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THE TIME DIMENSION IN RAILROAD OPERATING SCHEDULES: FACT OF SEMANTIC SMOG

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INTRODUCTION

The transportation service provided by a railroad can be viewed in terms of the model shown in Figure 1.

Figure 1

Railroad Service Model

<u>Economy</u>		<u>Level of Service</u>
		Speed
		Reliability
	Railroad	Loss & Damage
	Traffic	Equipment
<u>Competition</u>	Carried	Information
Highway		
Water		<u>Rates/Prices</u>
Pipe		

Of these components, the level of service warrants closer examination as the literature contains little information about how railroads operate to attain a given level of service.

Railroads have, historically, been criticized by many scholars for their inattentiveness to service (Wyckoff 1976, Gellman 1986). Many recent articles have surveyed a plethora of shippers to determine railroads responsiveness in meeting and dependent upon the audience being questioned. Certainly, members of CURE (Consumers United for Rail Equity) have expressed dissatisfaction with the service/price option bundle (right half of Figure 1) provided by railroads (Grimm and Smith 1986, 1987). Other shippers, often contracting for their transportation purchase, have been very satisfied with performance of rail service (Rhea and Schrock 1987).

The purpose of this article is not, however, to add to the number of articles exploring shippers' attitudes and perceptions. Rather, this explanatory effort is to provide a taxonomy of railroads operating factors which can assist traffic and railroad managers in their efforts to improve railroad service (Murphy 1988, Baghi 1987, Bookbinder 1987, Urba 1978). This article expands previous research concerning shippers' needs, but form the perspective of how railroads actually fulfill their service obligations (Williamson 1985, Lieb and Miller 1988, Ditmeyer 1987). The focal issue, form a railroad perspective, is a comparative assessment of how two Class I railroads provide service to their customers by type of train.

The paper is organized as follows: The next section discusses railroad operating characteristics of two railroads, one eastern and one western. Comparisons of operating data are presented, followed by a discussion of potential impacts. The final section provides some tentative conclusions and areas for future research.

RAILROAD OPERATING SERVICE FACTORS

When providing service to shippers in a competitive environment, railroads offer a bundle of services (Figure 1): sufficient equipment, information, claims adjustments, adherence to schedules, and speed of service. It is the latter aspect which has received little attention from scholars. Most studies assume speed is important, but typically analyze it on the basis of line haul miles per hour. In fact, speed is a function of several factors. These include line haul speed, arrival and departure times, amount of time spent in a terminal, and cutoff and availability times. Any of these elements can dramatically alter the line haul speed and, therefore, the ability of a railroad to fulfill shipper demands.

Simplistically, railroad sales personnel solicit business from shippers by offering the rail service at a specified price for a given schedule (Murphy 1988). Thus, the shipper is told that the shipment must be made available at a specified time and will be delivered at some future date and time for the quoted rate. Shippers, consignees and consignors, then plan their "Production schedules" based upon this quotation. Assuming prices remain competitive, the shipper will continue to utilize the rail carrier as long as the service performance level continues to be reliable.

Historically, railroads have not maintained high reliability levels and have experienced decline in market share (Association of American Railroads 1986). In part, this has been a result of the changes occurring in production requirements of shippers. For example, inventories have become increasingly expensive and shippers have opted for faster transit times and mode to control inventory costs. The next section explores how two railroads operated their trains to fulfill the dynamic movement requirements.

TAXONOMY AND OPERATIONAL PROVISION OF SERVICE

Two Class I railroads were selected for this study. These two roads, one eastern and one western, account for approximately thirty percent of rail traffic in the United States, as measured by ton miles, freight revenue, or miles of track.

Train briefs, published operating schedules, were analyzed to ascertain how the time dimension (door-to-door time) is actually performed. The train brief data does not permit an examination of adherence to the published schedule, thus the variance cannot be addressed.

The taxonomy of the speed variable (time dimension) is comprised of several elements from an operational perspective (Figure 2). Each of these elements contribute to the amount of time it takes to move a shipment door-to-door and, ultimately, determine whether or not the railroad can remain competitive.

While the distance, miles, reflects the geographical distance, other elements dictate the time lost in transit. Cutoff times for intermodal traffic represent the initial carrier contact with the physical shipment. From the perspective of the shipper, it represents the point for the door-to-door clock to start. The cutoff time can inhibit or promote customer service. For example, an early time (1500) means that the shipper must have the shipment at the intermodal hub no later than this time in order to be placed aboard the appropriate train. Such a cutoff time, in theory, may result in "idle time" for the workforce of the shipper if the normal workday is from 8:00 a.m. to 5:00 p.m.

Once the shipment is received, the railroad has a limited amount of time to load the traffic aboard the intermodal car and/or switch the car into the train. The amount of time will vary, but will contribute to the total transit time in any event.

Figure 2

Operating Elements Inherent in Speed

Element	Definition
Miles	miles between origin and destination
Cutoff	time shipment must be tendered at origin
Departure	scheduled departure time
Speed	miles per hour, line haul
Arrival	scheduled arrival time
Availability	scheduled time intermodal traffic made available at destination
Day	number of days in transit (from day shipment tendered to day of delivery)
Terminal	time, in hours, spent in terminals between origin and destination
Hours	scheduled duration of one haul trip, in hours
Door-to-Door	total trip time, cutoff to availability

Following the departure of the train, the line haul speed is governed by the speed of the train and the number of terminals through which the train passes. Typically, trains operating shorter distances will incur less terminal delays than longer trains. Longer trains incur delays due to mandatory inspections, crew changes, refueling, and/or awaiting the arrival of interline traffic or scheduling meets with other trains.

Upon arrival, the cars are again switched or spotted to the intermodal terminal where the trailers or containers are made available for delivery to the consignee. The total trip time from cutoff to availability constitutes the door-to-door time so critical to the shipper. This total time will vary between intermodal, priority, and general freight trains.

It is hypothesized that intermodal trains will operate at greater speeds and incur fast door-to-door times than other types of trains (priority and general). This should occur as intermodal traffic is of higher value and more time-sensitive than other traffic. According to the Association of American Railroads, intermodal traffic averages $50-$60 per ton while other traffic is considerably less (Association of American Railroads 1986).

Priority trains, while carrying time sensitive commodities, should exhibit slower transit times and greater terminal delays as these commodities are not as highly valued as intermodal traffic.

General freight trains should, comparatively, reveal the greatest transit times and greatest variance in departure times as they haul the least time-sensitive commodities. While not a part of this analysis, it can be speculated that these trains also would carry freight with the lowest comparative rates.

OPERATING CHARACTERISTICS OF SPEED

The operational elements of the time dimension are shown in Figure 3 for the two railroads by type of train.

As shown in Figure 3, the intermodal trains for both railroads are scheduled to operate at faster speeds. This would suggest that the railroads are attempting to fulfill the needs of shippers for his higher-valued freight. Similarly, the speed of the priority trains is greater than the general trains.

Figure 3

Operating Elements for Daily Scheduled Trains, By Type

	Western Railroad			Eastern Railroad		
Elements	IM	Prior	Gen	IM	Prior	Gen
No. of Trains	44	33	32	41	29	34
Ave. Miles	988	1141	417	715	584	329
Ave. Speed	31.4	24.2	18.0	28.0	18.9	16.9
Ave. Trip Hours	32.7	49.9	24.8	26.7	33.5	19.8
Days	2.6	3.2	1.9	2.2	2.4	1.9
Terminal	3.6	10.2	5.5	2.4	8.5	5.3
Cutoff to Dptr.	2.2	NA	NA	2.3	NA	NA
Arrival to Avail	3.2	NA	NA	3.8	NA	NA

Note: IM - Intermodal; Prior - Priority; Gen - General

The average miles per trip for the western road reflects the longer geographical distances to be traversed when compared to the eastern road. The data also indicates that priority trains are dominated by long hauls while both intermodal and general trains operate in short route corridors. The longer trip miles of the western road also are reflected in the longer terminal times as it incurs more inspections, refueling stops, and crew changes.

The days to receipt, departure to arrival days, appear as anticipated. A third day delivery for the western road reflects the longer average distances. Similarly, priority and general trains incur greater terminal times. Priority trains must await connecting traffic from interlining roads or connections from other trains on the same road. General trains handle non-priority freight and tend to incur more switching delays. These trains also travel shorter distances which is indicative of more local operations.

The additional data provided by the train briefs for intermodal trains permits greater insight into management attitudes for service. Quite naturally, these "hot shot" trains spend, comparatively, little time in terminals. Of the time, most is devoted to crew changes.

A more interesting statistic concerns the cutoff to departure times for the intermodal trains. Both railroads have added an average of two hours to tier schedules in order to handle the shippers' trailers or containers. For critical freight, this would appear to be an inordinate amount of time given the comparatively higher freight rates and cargo values.

Equally disturbing is the amount of time taken to make TOFC/ COFC traffic available once it has arrived at the destination. Both roads need an average of over three hours to provide the consignees with their traffic.

When the time taken on both ends of the trip (cutoff to departure and arrival to availability) are taken in to consideration, both roads exhibit a deterioration in service.

The door-to-door time provides some insight into the relative decline in market share to the trucking industry. So much time is lost in terminal delays that shippers may feel trucks offer faster service for the highly valued commodities. (See Figure 4)

While speed and transit times are important, the authors also feel that the actual times that trains arrived and departed might be critical for the three types of trains. Arrivals and departures for both railroads were grouped by the time of day as shown in Figures 5 and 6.

Figure 4

Comparison of Line Hauls to Door-to-Door*
Hours and Speed

	Road #1	Road #2
Average line haul trip hours	32.7	26.7
Average door-to-door trip hours	38.4	34.4
Average line haul speed	31.4	28.0
Average door-to-door speed	26.3	21.3

*Door-to-door calculated by adding the differences between cutoff and departure times, arrival and availability times to total line haul trip hours

Figure 5

Arrivals by Time of Day

Time	Type of Train		
	Intermodal	Priority	General
2400-0559	23	18	10
0600-1159	32	8	18
1200-1759	14	20	20
1800-2359	16	16	18

Figure 6

Departures by Time of Day

Time	Type of Train		
	Intermodal	Priority	General
2400-0559	19	14	15
0600-1159	11	15	12
1200-1759	12	13	11
1800-2359	43	20	28

With the exception of arrivals, where the time of arrival does exhibit some dependency on the type of train (Chi2 $p<.01$), departure for the types of trains appears to be somewhat random. This would suggest that railroads are, in fact, not scheduling operations for shipper convenience, but rather for their own operating convenience.

In assessing cutoff and availability time for intermodal trains by time of day, it would appear that railroads are less sensitive to shipper needs with respect to cutoff times than they are for availability times. As shown in Figure 7, more than 50 percent of the intermodal trains were made available before noon. His would suggest that the roads are attempting to adhere to shipper production schedules.

Figure 7

Combined Availability and Arrival Schedules by Time of Day

Time	Availability	Arrivals
2400-0559	10	23
0600-1159	33	32
1200-1759	23	14
1800-2359	14	16
Total	80*	85

*availability times not reported for five trains

Figure 8

Combined Cutoff and Departure Schedules by Time of Day

Time	Availability	Arrivals
2400-0559	12	19
0600-1159	15	11
1200-1759	14	12
1800-2359	38	43
Total	79*	85

*cutoff times not reported for six trains

An assessment of cutoff and departure times for both roads, Figure 8, suggests railroads provide detrimental schedules for shippers.

Assuming a working day of 8:00 a.m. - 5:00 p.m. for the shipper, the data indicates that shipments would have to have been received the previous working day or carried over until the next working day in order to meet the cutoff time for 12 trains. Twenty-nine trains, only 36.7 percent, have cutoff times during "normal working hours" and 23 trains, only 27.1 percent, depart during this time. This suggests that rail schedules are not coordinated with shipper production schedules. Such scheduling may impose burdens on the shipper as the work force of the shipper is structured in a manner that overtime may be incurred in order to meet rail schedules.

IMPACTS AND CONCLUSIONS

This article has been an exploratory effort to comprehend, from a railroad operating perspective, how two railroads provide service to shippers. Many recent articles, surveying shippers, have contended that service is exceeding cost as a prime consideration for modal and carrier selection and this study was conducted to learn how railroads schedule their operations to meet these service demands.

Two Class I railroads were studied, utilizing operating data contained in their train briefs. The train briefs represent the schedules that railroads plan to offer the shipping public for agreed upon prices.

The time dimension associated with these schedules is comprised of several elements, but from the perspective of a shipper, can be represented in terms of door-to-door time. Thus, the shipper is concerned not only about line haul speed, but also about the amount of time delayed in terminals and the delays encountered in arrivals and departures.

The data suggests that shippers are at the mercy of railroad schedules for movements of their products. Arrival and departure times appear to be somewhat random and not coordinated with "normal" working schedules of the industries served. In addition, considerable time is lost during transit as well as origin and destination terminals. This would indicate that railroad management must begin to improve adaptation of rail schedules to the production requirements of their customers.

At a time when shippers are vitally concerned about escalating inventory costs and rapidly changing markets, it appears that railroads maintain an inordinate amount of slack in schedule performance. If railroads are to recapture market share, they must be better able to offer operating schedules which truly reflect the needs of the shipper.

This exploratory effort represents only two Class I railroads and additional research is needed to study operating schedules of all railroads. An official railroad schedule guide is necessary in order to provide the shipping public with more realistic performance evaluations.

Railroads can benefit from this research by comprehending the pricing differentials that may be available with varying service options. Obviously, not all commodities require the same time dimension and it may be possible to segment further operating performance by customer and commodity.

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