Estimating the Benefits of Increased Gross Vehicle Weights

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ABSTRACT

Economic conditions force us all to explore methods of being more cost-effective. Logic suggests that less economic resources will be consumed if our transportation requirements are provided at larger average payloads. There is also the conventional perception that larger trucks will kill our highways. This paper describes an examination of the benefit side of this question, which is being used with parallel investigations of highway costs and heavy vehicle operating considerations.

The examination considered the benefits of allowing those truck types constrained by Gross Vehicle Weight to increase to the sum of the existing allowable axle loads. In Alberta, this applies to vehicle combinations with more than 7 axles; current GVW 53.5 tonnes, sum of the allowable axle loads up to 62.5 tonnes. The potential benefit of allowing all trucks to increase the winter tolerance from the current 110% to 120% was also examined.

This consideration of increased loadings was not intended to be a rigorous economic analysis, but to very quickly estimate the benefits that would accrue over time, based on estimates of a range from low utilization to high utilization. If the calculations found the benefits to be significantly smaller than the costs, the subject would be dropped. Benefits significantly higher than the costs could go forward to the next part of the decision making process. If the calculated benefits were close to the calculated costs, a more rigorous analysis would be required.

The study was done entirely in-house. Two weeks were required for a sample of vehicle utilization, collected through the routine operation of the existing vehicle inspection station. Another two weeks (admittedly more than 8 hour days) were required for the analysis using nothing more sophisticated than experience, logic, and a spread sheet program on a micro computer.

The result was positive. Allowing the Gross Vehicle Weight to rise to the sum of the allowable axle loads was found to provide an initial transportation cost saving of about one million dollars per year at the low utilization estimate, to 6 million dollars at the high utilization estimate. As the industry takes advantage of the new maximum, (about eight years) the benefits are calculated to be in the range of fifteen to twenty-two million dollars annually.

Allowing a winter tolerance of 120 instead of 110 percent was calculated to provide an initial benefit of two to four million dollars per year, and a potential benefit of four to nine million dollars per year as the truck fleet changed.

The cost calculations being done in parallel to this study indicated that, even at the low estimate, the cumulative benefits of increasing Gross Vehicle Weights would exceed the costs in a relatively short time. Increasing the winter tolerance on axle weights had significant benefits, but would require considerably more structural upgrading. Increasing the GVW to the sum of the allowable axle loads was more cost effective.

This quick sensitivity approach made it possible to conclude that a more rigorous examination of benefits would not enhance the decision making process.

INTRODUCTION

The trucking industry has never been backward about advising road authorities of the obvious cost savings to be gained by carrying a given quantity of material in fewer trips of larger payload. Road authorities are concerned that infrastructure designed for the technology of yesterday would not be adequate for vehicles of tomorrow.

With all the complexities of jurisdiction, regulation, and technical constraints, truck transportation has been characterized by incremental improvements rather than quantum leaps of

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progress. Alberta has been undertaking several examinations of various aspects of truck transportation, from pavement and structural impacts, traffic operations and safety, to vehicle inspection stations and the economic benefits of improving operation efficiency by increasing payload. The following is a brief report on two possible means of gaining economic benefit by increasing payload: increasing the Gross Vehicle Weight of trucks of more than seven axles to the sum of the allowable axles loads, up to 62,500 kg and allowing all trucks to increase the winter tolerance from 10% to 20%, again to a maximum of 62,500 kg. Table 1 summarizes the extent of changes being examined.

RATIONALE

In Alberta only those trucks with more than seven axles have a gross vehicle weight of less than the sum of the allowable weight; the A train configuration. It was rationalized that allowing these trucks to carry a payload which takes full advantage of the allowable axle load would not have a significant impact on the roadway, but could have serious consequences on the bridges and other structural elements of the highway system. Increasing the winter tolerance was also examined, since this would be applicable to more elements of the trucking industry. During Alberta's winter the frozen subgrade and pavement would not be extensively damaged by increasing the allowable axle weights. Again the major concern was the effect on the bridges. The problem was to estimate the relative benefits of these load limit changes for comparison with the structural costs the changes would cause.

The objective was to provide the decision makers with a timely estimate of the economic benefits that might be derived by these regulatory changes, in a simple and meaningful form.

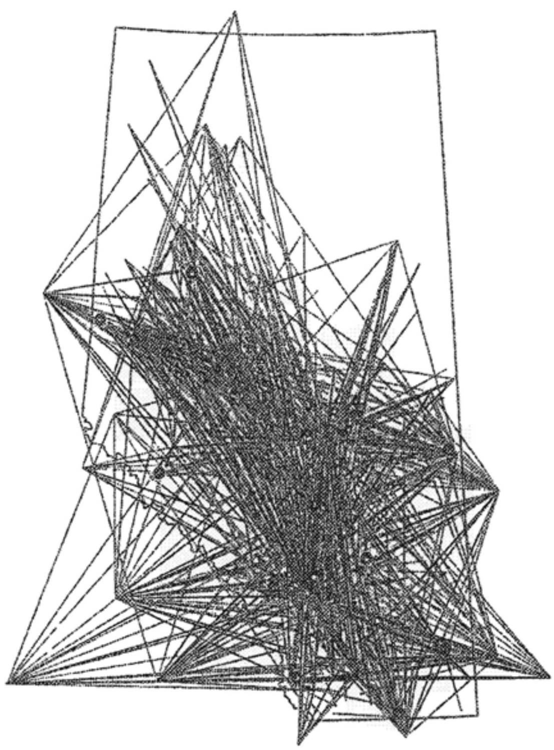
Analysis paralysis was avoided by adopting a modified Q and D (1) (quick and dirty) approach ascribed to Gordon Sparks. The modification was a form of sensitivity testing of high and low estimates of utilization. The procedure has been called the TITT (Think it Thru-Twice System).

There are dangers in less than rigorous analysis. It was rationalized that, if the range of benefits were clearly less than the costs of improving the structures, the subject would be dropped. If the estimates indicate that the range or benefits would clearly exceed the costs, more precision would not alter the decision. Should the analysis have indicated that the benefits were close to the costs, it was intended to undertake a more rigorous analysis before reaching a decision.

DATA

Increasing the G.V.W. or the winter tolerance would not be of advantage to all trucks or commodities. Truck type and loading data are almost continuously collected at Alberta Vehicle Inspection Stations. It was a relatively simple matter to acquire the commodity and volume utilization data at these sites.

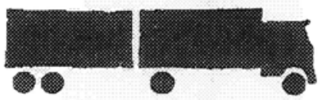
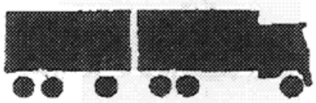
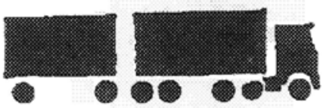
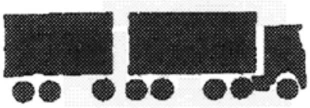
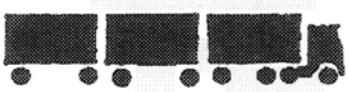
A rigorous analysis of sampling size was not undertaken. Over the years vehicle inspection stations have been used as sampling sites, from which has been developed a fairly reliable model. Figure 1 shows the location of the vehicle inspection stations superimposed on the desired line diagram of the modeled truck trips. A subsequent calculation as part of another project found that about 27% of the rural truck trips pass through at least one vehicle station. Excellent work by Wyatt and Hassan in Saskatchewan, using data from vehicle inspection stations, (2) indicates that most



Total truck trips

FIGURE 1

Table 1

Truck type		G.V.W. Existing tonnes (lb)	G.V.W. Proposed tonnes (lb)	Winter allowance Existing 110% tonnes (lb)	Winter allowance Proposed 120% tonnes (lb)
	Single unit, Single axle	14.1 (31,000)	14.1	15.5	16.9
	Single tandem	21.0 (46,300)	21.0	23.1	25.2
	Semi	37.0 (81,600)	37.0	40.7	44.4
	Single & pup	37.0	37.0	40.7	44.4
	Single & trailer	46.1 (102,000)	46.1	50.7	55.3
	B-train	53.5 (116,000)	53.5	53.5(1)	62.5(2)
	A-train, single axle trailer	53.5(1)	55.2 (121,700)	53.51	62.5(2)
	A-train, tandem trailer	53.5(1)	62.1 (136,900)	53.5(1)	62.5(2)
	Triple	53.5(1)	62.5 (137,800)	53.5(1)	62.5(2)

(1) Constrained by existing maximum G.V.W.

(2) Constrained by proposed maximum G.V.W.

Table 2 — Utilization data sample of Alberta highway trucking, Aug 26-30, 1985

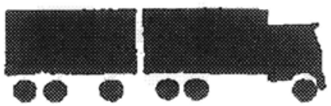
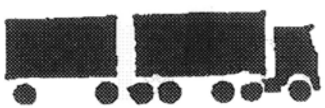
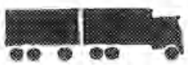
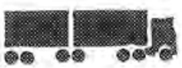
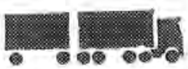
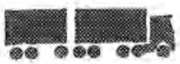
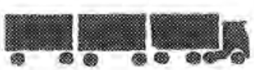
						Weighted out		
			Empty	Part load	Cubed out	Full cube	Part cube	Total
	Single unit single axle		1351	1522	617	179	134	3803
	Single unit tandem		647	570	272	278	88	1855
	Semi's	5 axle	693	1145	622	402	331	3193
		Other	44	82	51	1	1	179
	Single and trailers		70	67	16	2	0	105
	B train		195	165	146	161	109	776
	A train - 7 axle		188	226	98	124	141	777
	A train > 7 axle		7	118	12	10	7	154
	Triples		6	16	0	0	0	22

Table 3 — Theoretical payload increase

Truck type	Existing				Proposed			
					G.V.W. increase		Winter change	
	% in primary truck stream	Average observed payload of loaded trucks tonnes	Existing maximum payload tonnes	Winter payload @ 110% tonnes	Payload tonnes	%	Payload @ 120% tonnes	%
	34.9	2.9	6.3	7.7	No change	--	9.1	17.6
	17.1	8.4	9.5	11.6	No change	--	13.6	17.6
Other single units	0.1	—						
	29.4	15.5	23.6	27.3	No change	--	31.0	13.6
Other semis	1.6							
	0.5	18.4	22.7	26.4	No change	--	30.1	
	0.4	25.0	30.2	34.8	No change	--	39.4	
Other single + trailer	0.1	--						
 B trains	7.1	27.0	34.5	39.8	No change	--	44.3	11.8
	5.9	27.5	34.4	41.4	35.8	5.0	43.4	4.5
	2.7	26.9	32.6	40.2	43.1	26.4	41.6	0.0
A trains								
	0.1	21.54	31.3	40.3	40.3	28.7	40.3	0.0
Other triple	0.1							

of the trips missed would tend to be of relatively short length, predominantly single unit trucks.

The data collected by this minimal addition to the normal work load of the vehicle inspection station staff, after considerable summarization, is shown in Table 2.

Table 3 shows the percentage of each type of truck in the present "fleet" and the theoretical pay load increase that is possible if the commodity is amenable to trip reduction.

We also had available good data from comprehensive classification and traffic volume counts on all links in the highway system. This allowed reliable expansion of the utilization data and was the basis for calculation of vehicle kilometers of truck travel for each type of vehicle.

ASSUMPTIONS

We made the all encompassing assumption that the utilization rates were relatively constant over the system, and made no allowance for seasonal variation. This is a conservative assumption. For example fertilizer and grain are major commodities which can take advantage of the A Train configuration and which were not fairly represented in the sample. If they had been properly represented, the benefits of increased G.V.W. would be higher. Major assumptions had to be made concerning the commodities which, by divisible nature and size of market, could take advantage of the increase in weights. Here again reliance was placed on the work of Sparks and Duffee, whose discussion on the likelihood of particular commodities being able to utilize increased load limits became the guide, which was checked with phone calls to Alberta shippers. These general criteria are listed in Table 4.

This analysis did not consider the "pass through" of benefits as this usually contributes significantly to Analysis Paralysis. McDonald and Bouchard (3) estimated that the for-hire sector of the industry passed through 26 percent of savings in terms of freight reductions and the private sector passed through 10 percent of the savings. Reliance was placed on macro economic theory which considers any cost efficiency to eventually contribute to the "good" of the economy. This pass through of benefits can take many forms, as indicated by Clayton and Sparks (4) who found that rail rates for truck competitive hauls had been significantly reduced by relaxed regulations that stimulated the intensity of competition. This increased competition is particularly important in Alberta, where "what the market will bear" rate making has resulted in Alberta traffic paying a disproportionately large share of railway constant costs. (5)

CALCULATION

The analysis was done on a microcomputer with direct judgements made by the analyst. First those movements which were weighted out but had room were identified. This reduced list was examined to identify those commodities which were amenable to trip reduction through the proposed changes. These general commodity criteria are indicated in Table 4, but the analysts made many judgements which improved the validity of the estimates. For example, bulk fuel moving from refinery or pipeline terminals to regional distribution centres

Table 4 — Commodity assumptions

	Existing (%)	Increase G.V.W.	Increase winter tolerance
General freight	4.5		Some
Foodstuffs Non perishable Perishable	1.7		Some
Equipment	4.8		Some
Metal products	5.9	X	X
Petroleum products	2.0	X	X
Bulk liquids or chemicals	3.8	X	X
Dry bulk	7.0	X	X
Forest products	4.8	X	X
Live animals	2.4		
Construction material	1.1	X	X
Seed, feed	3.7	X	X
Trailer, building and currier, R.V.	1.0		
Household goods	0.2		
Mail	0.3		
Nursery, greenhouse, etc.	0.4		
Industrial products	1.8		Some
Waste	1.3	X	X
Service vehicles	6.8		
Empty	43.3		

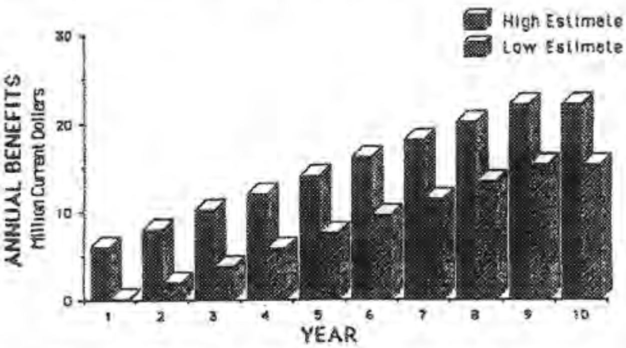
can take advantage of both types of load increase, whereas the deliveries to retail outlets in communities generally cannot use the large vehicles.

This type of more thoughtful rationalization is the basic difference between the low and high estimates. To continue the fuel example, the low estimate assumed only the refinery to distributor fuel movements were amenable to trip reduction by using larger trucks. The high estimates assumed all fuel movements on the rural system not "cubed out" could take advantage of increased pay loads.

The existing vehicle kilometers driven by each truck type was calculated from existing classifications and link data. The operating costs obtained from the Alberta Trucking Association, were applied to calculate the existing annual operating costs, with the current "fleet" of trucks.

Successive calculations were made of the trip reductions in each truck type, and estimates were made of the gradual conversion of equipment to take advantage of the changed regulations. New operating costs were applied, which accounted for the increased weight being pulled. This was done at the low and high estimates for both types of increase. The incremental difference from the existing operating cost is the "benefit".

The calculations were made for a theoretical one year after the change and after eight years, which the trucking industry advised would be the time for the industry to adjust to the new rules and convert equipment. Clayton and Sparks, in discussing changes to the prairie region truck fleet in response to previous regulatory changes (4), confirm that changing weight or dimension regulations has not resulted in rapid or large scale fleet modifications. They found the fleet modifications to be less than most industry observers anticipated. It is interesting in that regard that the Alberta Trucking Association provided a parallel benefit analysis which was slightly higher than our "high" estimate.



Benefit of increasing G.V.W. to the sum of allowable axle loads trucks > 7 axles

FIGURE 2

The range of benefits of increasing G.V.W. of trucks with greater than seven axles to 62,500 kg are shown in Figure 2, and for increasing the winter tolerance in Figure 3.

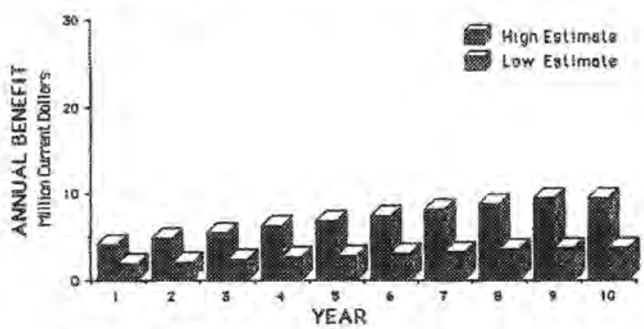
CONCLUSION

The benefit analysis has quantified the benefits of both regulatory devices to increase payloads and thus reduce trips.

	Annual benefits			
	Year 1		Year 10	
	Low	High	Low	High
Increased G.V.W. 7 axle trucks	$1m	$6m	$15m	$22m
Increased winter tolerance	$2m	$4m	$ 4m	$ 9m

Current examination of operational and safety aspects of heavier vehicles has indicated that the increased winter tolerance could overstress axle assemblies and tires could exceed the braking capabilities of some units. There are also questions of stability.

But the main problem with the increased winter tolerance is staging the structural strengthening. The proposed increase in G.V.W. vehicles of greater than 7 axles would tend to apply first to the major highway corridors, and spread gradually



Benefit of increasing winter axle weight tolerance from 10% to 20%

FIGURE 3

to the rest of the system as more vehicles come into service. The increased winter tolerance would be initially more widespread, and would apply to routes which could not have structures strengthened for some time.

To put this in numerical terms, 96 bridges on the primary highway system would require upgrading to accommodate the increased G.V.W. to 62,500 kilograms. An additional 129 bridges would require strengthening to allow the increase in winter tolerance.

The unanswered questions concerning increasing the winter axle weight tolerance, and the problem of staging bridge strengthening suggests that the increase in G.V.W. be considered first. The bridge strengthening costs have not been completed, but ballpark estimates suggest that accommodating the increased G.V.W. would cost $17 million for the primary highway system and $10 to $15 million for bridges in cities.

The cumulative total of annual benefits of increased G.V.W. will likely be between $100 to 170 million over ten years. In any case the benefits are likely to outweigh the costs to a significant degree.

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