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Some Thoughts on the Reliability of Railroading

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ABSTRACT

THE PAPER CONSIDERS the problem of how to set the standards of rail service at levels which offer the best compromise between meeting the shippers' needs and keeping rail costs at economical levels.

So far as the shipper is concerned it supports the view that the most practical approach is to carry out joint research into the total distribution cost and the effect of the quality of rail service upon it. So far as the railway is concerned, it considers the alternatives of scheduling the fastest possible service and of publishing a more conservative timetable at which there is sufficient margin to make up time after delays.

It views the shippers' holding of inventories to guard against stock-out situations and the railroads' holding of more than minimal power and other investments to improve reliability as uses of capital for a common purpose. It evaluates, in a small case study, the relative advantages of these two forms of inventory.

It describes some of the routines for assessing the optimal combinations of service for the railroad to offer.

SOME THOUGHTS ON THE RELIABILITY OF RAILROADS

When I was asked to write a paper on railroad reliability, it suddenly occurred to me that, frequently though I use the word, I was uncertain about its meaning. Webster's maintains that it's what:

"can be counted upon, what is expected or required."

This in itself is somewhat of a contradiction. What is expected of the North American railroads is not always quite the same as what is required of them.

Definitions

A more reasonable definition of reliability where railroads are concerned might be that level of variance in meeting stated arrival times which our clientele demand and are willing to pay for.

There are two fundamental difficulties. Firstly, most transcontinental freight trains carry the goods of a great many customers. In addition to car load shippers, there are those whose goods move in forwarder, shipper association, and piggyback (of all plans). To satisfy the needs of the most de-

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manding, would be to offer to many of the others much higher than the minimum service quality expected and for which they would be willing to pay.

The second difficulty is that a railway can generally achieve reliability if it trades off increased journey time to obtain it. To increase the power: weight ratio of a fast freight train from, say, 1.5 to 3 h.p. per ton would save about 3 hours on a typical haul of 30 hours in CP Rail's operation. For the cost of two additional SD40's each night, one could either advertise a later close-off time or an earlier delivery time or, alternatively, one could say nothing about it and enjoy the inner warmth stemming from the conviction that your services will be on time on possibly 99 rather than 90% of occasions.

A further difficulty is in obtaining precise information regarding the standard of service that our customers require. It is only natural that in any conversation with them, they should state that a service of unfailing reliability and earthshaking speed should be the target. More seriously, it is sometimes very difficult for a manufacturing company to make up its corporate mind regarding transportation specification because it probably has very little idea of the rate the railroad would charge for each combination of journey time and reliability and it may not even have any clear picture of how such a combination would affect its own total cost of distribution.

There is also the possibility that the traffic manager—bless him—sees matters in a somewhat personalized manner. He may be subjected to criticism within the company whenever the standard falls below what the sales manager, production manager, etc., have grown to expect and his views may reflect a Pavlovian conditioned response rather than a logical analysis of his company's position.

There are two difficulties in going to one's customer with a schedule of various qualities of service and various rate levels. The first and most obvious where the U. S. is concerned is that the railroad cannot assume that it will be free to vary rates with service levels. The second is that (even if the first difficulty could be overcome) the client would be justified in regarding the schedule as a commercial offer on the part of the railroad when this could not possibly be so because one customer might choose a standard of service none of the others are willing to pay for and hence that standard could not be offered.

I personally believe, therefore, that by far the most practical approach in the analysis of customer service requirements is to join with the clientele to calculate their total cost of distribution with them and to assess the effect of both speed and reliability upon it. Much of the remainder of this paper will be devoted to describing the experiences of CP Rail in applying a system of this kind to its clientele.

To know what one's customers would—or should—be willing to pay for one's product is very valuable but it can be deceptive information unless accompanied by knowledge of the effect on railway costs of providing the specified levels of service. We, therefore, regard our total distribution cost model and our multi-parameter cost model as part of the same computing system and we designed them as far as possible to measure change in one and the same range of service qualities.

It is not my purpose here to spend time in discussing the cost model which we generally refer to as FRATE, because this has been described in a number of earlier technical papers, but it is perhaps worthwhile, before returning to the subject of reliability and its measurement, to consider for a moment what it is we are trying to optimize.

All too often the objective of a calculus of this kind is assumed to be the sum of discounted net earnings, being the difference between the sum of discounted net revenue and the sum of discounted net cost.

All too often the life of the railway equipment is assumed to be 15 or 20 years but the movement of the particular goods in question may not be assured over such a period. Similarly, transport analysts sometimes fail to distinguish between such cost items as wages and fuel and cash flow items such as the depreciation on cars and locomotives which, although expenses in an accountant's and in a taxation sense, augment the funds which may be used for any desired purpose.

Personally I have grown to prefer the cash flow approach to conventional accounting. (This is the term which economists use when they really mean pay-back period, but remember that they were taught at their business schools that this is an old-fashioned concept.) I have found that the discounted sum of cash benefits over, say, ten years is a very realistic yardstick for appraisal and one which generally produces sensible results.

Our total distribution cost model, which we call MINDISC, calculates the cost of shipments of one kind between one pair of points by summing the cost of warehouses, inventory, packing, packaging, insurance, deterioration, as well as transportation. The shorter the journey time the lower will be the cost of warehousing, inventory, insurance, and deterioration. The lower the reliability, the higher will be the size of inventories (and associated costs) that must be held to avoid an occasional stock-out.

But for higher reliability, the higher the inventories the railway itself must hold. To put an additional locomotive in a train in order to increase reliability rather than to advertise a shorter journey time in the published timetable is, of course, to carry additional inventory. Hot box detectors and computerized car tracing systems are other examples of inventory carried to increase reliability although they may have additional payoffs in reduced delays and in the improved utilization of cars and locomotives.

The essential truth is that the client's holding of inventories to avoid a stock-out and the railroad's holding of inventories to prevent lateness, which might cause the client to stock out, have a common purpose. If the client owned an exclusive railroad, it would be reasonable for him to view these two inventories as alternative means of achieving the same purpose and to adopt the combination of them that achieves the purpose at least cost.

The fact that the clientele do not own the railroad does not affect the economic principles which should govern their collective actions. The principal factors which prevent the clients and the railroads from producing, by the normal competitive process, a distribution system optimally suited to their needs is the inflexibility of rate regulation coupled with ignorance both on the client's part of what his total distribution costs really are, and on the railroad's part of the effect of railway inventory—car trace systems for example—on reliability.

If one adopts this basic concept then it is not too far fetched to visualize premium payments for high quality service as a transfer of the shippers' reduced cost of inventory and warehousing to the railroad to meet the increase in cost of holding larger inventory within the railway system.

This may seem excessively theoretical so I shall now explore the approach in a more practical manner. Using "FRATE" we simulated the cost of running a 90 car train from Toronto to Calgary carrying—for the sake of simplicity—one kind of consumer non-durable product moving in car loads. The gross trailing load of the train was 4168 tons.

We simulated motive power formations made up of from two (the minimum to haul the train) to eight SD40 locomotives measuring for each additional unit:

1. the decrease in journey time;
2. the percentage of on time performance to be expected compared with the use of two units. This we obtained from records of arrival times actually achieved.

Then using MINDISC we computed the total distribution cost with a range of door to door times varying from 2.5 to 5 days, assuming in each case that on 99% of occasions, delivery would be within this time.

MINDISC indicated that for this particular product, the maximum saving which could be made in the shippers' total distribution cost by providing a theoretical "perfect" service would be in the order of $2.50 per ton. By "perfect" I mean the fastest service that would be technically possible to achieve using any power:weight ratio and this would be achieved on 99% of occasions.

This is not wholly realistic because the fastest possible service cannot be achieved as reliably as a slower service, because by definition, there can be no recovery margin to make up lost time and on more than 1% of days, winter storms would be expected to cause delays. This computation served the purpose, however, of setting a maximum limit on what the railroad could afford to spend in improving service quality for this particular traffic.

Unfortunately, the cost of using power in this manner would cost more than $5 a ton by comparison with the present standard and, as it would not be assured of saving this particular shipper the $2.50 per ton of potential saving, this change would not benefit the overall shipper/railroad position.

If such an increase in cost were passed on to the shipper, he would be made worse off. Better that he carry the inventory himself to the extent necessary to insure against loss of his market, than that he should pay the railroad to carry it for him.

In this particular case study, a smaller improvement in railroad service might be worth considering. An increase from three to four 3000 h.p. units would increase railway cost by about $1.50 per ton, but would reduce the total distribution cost to this particular shipper by about $1.20 per ton, so it is still not worthwhile.

There are three stages of refinement before this oversimplified analysis becomes useful. Firstly, a range of products varying widely in value:weight ratio must be considered. For some high value products, the shipper could improve his position by meeting the cost of higher power:weight ratio because the reduction in the total distribution cost of his product would be even greater.

The method I recommend for this single train analysis is to:

1. Establish a representative sample of commodities on the train.
2. Establish the long term variable cost of using any number of locomotives within limits of physical possibility at the low end and ultimate absurdity at the high end.
3. For each number of units, compute the sum of the differences between unit distribution cost and long term rail variable cost for the content of the train.
4. Select the power to weight ratio at which sum of the differences (and therefore the railroad's profit) is maximized.

The second refinement is to cope with the possibility that it might pay to run trains of differing service quality. The third is to take account of competing modes.

MINDISC can, of course, compute total cost of distribution for truck service as well as for rail. FRATE can compute cost of line haul for trains of any size as well as for any power:weight ratio.

To analyze the whole train service and to take account of the actions of competition, the procedure needed to identify the best rail strategy in terms of number and performance standard of train is as follows:

1. List each combination of train size and power to weight ratio.
2. For each of these combinations compute the total distribution cost for each product of each quality of rail service offered assuming (for the moment) that the rail rate equals the long term variable cost. Assign each product to one of the trains postulated.
3. Compute for competing truck movement the total cost of distribution for each product assuming various qualities of service and using the appropriate cost in each case. Repeat the procedure for air freight when appropriate.
4. For each train no./size/power:weight combination and for each product assigned to a particular train, test if there is any truck (or air) quality of service at which total distribution cost would be lower than that offered by rail. Delete such items.
5. For each train combination compute the sum of differences between total distribution cost and long term rail variable cost and find that at which the sum of differences is greatest.

6. If the size of any train differs substantially from that assumed in 1, repeat the calculation on the revised tonnages.

Note that I have not dealt with the problem of directional imbalance or with the marginal cost pricing that generally accompany them. The procedure could be extended to analyze such situations but would be lengthy to describe.

Note too, that I have said very little about the rail rating system. For each product the rate could be at any level between the lower limit of the rail long term variable and the upper limit at which either total distribution cost by rail would equal the lowest total distribution cost obtainable by a competing mode, or the goods would cease to move, or some regulatory agency would intervene.

If this procedure seems excessively complicated I would remind you that Oscar Wilde considered that:

"Truth is rarely pure and never simple."

It is important to point out that to use FRATE and MINDISC for the procedure I have described involves a lengthy manual procedure. I see no reason, however, why a computer technique should not be developed which would analyze the competitive situation on each route and indicate the specification of the most profitable train service within a few minutes.

Although such a program would be an even more powerful aid to decision taking than FRATE and MINDISC used with manual manipulation of the figures, one should not pretend that several months of trial use would not be required before it could be applied with confidence. Part of the usefulness of techniques of this kind lies in deepening the understanding of the problem on the part of the users who play a kind of "business game"—if unconsciously—whenever they use it.

The computation I have described measures the influence of reliability on total distribution cost and the cost of improving reliability by powering trains to be able to recover some margin of lost time.

It does not measure the effect of car trace systems, hot box detectors, C.T.C. systems, or two way radio on reliability or indicate any R.O.I. on their installation. Neither does it measure the cost to the railway of breakdowns which, together with value of service to the shipper, makes up this return.

Our experience in Canadian Pacific with this form of analysis has been both useful and encouraging. Altogether we have been in touch with some thirty companies. The original purpose of making contact was mainly to establish the most cost effective standard of service for the original exercise on the lines described earlier in this paper.

Generally the effect of small changes both in journey time and in reliability have been shown to be rather less dramatic than many of us would have imagined. This is for two general reasons. Firstly, the total distribution costs of products of under 14¢ per pound in value:weight ratio are relatively insensitive to changes in journey time over the range of operation between the best a railroad could possibly achieve and the worst a very poor railroad might provide.

Secondly, businesses tend to carry more inventory in terms both of input materials and also of their product than they appear to really need based at least on what is seemingly a rational economic calculus. For this reason MINDISC was designed to measure the effect on total distribution cost of railway services both:

- with inventory levels of optimum efficiency having regard to the probability and the cost of the stock-out and to the cost of holding inventory;
- with the inventory levels in fact carried.

Where the latter is concerned, we often found that even with high value products the range of inventory levels achievable with various qualities of rail service was much less than the inventory actually carried.

A cynic might suppose that this is because of a past record of unsatisfactory performance by the transportation industry. Personally, I rather doubt if this is the correct conclusion. Several companies appeared to be very surprised to see the kind of savings they could make by optimizing their distribution systems regardless of the form of transportation they employed, suggesting that they had not previously looked to this field for savings and had got used to living with stocks at a comfortable level.

One of the by-products of our exercise was to get to know our shippers better and for both to understand the other's problems better than before. I would not suggest to you that our relationship is not and will not continue to be strongly commercial, but by understanding better the ways in which we can save our clientele the most money, we are also learning ways of improving our own business position. Within CP Rail itself the Marketing & Sales Department in our two largest cities as well as at headquarters have trained members of their staff to understand and to use these programs which are now being put to effective use in day-to-day business.

The work I have described to you is little more than a start at tackling the problem of establishing the quality of rail service most suited to the clientele and most profitable to the railway. The work we have done is useful in establishing a direction in which to head; it is very far from being a detailed map. There is a great deal more to be done in training and in deepening understanding of these methods as much as in producing new, more sophisticated analytical tools.

After several years of working on projects of this kind I personally am convinced that such a large and complex undertaking as a railroad is unlikely to orient its strategies towards its market and vis-à-vis competing modes with close to optimal success unless it employs devices of this kind. I believe, further, that the effect on the efficiency of the distribution system as a whole in the United States and in Canada will be improved by the more general use of analytic techniques of this and allied kinds.