound planning and programming decision process will be based on various needs studies such as those following: physical, administrative, and financial studies. The problem of planning is not only one of determining long range development and replacement programs but it is also one of overcoming immediate road deficiencies in order to provide a level of service guaranteeing safety, comfort, and convenience.

### 8.1 The Short Term Plan

The main concern in formulating the short term plan is to overcome immediate deficiencies of the highway network. The first question that comes to mind is what constitutes such a deficiency. A possible approach to this problem is to associate a deficient facility with the benefits that may result from the facility once it has been improved. Such benefits might be expressed in terms of operating costs savings, accidents prevented, and time savings. If the expected benefits resulting from an

improved facility exceed the cost of effecting the necessary correction, the facility is to be considered deficient and reconstruction or improvements are warranted.

Many deficiencies can be resolved with relatively little financial outlays. Some examples may be stated: inefficient intersections, inadequate roadway signalization, lack of pavement markings, etc. Traffic congestion and inadequate driving aids not only cause inconvenience to pedestrians and motorists but are often the cause of fatal accidents, great loss of time, and increased operating costs. Under ideal conditions, it is desirable that all inadequate facilities be at once improved or replaced since they are a cause of economic waste while they are being used. However, the highway demands and the limited financial capabilities do not allow immediate and integral corrections.

The best way of financing the improvements is through bond issues retired from the road user taxes during the design life of the improvement. In this way, the actual users of the improved facilities would pay for the renewal cost.

## 8.2 The Long Term Plan

Considering population increases and the trend towards greater volume of travel, a long range operation, maintenance, replacement, and improvement plan is required. It is here that the annual construction programs and the revenue requirements are planned for.

Estimates of future traffic demands are key in the formulation of a long range plan. Since it is difficult to get reliable figures for more than five years ahead, the anticipated expenditure and revenue requirements are as complex to pinpoint. For this reason, a relatively short financial program is required. In this way, the revenue requirements which are translated into road user taxes directly affect the travel of various vehicle classes. Establishing a tax structure that would be based on revenue requirements for a long time period would result in unrealistic charges that would either assist or hinder the economic development of the highway transportation industry.

### 8.3 The Planning Methods

Certain procedures and requirements for adequate planning will be presented in order to gain a deeper understanding of the underlying concepts.<sup>21</sup> It must be remembered that any improvement or construction program and its financial implications is highly dependent upon the supply of technical personnel, the availability of low cost local materials, and the ability of the construction industry to undertake the work, especially if it is an accelerated program. For these reasons, it is essential that highway planners consult on a continuous basis the construction firms, participate in research, and constantly exchange information on highway problems.

Some essential studies and fact finding techniques are presented in Table No. 9. Table No. 10 attempts to present

TABLE NO. 9  
PLANNING STUDIES

Studies	Elements
1. Highway Use	Volume counts by vehicle class. Vehicle weight. Vehicle speed.
2. Highway Life	Design life of various structures under different use, climatic, and topographic conditions.
3. Vehicle Use and Operation	Average annual travel by various classes of vehicles. Fuel consumption and other operating expenses by various classes of vehicles. Origin-destination surveys. Occupancy or utilization rate of vehicles. Purpose of travel.
4. Registration Trends	Statistics of vehicle registration variations.
5. Land Use	Development plans. Land values.
6. Highway Costs	Statistics of construction costs. Construction, maintenance, administration costs.
7. Highway Inventory	Statistics and information on the conditions and utilization of all roads and streets.
8. Economic Studies	Economic indices. Transportation studies.

TABLE NO. 10  
STUDY PURPOSES

Study	Purposes
1. Highway Use	Geometric and structural design.
2. Highway Life	Financial and design requirements.
3. Vehicle Use and Operation	Demand projections. Taxation structure.
4. Registration Trends	Demand projections.
5. Land Use	Right-of-way acquisition. Urban and regional planning. Financial requirements.
6. Highway Costs	Financial and administrative requirements.
7. Highway Inventory	Indication of deficiencies. Setting of priorities.
8. Economic Studies	Level of economic activities. Developing regions. Competition of transportation modes. Government intervention.

the purpose of these studies. Once all the information is gathered and updated, it is essential to determine priorities. Priority setting is undoubtedly the most difficult element of any plan. Let us analyze a widely used method of determining priorities called the Sufficiency Rating Technique.<sup>22</sup> The technique consists of scaling a highway on three different scales: structural condition, safety, convenience and comfort. The different factors are evaluated following an established procedure, assigned a weight, and combined to give an overall percentile rating for a stretch of highway. The higher the rating, the more suitable is the highway; the lower the rating, the greater is the priority for implementing corrective measures.

A different method of assigning priorities is based on the concept of the Benefit-Cost Ratio.<sup>23</sup> Benefits are considered as savings such as: operating savings, time savings, and accident prevention; intangible benefits such as social benefits or increases in land values are usually not included. Costs normally include capital and interest payments, maintenance, and operation of the improved facility. When the ratio of benefits to costs exceeds unity, the improvement is deemed necessary and the greater the ratio, the greater is the priority for implementing the changes. The difficulty in establishing this ratio is the evaluation in money terms of the benefits resulting from an improvement.

In our type of society, planning is not strictly based on facts and figures, there is a great deal of influences and

pressures that must be taken into consideration. For example, politicians who rightly represent the wishes of the population at large have a powerful say in the decisions with respect to a highway expansion proposal. However, it must be emphasized that the decision makers should always base their judgment on sound scientific recommendations on the part of the engineers. Political decisions per se are also essential when many projects have identical priority ratings while budgets to be assigned are limited.

## RECENT AND FUTURE DEVELOPMENTS

### 9.1 The Environmental Aspects

In the recent years, the level of awareness for quality of life has increased considerably and this has contributed to give heavier weight to environmental considerations when designing highways.

An indication of this greater concern may be seen in the United States where the Environmental Development Division was created in 1968. The purpose of this office is the development and promotion of the construction of highways that are compatible with their environments and that help to further the goals of the communities which they serve.<sup>33</sup>

Social and community values as related to land use development and to transportation is becoming an important part of planning. More and more in transportation planning additional attention is being given not only to the enhancement and preservation of existing open spaces, parks, and recreational facilities, but also the the provision of new facilities in anticipation of future development.

Greater concern is being given to the avoidance of



historic sites, parks, and conservation lands. Designs are being done with attention to protect fish and wildlife, provide flood control measures and scenic enhancement. Care is also exercised to select locations for new transportation facilities so that neighborhoods are not disrupted. The appearance of the facility from the viewpoint of the motorists, the pedestrians, and the nearby residents is considered.

Evaluation of possible highway programs can no longer be considered valid unless there are included estimates of their environmental impact. Of course, the economic costs and benefits of alternate highway programs are much easier arrived at than the less tangible but equally valid environmental and social costs and benefits. Considerable research is underway to develop procedures for estimating the impact of various highway programs on nine variables:<sup>34</sup>

- (a) Economic activity and population distribution.
- (b) Recreational and cultural opportunities.
- (c) Displacement of families and businesses.
- (d) Structure of neighborhoods.
- (e) Land use patterns and land values.
- (f) Air and water pollution.
- (g) Noise pollution.
- (h) Visual quality of the environment.
- (i) National defence.

In order to blend the highways into the existing

environments, highway corridors are being especially controlled for outdoor advertising, junkyards, and roadside improvements such as rest and picnic areas.

The transportation efficiency criteria which often were the determining factors in highway construction are losing weight in favor of social and environmental considerations.<sup>35</sup> It is no more sufficient to set as a goal the most efficient method of connecting point X with point Y. Transportation planning can only be reasonably carried out as an integrated aspect of total urban and regional planning.<sup>36</sup>

## 9.2 The Urban Problem

All large cities are experiencing severe traffic problems and are planning for changes away from the conventional car transportation. The country is experiencing rapid urbanization coupled with increased population mobility. These factors increase the demand for transportation and the automobile has been and continues to be a preferred mode of transportation with the consequence that the structure of the cities have been affected by massive roadway construction.

A National Transportation Policy Report prepared for the United States Government considered the effects of the automobile on the residential patterns of the metro-

politan areas as well as the impact on mass rapid transit. The Report suggested that commuters should be given free mass transportation which would cost less than providing the additional highway and parking facilities needed for their automobiles.<sup>24</sup>

Transportation planners for the metropolitan areas are faced with the fact that the automotive vehicle has become the prime mover of urban traffic and the problem is pointed out clearly by W. Owen:

Cities can never solve their transportation problems if they continue to crowd too many people and too much economic activity into too little space... We will have to avoid unmanageable transportation demands through the dispersal of population and economic activity, the preservation of open spaces, and the planning of land use densities and arrangements.<sup>25</sup>

All urban concentration is not only the result of economic influences. For example, authorizing the construction of high-rise buildings for both business and apartments generates large amounts of traffic which the existing transport facilities may not be able to cater.<sup>26</sup> Adequate coordination is essential and this can only be done by integrating the various parts of the metropolitan development plans. In this way, an increase in population density would only be allowed if the transportation facilities are sufficient to prevent congestion and great time losses. Air pollution caused by increased car usage is another problem affecting the quality of life in urban areas and calling for

an urgent solution.

Public aid must be given to researchers for the invention of new technologies that will attract people away from the automobiles. The new rapid mass transit systems, in order to succeed, will have to provide commuters with the convenience and flexibility that they now find by using their private cars. The basic inflexibilities of mass transportation such as: fixed routes and fixed schedules, must somehow be transformed to become more appealing to the public.<sup>27</sup> An example of the attempt on the part of public authorities to increase the flexibility of mass transportation may be seen in Ontario where large sums of money are being spent for the study of new ways of urban transportation such as dial-a-bus.

Research must also be carried out in fields such as multi-modal transportation and feasibility studies are essential in order to implement as soon as possible some of the solutions.

### 9.3 An Autoless Core

A possible solution to the downtown congestion, parking, and pollution problems would be the autoless core concept. The philosophy of an autoless city core would reduce to the minimum the presence of cars in the downtown area. Walking would dominate as a principal mode of transportation within

the core. Some type of personal transport would be provided to move individuals within the enclosure.

The design of the core must also allow heavy vehicles to enter to carry out emergency services such as fire fighting, as well as normal services for building maintenance and new construction. There may be allowance made for an auto circuit separate from a pedestrian circuit within the core.

A practical idea is to implement an autoless core over a period of 10 to 20 years since it is impractical to tear down at once a whole central area.<sup>28</sup> Proper allowance must be made for the flow of external traffic around the core. A large circumferential street around the enclosure would permit automobile traffic to by-pass the core area without excessive inconvenience, would provide entry to service ways, and would allow access to perform emergency functions.

Parking facilities would have to be provided around the core and due to the size of the enclosure, personal automatic transportation devices would have to be installed for movement beyond walking distance. Some possibilities are moving sidewalks, small automatic tracked vehicles, and electric-powered small trains.

Of course, to implement such a city core concept at once would be enormously expensive, however, the actualization over a few decades would be feasible financially and would provide a solution to the poor living conditions

of the downtown areas.

#### 9.4 Future Intercity Highways

A very near future application of new technology is an intercity expressway capable of accommodating cruising speeds of 100 miles per hour. The first development phase would permit speeds of about 100 miles per hour under manual vehicle control with a special class of vehicles, drivers, and a highway incorporating new features of design, traffic control, communications and operational procedures. The second phase of development would introduce a type of guideway for the provision of side forces required for stability and control.<sup>29</sup>

The idea described above was initiated in a Cornell Aeronautical Laboratory Report made to the United States Department of Commerce.<sup>30</sup> The expressway would by-pass cities but would be connected to the conventional highway network by means of special access ways. As far as safety is concerned, speed is not necessarily dangerous. It is a fact that conventional low speed highways accidents are much more numerous and costly than those of the faster autoroutes. Of course, additional safety devices need to be provided.

The effectiveness of such a system would be in terms of reduction in travel time and increase of traffic capacity. It is believed that increased effectiveness can be obtained

without an increase in accidents by building a highway with safety features such as roadside energy absorbing guide rails, continuous emergency escape shoulders, wider lanes, improved communications, and new ramp control systems designed to produce safe merges.

As far as the vehicles are concerned, they would have to be inspected at entries to the expressway and satisfy the safety requirements for tires, brakes, steering, communication and signaling equipment.

From the manual expressway described above would evolve an automatic highway. This highway offers benefits by improving capacity, comfort, travel time, and safety of individual transportation systems. These benefits are obtained by increasing speed while reducing the headway between vehicles. The feasible method to be used consists of packing the vehicles close to one another on guideways with no passing and limited access points. The main line of traffic is in constant movement while entry and egress operations are done automatically. The speed to be reached on the automatic highway, in order to be competitive with other intercity modes such as advanced rail systems, must be in the neighborhood of 150 miles per hour.

Three main classes of automatic highways may be described:

- (a) Individually powered vehicles that follow an

electronic system which is applied to the conventional roadway.

- (b) Individually powered two-mode systems in which a low-powered, wheeled vehicle designed for manual operation on the urban street system can also enter a special guideway where it picks up additional power and automatic guidance for high speed operation.
- (c) Pallet-type systems in which the traditional automobile enters a guideway system and merely attaches to or rides on a separately powered conveyance.<sup>31</sup>

As we have seen above, the trend is towards greater speed and increased capacity. These two objectives must, however, be achieved within one constraint: safety. Numerous resources, both human and material must be pooled by the Governments to help these technologically feasible projects become reality.



## CONCLUSIONS

10.1 Integrated Transportation Policy

The problem of providing adequate highways must be considered in its relationships with the overall transportation policy. By this is meant that economic advantages inherent in each transportation modes must be recognized and that the allocation of business among these modes should be strictly determined by fair competition without undue governmental interference that would either assist or hinder a specific mode.

The planning of highway facilities must also be done with due regard to the planning of other transportation modes. Many influencing factors must be considered in this process; to name a few, let us consider changes in needs and desires of the population, technological changes affecting various modes of transportation, development of northern regions and of new resources, and the strategic importance of various transportation modes.

Currently, the competitive relationships of the railways versus the commercial motor carriers is a source of conflict. The spread of Canadian land and the dispersion of its population favor the development of air transportation. The natural and artificial waterways have and still are contri-

buting to national development. Pipelines are becoming an important transportation media especially with the technological advances realized in this field. These different modes as we have already said are competing and what determines their viability is of course demand.

Demand is a direct result of the charges or rates and of the quality of the service. It is therefore essential that these rates reflect the relative costs of providing a particular service in order to arrive at an economical allocation of traffic among the alternate transportation modes. Differential subsidization by the Governments to various modes is therefore unjustifiable since it hinders fair competition.

The unprofitable branches of railways that are now maintained through public subsidy should be dropped and more versatile and economical motor transportation could take over.

It appears essential that an integrated national transportation policy be formulated with the cooperation of provincial regulatory agencies. This cooperation is essential since the trucking industry is controlled by the Provinces while rail, water, and air transportation are regulated by the Federal Government.

Regulation agencies must be vigilant and have the power of inquiry and intervention to prevent discriminatory practices and ensure that rates guarantee safe, dependable, and convenient service while still allowing for competition.

## 10.2 Finances

The highway costs should be borne by the actual consumers of the service and should therefore be based on the total travel on the network. The costs should thus be assigned on a vehicle-mile basis supplemented by weight-distance charges for heavier vehicles. In this way, the cost of travel would affect the rates directly as being an operating cost and would prevent motor carriers from getting business that might be more economically accommodated by competing modes. However, further studies are needed to determine the administrative and enforcement costs of collecting a mileage tax, thus establishing the feasibility of this type of taxation.

Interprovincial cooperation should be promoted for the establishment of methods of highway cost allocation and taxation structures. The allocation of costs should be fair within a two-dimensional framework: allocation among interest groups and allocation among road users.

Different financial methods must be considered on the basis of their respective merits. For example, credit financing through bond issues may be feasible in many cases but toll financing can also be used for its expediency.

## 10.3 Research and Development

Highway needs studies should be carried out on a continuing basis to determine the level of service demanded by the users. Let us consider the essential elements to attain this result: classification method, inventory reports,

vehicle characteristics studies, establishment of design standards, planning and programming of improvements and expansions. In addition, due consideration must be given to manpower, construction materials, and equipment costs and availability.

Constant effort should be deployed to promote highway studies that will produce breakthroughs in design, material usage, and traffic operations. Governments should financially support research in transportation technology in order to be able to implement new concepts as solutions to the problems of urban and intercity transportation.

Further studies are required to implement a systems approach to the problem of highway transportation. Systems analysis will allow to consider and weigh all factors for and against alternative proposals by considering not only the economic costs and benefits but also the social and environmental costs and benefits.

All of the above considerations are essential for the development of an adequate highway system that plays an essential role in an integrated transportation plan and further in an integrated urban and regional development plan.

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