Analysis of Operating and Economic Impacts of Proposed CN Purchase and Operation of the EJE

September 20, 2008

Carl D. Martland
16 Post Road
Sugar Hill, NH 03586
martland@mit.edu

Introduction

This memo provides a rough estimate of the operating, service, and productivity changes that would result from CN's proposed acquisition and operation of the EJE. Since the CN application and the draft Environmental Impact Statement (EIS) provide little information concerning the benefits of the proposed operation, it has been necessary to make numerous assumptions concerning the types of traffic that will be affected, the magnitude of the impacts, and the implications for cost and service. On September 5th, Chicago Metropolis 2020 hosted a series of meetings with railroad officials, public officials, and consultants familiar with operations within the Chicago Terminal region. I have incorporated a great deal of insight and information garnered from those meetings, but in the spirit of the meetings, I have not attributed comments or information to any individuals.

Because of the short time frame for this study, it has not been possible to conduct any extensive modeling efforts, nor has it been possible or necessary to provide extensive documentation in support of my assumptions. Instead, I have drawn upon my extensive experience studying terminal performance, including studies conducted in cooperation with UP, BNSF, CSX, NS, and CN. I have also conducted extensive research on both freight car utilization and rail freight service reliability in a long series of research projects funded by the Association of American Railroads and the Federal Railroad Administration.

While many of the assumptions and approximations in my analysis cannot be precise, I believe that they provide a reasonable picture of the types of benefits that can be expected once CN completes its planned investments in the EJE. The main conclusion is that the annual benefits are expected to be on the order of $50 to 100 million, with at least a quarter to a third of these benefits attributable directly to rail customers within the Chicago region.

This is a draft document that summarizes what I believe are the major operating and service benefits resulting from the proposed acquisition and operation of the EJE. Information from this memo will be used to help structure inputs into an economic model that EDRG will use to estimate the economic impacts of the proposed transaction on the regional and national economies. The specific results from this memo are certainly subject to change, either as more data becomes available or as better methodologies are identified for estimating the impacts of the transactions.

Current and Proposed Operating Plans

The current and proposed train movements along the CN and EJE are well-documented in the CN application and in the draft EIS.

The draft EIS does not consider the effect of the proposed merger on train movements on railroads other than the CN and the EJE. This is a major omission, because 15 to 20 trains per day must currently move via the IHB or the BRC between the Waukesha Subdivision and the other CN subdivisions or interchanges with CSX and NS.

The routing of all freight trains through the Chicago Terminal is coordinated by the CTO, and the actual routing can vary with actual operating conditions. Train speeds are limited to 10 mph on some routes, and there are frequent, lengthy delays caused by conflicting train movements. The UP and BNSF mainlines into Chicago from the west are operating close to capacity, and operations through critical interlockings can be very difficult. Operations through the terminal are exacerbated by the fact that most of the terminals within the region are also operating close to capacity and periodically become jammed, at which times they are unable to receive any additional trains for hours at a time. CN reports delays of 8-12 hours to trains trying to move to or from the Waukesha Sub line when the BRC is jammed.

Trains have considerable difficulty moving within the Chicago Terminal. The CTO measures the time at which trains pass into or out of the region, roughly defined as the perimeter defined by the EJE. Many trains are simply trying to move across the region from one railroad to another without requiring any work other than a crew change within the terminal. The average time for these run-through trains to move the 60-80 miles through the terminal is 12 hours on a good day and averages about 16 hours.

<u>Run-through trains</u>

CN did not indicate how many run-through trains it currently has or would have once the EJE route is available. Discussions with operating officials indicated that there is at least one through train currently; I have assumed that there would be two additional through trains once the EJE route is available (this would not be new traffic, but existing CN traffic that would be able to operate through the region once the network connections are completed).

<u>General freight trains</u>

Most general freight trains either originate or terminate within the terminal. The cars on the train must be classified for movement on another system train, for local delivery, or for interchange to another railroad. The Class I railroads attempt to arrange their interchange operations to minimize the amount of classifications required and to simplify the transfer of cars between railroads. Cars that are moving through Chicago are generally classified just once, at one of the hump yards, and they move through the terminal in an average of about 40 hours. Cars that are moving to or from local industry are sometimes handled at a local yard as well as one of the hump yards, adding more time to the overall terminal process.

The CN application does not indicate how many general freight trains are currently operated or an expected to be operated in the future. An estimate of the number of such trains can be made by considering a) the added classification work planned for Kirk (1355 cars per day) and E. Joliet (709 cars) and b) the likely interchange operations with the other Class I railroads. The new classifications are equivalent to 20.6 100-car trains into or out of the region. The operating plan shows a drop of two trains per day at the intersections with BNSF near Eola and also with the intersection with UP in West Chicago. I interpret this to mean that CN is planning daily trains to and from the BNSF and UP from Kirk Yard. CN plans to have interchanges with NS and CSX at Kirk Yard; NS indicated that they are willing to do so, but CSX has not yet agreed.

Intermodal trains

Intermodal traffic within the Chicago Terminal is generally believed to have three roughly equal components: trailers or containers originating in Chicago, terminating in Chicago, or moving through Chicago. Originating or terminating traffic will move through one of the intermodal terminals (Markham Yard for CN). Through traffic will be interchanged either by a drayage move between the two railroads' yards or via a block swap of the rail cars. CN will now be able to reach Markham Yard from the EJE from any of its subdivisions. For the first time, CN will have a direct route to its intermodal yard from Canada, saving approximately 14 hours by avoiding the congested routes through the center of the Chicago Terminal. According to the EIS, there will be 12 trains per day that move between the EJE and Markham Yard, of which two will continue past Markham Yard. I interpret this to mean that CN expects 10 intermodal trains per day coming in or out of Markam Yard. By the same logic, there will be 62,500 gross tons per day for intermodal traffic moving to or from Markham (tonnage data is shown in Attachment 1 to the 1/3/8 corrections to the operating plan). The gross tonnage can be converted to an estimate of loaded containers and trailers by making assumptions concerning net tons per load, tare weight and % empty return:

- Net tons/load: 15 tons (a typical load for intermodal traffic in North America) bulk
- Ratio of gross to net tonnage for intermodal traffic: assumed to be 2.5 on average (the gross tonnage per intermodal container or trailer will include weight of the locomotives, the weight of the car, the weight of the containers for loaded containers, plus the weight of the empty container multiplied by the percentage of empty containers)
- % empty return: CN indicated approximately 100% for general freight and unit trains and 0% for intermodal

With these assumptions, the 62,500 gross tons would be approximately 25,000 net tons or1600-1700 containers or trailers per day. A double stack container train can handle up to 250 containers, while a standard COFC or TOFC (container- or trailer-on-flat-car) train can handle 120 or so trailers or containers. Thus, 1600-1700 containers would be equivalent to about 10 daily intermodal trains, some of which would be double stack trains.

Local Traffic

CN has differing amounts of local traffic on its five subdivisions. The traffic volumes can be estimated from the tonnage estimates shown in CN's corrected operating plan submitted January 3, 2008. Attachment A1 to that exhibit shows the gross tons per day for the CN lines in the region. Since there will be no remaining through traffic on these lines, the gross tonnage remaining on the line represents traffic moving to or from industry. The gross tonnage can be converted to an estimate of cars and loads by making assumptions concerning net tons per load, tare weight and % empty return:

- Net tons/load: 50-70 tons for general freight; 80-110 tons for bulk
- Tare weight: 30 tons for the freight car plus a share of the weight of the locomotive (approximately 10 tons per car)
- % empty return: CN indicated approximately 100% for general freight and unit trains and 0% for intermodal

The results are shown in Table 1.

Table 1 Estimated Local Traffic

Subdivision	Gross-tons/day	GT/load	Loads	Total
Waukesha	8039	140	57.5	115
Freeport	6402	140	45.5	91
Joliet	16570	140	119	238
Chicago	1045	140	7.5	15
Elsdon	6433	140	46	92
Total			275.5	551

Assumptions: an average of 70 tons for the shipment; 30 tons tare weight for the car on the loaded move; 30 tons tare weight for the empty move; 10 tons of locomotive weight allocated to each load for the locomotive.

The highest volume of traffic is located on the Joliet Subdivision; this is where CN expects to attract some additional traffic (Attachment A1 to CN's corrected operating plan shows that CN expects to attract a total of 4037 additional tons of freight, with 5818 additional gross tons of freight on the Joliet Subdivision). This traffic would be handled in much the same way as it is currently handled except that service would be from the south (E. Joliet) rather than from the north. There are modest amounts of traffic on the Freeport Subdivision and Waukesha subdivisions, which would initially continue to be handled by local trains operating out of Hawthorne and Schiller Park. Eventually, these locals would operate out of E. Joliet or Kirk Yard. There are also modest amounts of local traffic near Markam Yard and on the Elsdon subdivision that are currently served via Markham yard; these local trains would immediately be shifted to Kirk Yard. By serving industry from the periphery, CN would in most cases avoid the need to move this traffic through the center of the Chicago Terminal, saving considerable train delay as well as avoiding the need for an additional yard classification.

Type of Train, by Subdivision

CN has not provided any specifics concerning the types of trains operating in and out of Chicago on each sub-division. However, an estimate of the types of trains can be made based upon the information and assumptions presented above. The second column of Table 2 shows the trains per day at the outermost portion of each subdivision, as shown in the CN application and the EIS. I interpret this to be the trains per day that are coming into or departing the region. The remaining columns show my estimates of the number of each type of train. Since CN has not volunteered anything other than the total number of trains and typical train characteristics, I have had to estimate this information.

Table 2 Estimated CN Trains in and out of Chicago Terminal Daily, by Type of Train

Subdivision	Trains/ day	Intermodal	Local	Interchange	Through Train	General Freight
Waukesha	19.1	4	2.0 (1)	2 – CSX 2 - NS	2	8
Freeport	3.0	0	1.7 (1)	0	0	2
Joliet (E. Joliet)	2.0	0	2.0 (1.5)	0	0	0
Chicago (Markham)	12.6	2	2.0 (1)	1 – BNSF 1 - UP	0	7.6
Elsdon (Kirk Yard)	22	4	2.9 (1)	1-BNSF 1-UP	4	10.6
Total CN trains in plan (entering, leaving or local)	63.8	10	10.6	8	6	29.2
Total trains entering or leaving	58.7	10	5.5	8	6	29.2

Column 3 of the table shows the intermodal trains. As discussed above, I believe that CN plans to have 10 trains per day in and out of Markham Yard. I have assumed that 4 trains go to or from Canada, 2 trains move to or from the south, and 4 move to or from the east and southeast.

Column 4 shows two numbers. The first is the number of trains (other than intermodal) on each subdivision in the proposed operation. I assume that these are local trains, which are likely shorter than the general merchandise trains entering or leaving the region (i.e.

the trains that would originate or terminate at Kirk Yard). The analysis in the previous section indicated that there are approximately 550 loaded or empty cars to or from local industry each day. I estimate that this is equivalent to 5.5 100-car general merchandise trains coming into or leaving the region with local industry traffic. I have allocated these 5.5 trains to the sub-divisions as shown by the numbers in parentheses in this column. The local trains are included in the 63.8 trains identified in the CN operating plan. However, the 550 cars handled by the local trains are equivalent only to 5.5 of the 58.7 100-car trains that would be entering or leaving the region.

Column 5 shows the interchange traffic. I am assuming that there is the equivalent of one trainload per day from the Waukesha Subdivision to and from both the CSX and the NS. Likewise, I assume that there is the equivalent of one trainload per day each way between CN (GTW and IC) and both the BNSF and the UP. Because of geography, I doubt that there is much interchange between CN and CP or between CN (from Canada) and BNSF or UP.

Column 6 shows the estimated three through trains, each of which counts twice as entering or leaving the region. The general freight trains in Column 7 are estimated by subtracting the sum of the other types of trains from the total for each subdivision. In calculating this number, I have used the numbers in parentheses from the local column. This column represents the general freight that comes into Chicago along one of CN's subdivisions and departs on one of the other CN subdivisions. Thus, the total of 29.2 general freight trains entering or leaving the region is equivalent to 14.6 trains operating through the region.

The overall total of 58.7 trains matches the total proposed trains used in the EIS. This represents the mainline trains that would be entering or leaving the EJE route.

Using these approximations and a few more assumptions, it is possible to estimate the percentage of CN traffic that involves Chicago customers:

- Intermodal: assume 1/3 originates and 1/3 terminates in Chicago (7,200 tons originates and 7,200 tons terminate).
- Local: assuming 275.5 loads per day (see Table 2) and 70 tons per load, there will be 19,300 tons of CN traffic originating or terminating in Chicago.
- General freight: assuming 14.6 trainloads of freight through the region (see Table 2), 100 cars per train, 50% loaded, and 70 tons per car, this means that there are about 51,100 tons of general freight that moves through the region from one CN line to another CN line.
- Through freight: 3 through trains without origin and terminus in Chicago. With 100 cars per train, 50% loaded, and 70 tons per car, this means that 10,500 tons of freight by-pass the region and avoid classification at any CN yard.
- Interchanged traffic: some portion of this traffic will be interchanged to the other roads for delivery to customers within the region, just as some will be originated on CN lines within Chicago and delivered to another railroad in Chicago for movement out of the region. I assume that the great majority – say 90% - of this

traffic is has no trip end within the region. If there are 8 100-car trains per day with 50% loaded cars and 70 tons per load, there would be 28,000 tons per day total of which 25,200 would be through traffic and 2,800 would be originating or terminating within Chicago.

The total would be as shown in Table 3. Of the estimated total of 130 thousand tons of CN freight moving within the region, approximately 28% would be originating or terminating within the region.

Table 3 Estimated Tonnage Originating or Terminating Within Chicago Region

	Chicago Origin or Destination	**Other Traffic**	**Total**	**%**
Intermodal	14,300	7,200	21,500	16%
Local, to CN lines	19,300		19,300	15%
CN, through general freight (classified at E. Joliet or Kirk Yard)		51,100	51,100	39%
CN Run-Through Trains		10,500	10,500	8%
Interchanged	2,800	25,200	28,000	21%
Total	36,400 tons/day	94,000	130,400	100%
%	28%	72%	100%	

Improvements in Performance for CN Traffic

<u>Freight Car Utilization</u>

Intermodal trains to or from Canada would no longer have to traverse the congested center portion of the Chicago Terminal, saving 14 hours per train. This estimate assumes that the average time to traverse the terminal will slowly increase, from the current average of 16 hours to 17 hours as of the completion of Phase III of the CN's upgrading of the EJE. The EIS estimated that the travel time from the Waukesha Subdivision to Kirk Yard would be somewhere between 2 and 4 hours; I assume that the intermodal trains would be able to cover the shorter distance between Markham Yard and the Waukesha Subdivision in 3 hours. Intermodal trains to or from the south and the east would not be affected, as they would still be using existing CN lines (the Elsdon and the Chicago Subdivisions) to access Markham Yard.

Through trains would also save approximately 14 hours per train in by-passing the center of the Chicago Terminal.

General freight trains would all be routed to or from Kirk Yard or E. Joliet Yard. All of this traffic would be moving around the EJE from one CN line to another, with savings on the order of 14 hours by by-passing the center of the Chicago Terminal. In addition, a portion of this traffic currently requires two classifications to move through the terminal. CN did not provide an estimate of the fraction that would save a classification, but indicated that most traffic currently requires only one classification. I therefore assume that 20% of the traffic avoids a second classification, saving an average of 30 hours per car.

Local train service would be simplified in the new operating plan, as classification would be concentrated at two yards (E. Joliet and Kirk) and local trains would operate in from the EJE rather than out from one of the yards in the congested center of the Chicago Terminal. CN did not provide as estimate of the fraction that would save a classification, but indicated that most traffic currently requires two classifications. I therefore assume that 80% of the traffic avoids a second classification, saving 30 hours per car.

Interchange service would also be simplified if the interchanges were moved as anticipated in the proposed operating plan. The traffic interchanged between BNSF/UP and the IC/GTW lines would be moved along the EJE rather than going through the center of the Chicago Terminal, as would the traffic interchanged between the Waukesha Subdivision (i.e. Canada, Wisconsin, and Minnesota) and the IC/GTW lines. All of this traffic would save approximately 14 hours in train time and some (I assume a small portion, say 20%) would save work at one or more yards.

Table 4 summarizes the travel time impacts. The average savings per car is 16.4 hours, which is consistent with CN's estimated savings of 15-18 hours per car. The total car-hour savings are 80 thousand per day or 29 million per year. A typical value for car-hire is $1/hour, so that these car-time savings amount to approximately $29 million per year. Since cars involved in these moves may be owned by CN, other Class I railroads, other railroads, customers, or car supply companies, it is unclear who would actually receive this savings. Given the competitive nature of freight transportation, it is likely that improvements in utilization will ultimately be passed on to customer in the form of lower rates even if the customer does not own the cars.

Locomotive Utilization

A similar analysis can be done for locomotive utilization (Table 5). If diverting trains away from the center of the terminal saves 14 hours per train, then there will also be 14 hours saved for every locomotive unit on the train. Table 1 indicates that there are 58.7 CN trains entering or leaving the region. However, the run-through trains should only be counted once, because they both enter and leave the region. Likewise, only half of the general freight trains that are classified at Kirk Yard should only be counted, since half of these trains will be arriving from or departing to the east or the south and therefore having very little savings from routing via the EJE. Another way to look at this portion of the freight is that each car on these trains will be traversing the Chicago Terminal once, but it will arrive on one train and depart on another.

Table 4 CN Service Improvements

	Daily Traffic Volume	Savings in Train Time	Savings in Yard Time	Total Time Saved	Hours Saved/Day
Intermodal					
• To or from Canada	720	14	0	14	10,080
• Other	1080	0	0	0	0
CN Run-Through Trains	300	14	0	14	4,200
Local, to CN lines					
• Bypass one yard (80%)	440	14	30	44	19,360
• Same number of yards (20%)	110	14	0	14	1,540
CN, through general freight (classified at E. Joliet or Kirk Yard)	1460				
• Bypass one yard (80%)	292	14	30	44	12,848
• Same number of yards (20%)	1168	14	14	14	16,352
Interchanged	800	14	6	20	16,000
Total	4910				80,380
Average per car or intermodal unit				16.4 hours	

Table 5 Locomotive Utilization Savings

	Daily Trains	Savings in Train Time	Locomotives per Train	Total Time Saved	Hours Saved/Day
Intermodal					
- To or from Canada	4	14	3	14	168
- Other	6	0	3	0	0
CN Run-Through Trains	3	14	3	14	126
Local, to CN lines	5.5	14	3	14	613
CN, through general freight (classified at E. Joliet or Kirk Yard)	14.6		3	14	231
Interchanged	8	14	3	14	336
Total	41.1				1474

Thus, the locomotive savings can be estimated by assuming that 41.6 trains per day will each save 14 hours by by-passing the center of the terminal. If there are 3 locomotive units per train, the daily savings will be 1474 hours, as shown in Table 5. This savings is 0.3 locomotive-hours per car, and the savings will initially accrue entirely to CN, as CN either owns or leases the locomotives used for its trains. If a locomotive costs $2 million, then the annual carrying costs or lease rates will be on the order of $200,000 per year, which would be $25/hour assuming 90% serviceability. Taking $25/hour as the marginal benefit from saving locomotive hours, the daily savings would be $37 thousand and the annual savings would be $13.5 million.

Service Reliability

Customers whose shipments by-pass a yard will not only enjoy savings of nearly two days in average trip time, they will have more reliable service. For example, consider a hypothetical move between western Canada and Chicago that currently is scheduled to be handled at five yards, including two in Chicago. This move might initially experience typical levels of service for general merchandise traffic: an average trip time of 7-8 days, with the 95th percentile of the trip time distribution equal to 9-11 days. Accessing the proper CN subdivision via the EJE could save nearly two days: 14 hours by avoiding a congested route through the center of the terminal and another 30 hours by avoiding one of the yards in Chicago. The 95th percentile of the trip - a time that shippers might consider more relevant the average trip time in planning their inventories – will probably drop close to 3 days.

Table 6 shows an example of the effect that improved line and yard operations might have on the trip time distribution. This table shows various performance measures for a 1000-mile trip that requires three, four, or five yards. In each case, it is assumed that cars are scheduled to spend 18 hours in each yard, but there are different probabilities that the cars might miss connections and be delayed another 24 hours until the next day's train departs. The base case schedule includes 50 hours to travel 1000 miles at 20 mph, 90 hours total time for 5 yards, plus an additional 12 hours of delay in moving across Chicago. At each yard, there is an 80% chance of making the desired connection and a 20% chance of being delayed until the next day's train. The average trip time is therefore longer than the scheduled time by a factor equal to 24 hours multiplied by the expected number of missed connections. The 95th percentile can be calculated by assuming that the delays are independently distributed and using the binomial distribution to determine the probability that cars are delayed 0, 1, 2, 3, 4, or 5 times. In the base case, there is a 20% chance of missing each of five connections, so that the average time is 24 hours longer than the scheduled time (5 yards x 0.2 probability of missing connection x 24 hours delay if connection is missed = 24 hours). The 95th percentile in this case is 224 hours; it is necessary to add three days beyond the scheduled time in order to have a 95% chance that the shipment will arrive on time.

The next row simply eliminates 14 hours from the trip to represent the savings from routing via the EJE. All of the performance measures are reduced by 14 hours.

Table 6 How By-Passing a Yard Improves Reliability

	Yards	PMAKE	Scheduled Trip Time	Average Trip Time	95th Percentile
Base Case	5	80%	152	176 hrs	224 hrs
Better access via EJE	5	80%	138	162	210
Better access and more reliable connections	5	90%	138	150	186
Better access and by-pass yard in Chicago	4	80%	120	139	168
Better access, by-pass yard and more reliable connections	4	90%	120	130	144

The third row shows what happens if the more reliable train operations lead to more reliable yard operations. Instead of an 80% chance of making each connection, there is a 90% chance – and therefore only a 10% chance of missing. The average trip time drops another 12 hours and the 95th percentile drops a full day, from 210 to 186 hours.

The fourth and fifth rows show further improvements if a yard is by-passed in Chicago. The fourth row has the base case PMAKE (which is pronounced P-Make and stands for the probability of making a connection) of 80%; better access and by-passing a yard reduces the average time by 37 hours and the 95th percentile by 56 hours from the base case. The case illustrated by the last row has improved PMAKE of 90% along with better access and connections as well as by-passing a yard. In this most optimistic case, the average trip time drops by 46 hours and the 95th percentile by more than 3 days (80 hours) relative to the base case.

Equipment Utilization Benefits for Other Traffic Using the Chicago Terminal

Removing traffic from any congested network will improve performance for the remaining traffic. Applying this basic principle of transportation systems analysis to the current situation will provide a lower bound upon the performance benefits that would result from the proposed diversion of freight trains to the EJE.

The Chicago Terminal is operating close to its capacity, and it is certainly congested. Discussions with railroad officials indicated that train delays are extensive, service reliability is poor, and the terminal risks gridlock in the event of a major storm. Rail-rail crossings, conflicts among freight and passenger trains, outmoded infrastructure, slow orders, and yard capacity problems all contribute to the terminals difficulties. For trains that are just trying to pass through the terminal with nothing more than a crew change, the average time required is 16 hours, and 12 hours would be a very good time. Since the terminal is at most 80 miles across, even the best time indicates an average speed of only 6-7 miles per hour.

Despite the difficulties of getting through the terminal, Chicago remains the nation's largest rail hub for two major reasons. First, the geography of the country is such that Chicago is on a direct route for a very large proportion of all rail moves. Second, the industry has constructed high quality, multi-track mainlines that converge on Chicago. No other terminal in the country has the capacity to handle the volumes of train movements that converge in Chicago. Hence, even though the terminal is congested, its strategic location still attracts more freight traffic through Chicago, which in turn continues to make Chicago an ideal location for companies that use rail service.

The Class I railroads have created the CTCO to coordinate movements through the Chicago Terminal. This group has access to a model of the entire Chicago Terminal (but not including the EJE), which it can use to determine the extent of train delays associated with various operating plan, traffic flows and capital improvements. This model was used to illustrate the potential effects of completing the CREATE projects. One study, completed with 2004 as a base year, assumed annual growth rates of approximately 3% for coal, 1% for carload, and 4% for intermodal. While the results have not been made public, rail officials familiar with the analysis indicated that CREATE would enable the terminal to run better in 2035 than it now does, while failure to implement CREATE would lead to gridlock before 2015.

In any complex congested transportation network, the marginal delay associated with each increment of traffic exceeds the average delay. Hence, adding more traffic to the system increases the average time for all traffic moving within the system. As the network approaches capacity, delays extend from critical bottlenecks and affect movements through more and more portions of the network. A hump yard that operates smoothly with an average yard time of 24 hours per car for volumes less than 2000 cars per day may have average yard time climb to 28 or more hours when volume reaches 2200 cars per day. In this case, the increment of 200 cars has increased total delay from 48,000 car-hours (i.e. 24 hours/car x 2000 cars per day) to 61,600 (i.e. 28 hours/car x 2200 cars) . The increase of 13,600 includes the 5,600 hours of delay for the incremental traffic (28 hours/car x 200 cars) plus 8,000 hours of delay for the initial traffic (2000 cars per day delayed an extra 4 hours per car). More generally, a 10% increase in traffic can easily lead to more than 10% increase in average delay for congested rail yards or for line operations through a congested terminal. As actual volume approaches capacity, performance becomes unstable, and events that once had minor consequences begin to cause major problems.

From all accounts, the rail operating environment in Chicago exhibits the symptoms of a highly congested network. Based upon discussion with operating officials familiar with the Chicago terminal, the average daily time for through trains to wend their way through the terminal varies from 12 to 20 hours; delays to individual trains can be far longer, especially when yards are plugged and unable to accept any more inbound trains.

Without major investment, railroad officials fear that the overall growth rate of 2-3% will lead to gridlock within a few years.

It is far beyond the scope of this operating analysis to go into the details of the operation of the Chicago Terminal with and without the CN traffic. While either CN or CTCO has the capacity for such an analysis, neither has attempted to use their existing models to simulate performance before and after the proposed CN acquisition of the EJE.

Even without any detailed analysis of the terminal, however, it is possible to provide an estimate of the potential impact of the changes on the operation of the terminal. The anecdotal evidence certainly supports the logical approach:

- The terminal is operating close to capacity, so that small increases in traffic will lead to longer average times and lower reliability for movements through the region.
- The same logic indicates that small decreases in traffic will lead to shorter average times and higher reliability for movements through the region.
- The terminal has many alternative routes available for moving between the dozens of major rail yards that are operated by the Class Is, the IHB, and the BRC. Any significant capacity added to any of these routes could lead to adjustments in the flows throughout the terminal.

In the absence of any specific studies of the Chicago terminal, I would assume that the congested operations within the terminal exhibit the behavior discussed above: a small increase in traffic can increase average delay for all previously existing traffic. I therefore estimate that the benefits to the other flows through the terminal would in the aggregate be at least as great as the benefits to CN's traffic. CN estimates savings of 15-18 hours per car, which I have broken out across various traffic classes in the Table 4 above. The total annual car-hour savings are estimated to be 29 million per year, while the daily locomotive hour savings are estimated to be more than 0.5 million per year. I therefore expect that benefits to other traffic flows would be annual reductions of more than 29 million car-hours and 0.5 million locomotive hours. These annual benefits would continue (and increase) until and unless CREATE or other projects provided enough capacity to allow free flow of freight through the system.

The benefits per car or intermodal unit will be much less for other rail carriers than for the CN traffic. Since CN represents only 7% of the traffic through the terminal, the savings per car for other traffic would be approximately 7.5% (i.e. 0.07/0.93) of the savings per car for CN's traffic: 1.2 car-hours per car and 0.02 locomotive hours per car. Using the same logic as used for the CN analysis, the value of these savings would be at least $29 million for freight cars and intermodal equipment and $13.5 million for locomotives. As with the CN traffic, the benefits related to shipments moving to or from Chicago would be expected to be about a quarter of the total.

Rail/Highway Crossing Delays

The EIS provides a detailed analysis of the delays to highway vehicles at all of the major crossings affected by changes in train volume on the CN or the EJE. Using the data presented in the EIS it is possible to calculate the total changes in delays expected for the CN and the EJE lines. While there are a few crossings on the EJE that were highlighted in the EIS because of the magnitude of the expected delays, most of the added delays on the EJE route were balanced by a reduction in delays along the CN routes:

- Increase in delay hours per year on EJE: 560 thousand
- Decrease in delay hours per year on CN: 464 thousand
- Net increase in delay hours per year on EJE and CN: 96 thousand

The EIS did not consider the reduction in crossing delays on routes other than the CN or the EJE. The net increase in delay hours is therefore less than implied by the EIS. Data on crossing delays for the Chicago region is available in a study conducted for the Illinois Commerce Commission ("Motorist Delay at Public Highway-Rail Grade Crossings in Northeastern Illinois", Working Paper 2002-03, July 2002). The data in this report can be used to estimate the average crossing delays along routes that are currently used by the CN to move between the Waukesha Subdivision and the other CN lines in the region. For example, the average delay per train moving along the IHB from McCook to Franklin Park is 6.75 hours per train (this route has 12 grade crossing, 76 daily freight trains, and 413 hours of highway vehicle delay per day at the crossings). The average delay per train moving along the BRC from Clearing to Cragin is 24.18 hours per train. Since CN plans to divert at least 20 trains per day from these and similarly conflicted routes through the city, the delays are important: saving 7 hours per train for 20 trains per day amounts to 51 thousand hours per year.

CN also anticipates moving substantial amounts of interchange traffic to the EJE, which would eliminate two trains per day on both the UP and the BNSF mainlines to the west of Chicago. Both the UP and the BNSF lines have extensive grade crossings, and the average delay to highway vehicles per train was on the order of 7 hours per train according to the ICC study. Hence, there would be another 10 thousand hours saved per year on these two routes (4 trains/day x 7 hours of vehicle delay per train x 365 days/year). The net increase in delay, taking into account these four routes, is therefore less than 40 thousand hours per year or 110 hours per day for the entire region. To put this number into perspective, there are 18 individual crossings within Northeastern Illinois that each had at least that much delay in 2002.

There will also be savings at crossings on the other routes that would have less traffic after the merger. If those crossings were also included in the analysis, there would likely be no overall increase in delays and possibly an overall decrease.

During discussions with railroad and city officials, comments were made suggesting that there would be no reductions in delay within the Chicago Terminal on the IHB, BRC or other routes because new freight or passenger services would simply use the capacity vacated by CN. That may well be true – but the new services, not the CN, would be responsible for the crossing delays. In the context of the proposed acquisition and operation of the EJE, there is a benefit to the system in reducing the number of CN freight trains moving through the center of the region.

Impact on passenger service

Amtrak

Since CN has agreed to allow Amtrak to operate over its lines until an alternative routing is found, the proposed acquisition and change in operations will have no impact on Amtrak.

METRA

By removing 17 trains per day from the Waukesha Subdivision, the proposed acquisition will allow opportunities for increasing service. METRA has indicated that they would consider adding 10 week-day trains plus additional weekend service on this line. The additional commuter service would provide the types of economic and environmental benefits normally associated with such services. For example, if the added trains carried an average of 150 passengers a distance of 10 miles, then each train would save 1500 passenger miles that presumably would otherwise move on the highways. Over the course of a year, 10 such daily trains plus 4 weekend trains would carry 1 to 1.5 million passenger-miles.

There is also a concern with the potential for delays to METRA trains that cross the EJE. Since METRA has first priority at all of these crossings, they should have minimal impacts resulting from the increase in CN traffic.

Efficiency Savings

CN has identified labor efficiencies resulting from the joint operation. Their application and the EIS identified 114 positions that could be eliminated once the operations were completely integrated. The three major categories were as follows:

- 36 Maintenance of Way (because CN would use its more efficient MOW forces to upgrade and maintain the EJE)
- 36 Train and Engine Service (because CN and EJE local operations would be more efficient once they were combined)
- 28 Clerks (because CN would introduce its more efficient information systems)

According to AAR statistics ("Railroad Facts"), the average wage for MOW workers was $57,000, the average wage for T&E service was $66,000 and the average wage for professional and clerical workers was $64,000. Employee benefits and payroll taxes amounted to 38% of wages for the industry as a whole in 2006. The average 2006 total of wages plus benefits for the positions that could be eliminated on the EJE were therefore approximately $88,000 per employee. The total cost savings would be $10 million per year.

CN did not specify how the changes in operations would affect its work force. Based upon the assessment of train travel times described above, it is apparent that there will be significant impact on CN labor productivity. If more than 40 trains each save an average of 14 hours in moving through the region, there will be substantial savings in crew costs. Exactly how many crews would be saved, and how much would be saved in wages would depend upon the changes in distances as well as the changes in times. However, a preliminary estimate is that there would be a reduction of at least 41 2-person crews per day as a result of the more efficient routing of trains along the EJE. The reduction of 82 T&E jobs with an average wage of $66,000 would save approximately $8 million per year including benefits.

CN would also reduce its yard costs by a) reducing the amount of classifications required and b) by consolidating yard work at Kirk and E. Joliet Yards. According to the analysis in Table 4, more than 700 cars/day would by-pass a classification yard. This amount of work would ordinarily take up an entire shift at a hump yard utilizing one or two yard crews at the hump, two or three yard crews assembling cars, and two or more car inspectors, plus an allocation equivalent to a third of the total maintenance, clerical, and managerial employees that are required to operate a hump yard. Labor requirements at small switching yards such as CN operates at Glenn, Hawthorne and Schiller Park would be at least twice as labor intensive. I estimate that the savings would be equivalent to approximately 35 positions, an annual savings of $3 million, and a cost savings of more than $20/car per day.

Table 7 summarizes the benefits from labor efficiency. The EJE benefits are what CN provided in its application. The reductions in train & enginemen (T&E) on CN and the reduction in positions within the Chicago terminals are based upon my own rough estimates described above. I have converted the numbers of positions into hours by day by assuming each position works 2000 hours per year to get annual hours and dividing by 365 to get daily hours.

The efficiencies can, to a limited extent, be allocated to particular classes of traffic:

1. 114 EJE positions eliminated: this savings of approximately 228,000 employee-hours per year can be allocated to all of the traffic that uses the EJE, i.e. all but the intermodal trains serving southern and eastern destination, since that traffic would continue to operate to or from Markham Yard.
2. 82 train & enginemen positions eliminated on CN: this savings of approximately 164,000 employee-hours can also be allocated to all of the traffic except the intermodal trains serving southern and eastern destinations
3. 35 yard positions eliminated on CN or freed up at Clearing Yard or at other yards within the Chicago Terminal: this saving of approximately 70,000 employee-hours can be allocated to the local freight and general freight that bypasses a yard

Table 7 Labor Efficiency

	Daily Traffic Volume	EJE	CN T&E	Chicago Yards	Total
Positions eliminated		114	81	35	231
Annual hours (000s)		228	164	70	462
Daily hours		625	449	192	1266
Intermodal					
• To or from Canada	720	.16	.12	0	.28
• Other	1080	0	0	0	0
CN Run-Through Trains	300	.16	.12	0	.28
Local, to CN lines					
• Bypass one yard (80%)	440	.16	.12	.21	.49
• Same number of yards (20%)	110	.16	.12	0	.28
CN, through general freight (classified at E. Joliet or Kirk Yard)					
• Bypass one yard (80%)	292	.16	.12	.21	.49
• Same number of yards (20%)	1168	.16	.12	0	.28
Interchanged	800	.28	.28	.02	.30
Total	4910				0.26

The savings from consolidating the yard work associated with 2000 cars/day at Kirk Yard and E. Joliet could also be worth considering. There could also be further utilization and service improvements if CN were able to operate Kirk Yard with yard times equal to those at efficient hump yards (20-24 hours) rather that yard times of 30 or more hours that are likely to be seen in congested yards.

The diversion of trains from the congested center of the city would also affect other categories of train operations and track maintenance. Since the distance along the EJE would be longer for many of the trains, there could be an increase in fuel consumption. On the other hand, the trains would spend far less time idling, and fuel consumption increases per ton-mile when trains operate at slow speeds. There would be a reduction in emissions from delayed trains waiting for hours to get across interlockings within Chicago. Despite the increase in distance, crew costs, as discussed above, would likely go down, not up because of the dramatic savings in time. Track maintenance costs would also likely go down, as the EJE route would be a high density, well-maintained route.

Competitive effects

The CN application identified 4057 tons/day of additional freight and $14 million of additional freight revenue that would be gained as a result of the changes in the network structure. Most of this traffic would be originating or terminating on the Joliet Subdivision. CN currently has an operating ratio on the order of 70%, so that the additional contribution of this traffic could be estimated as 30% of $14 million or $4 million per year.   This would be an important financial consideration for CN, even though there would be minimal change in the resources used to serve these customers (just a shift of the workload and the revenue from one railroad to CN).

CN did not foresee any mode shifts resulting from the changes. In this memo, I have identified improvements in service that range from a half day reduction in trip time to as much as a 2-day reduction in travel time and a 3-day reduction in the 95th percentile of the trip time distribution.   Such changes could have a impact on mode share in some markets. In a separate memo ("Estimating the Effects of The Proposed CN Purchase and Operation of the EJE on Railroad Mode Share"), I have estimated the changes in logistics costs for typical classes of traffic and customers that would result from the service changes identified above. How much, if any traffic would be diverted will depend upon the pricing policy that is adopted by CN and its connecting railroads. It is conceivable that prices could be increased so as to maintain market share; it is also conceivable that a competitive freight market would drive prices down to marginal cost, so that customers would enjoy lower prices as well as better service and therefore ship more by rail. More likely, the railroads would share the benefits with their customers, thereby having some increase in mode split while providing customers some reduction in price. In the other memo, I estimated that the potential diversion from other modes could increase intermodal traffic by almost 2% and general freight traffic by almost 7%. This increase would add just over two trains per day or 16-17 trains/week to the EJE route (i.e. 15.4 100-car freight trains per week plus and one additional intermodal train per week).

The added traffic would have two effects on highway traffic in the region. The additional trains would increase the crossing delays estimated for the EJE by approximately 5%. The estimated increase in intermodal traffic would have a modest impact on highways by diverting 30 trucks per day. The increase in rail carload traffic would be much greater, as each freight car carries the equivalent of 3-5 truckloads. The estimated increase of 220 cars per day from the region's highways would therefore divert 600 to 1000 trucks per day from the highways.

The added traffic would divert to rail because of the opportunity to reduce logistics costs for shippers. The magnitude of the benefit could be very large, for a customer that was already wavering between rail and truck, or it could be very small if the reductions in trip time and prices barely made rail more attractive than truck. The average savings for new customers will always be less than the reduction in logistics costs for shipping by rail (because the new customer previously used truck, presumably because the total logistics costs for using truck were less than the total logistics costs for using rail). The average savings can be estimated as half of the reduction in logistics costs for shipping by rail (using the so-called “rule of one half” devised by economists for estimating the benefits of price reductions to new customers.) The operating benefits for the new traffic would therefore be on the order of $15 to $45/car rather than $30 to $90 per car.

Summary of Changes

This summary reflects the general magnitude of benefits to be expected following completion of Phase 3 of CN’s efforts to upgrade the EJE and to establish connections to all of its subdivisions and to the other Class I railroads where necessary. This summary does not include any benefits related to traffic diversion to be consistent with the CN application, which did not anticipate any diversion from other modes.

a. Equipment utilization on CN/EJE
    i. Car utilization: 29 million car-hours saved per year for a savings of $29 million at $1/car-hour
    ii. Locomotive utilization: 1474 locomotive hours saved per day for a savings of $13.5 million/year at $25/locomotive hour

b. Equipment utilization on other railroads
    i. Car utilization: more than $29 million (at least the same as achieved by CN/EJE)
    ii. Locomotive utilization: more than $13.5 million/year (at least the same as achieved by CN/EJE)

c. Labor efficiencies
    i. 114 EJE positions eliminated @ $88,000 per year including benefits: $10 million per year (this savings of approximately 228,000 employee-hours per year can be allocated to all of the traffic that uses the EJE, i.e. all but the intermodal trains serving southern and eastern destination, since that traffic would make no or minimal use of the EJE)
    ii. 82 train & enginemen positions eliminated on CN: $8 million/year (this saving of approximately 164,000 employee-hours can be allocated to all of the traffic except the intermodal trains serving southern and eastern destinations)
    iii. 35 yard positions eliminated on CN or freed up at Clearing yard: $3 million/year (this saving of approximately 70,000 employee-hours can be allocated to the local freight and general freight that bypasses a yard)
    iv. Total: 216-246 positions saving $21 million/year

d. Train costs: fuel costs could rise because the EJE route is longer; crew costs presumably would decline (and some of these cost savings are included in the above estimate of labor efficiencies); MOW costs should decline as traffic is concentrated on a single, well-maintained line.

e. Logistics savings:
    i. The cost savings could be assumed to go to customers based upon the history of competition in the rail industry (even though recent history has railroads raising rates)
    ii. Much of the car utilization savings (approx. 50%) will go directly to customers who own or lease their own cars
    iii. Inventory savings vary from less than $5/day per shipment (for coal) to perhaps $50 for soybeans (or any commodity at $200/ton) to $100 or more/day for manufactured goods. The total benefits are likely at least as large as the car utilization benefits (i.e. $20-40 million/year, approx. half to CN traffic and half to all other traffic moving through Chicago))

f. Increased traffic:
    i. Diverted from other railroads: CN forecasts an additional $14 million in revenue from diverted traffic. At CN's operating ratio of about 70%, this would translate into an additional contribution of about $4 million to CN's overhead and profit.
    ii. Diverted from highways: CN does not expect any diversions. A separate memo indicated that there is a potential for a 1-2% increase in intermodal traffic, a 6-7% increase in general freight traffic, and no impact on unit train traffic.

g. Crossing delays: no significant change expected for the region, although there will be an increase along the EJE route and decreases along the CN routes and also along various routes within the Chicago Terminal. If truck traffic is diverted to rail, there could be an additional 5% increase in crossing delays along the EJE route, but there would be a reduction in highway traffic because 600-1000 trucks per day would be diverted from the highways.

Table 8 summarizes the operating benefits to CN and the other roads operating within the Chicago terminal area. The unit costs used in this exhibit to estimate the dollar value of the benefits are as follows: $1 per car-hour, $25 per locomotive hour, and $36 per employee hour.

The benefits are greatest for local CN general merchandise traffic that benefits from more efficient routes with fewer classifications. Since this traffic is assumed to have 100% empty return (at least within the Chicago region), each loaded shipment reaps savings from both an inbound and an outbound movement through the terminal. By-passing two terminals and avoiding two trips through the most congested portion of the terminal is estimated to save $90/car.

Even if cars do not avoid any yard work, the benefits are still substantial. By avoiding the use of the most congested routes, savings will be on the order of $30 per car – or $3,000 per train – for any CN traffic that uses the EJE to move around the center of the region. The benefits to other traffic moving on other railroads, while very substantial in total, amount to less than $4 per car. This amount represents the expected reduction in train delay within the terminal once the CN traffic diverted.

Table 8: Summary of Operating Benefits, CN and Other Carrier Traffic

	Daily Traffic Volume	**Car Time Savings**	**Loco-hr Savings**	**Employee Hours Saved**	**Total**	**Avg. Per Unit**
CN Intermodal						
• To or from Canada	720	$10,080	$4,200	$7,258	$21,538	$29.91
• Other	1080	0	0	0	0	0
CN Run-Through Trains	300	4,200	2,150	3,024	$10,374	$34.58
Local, to CN lines						
• Bypass one yard (80%)	440	19,360	12,250	7,762	$39,372	$89.48
• Same number of yards (20%)	110	1,540	3,075	1,109	$5,724	$52.03
CN, through general freight (classified at E. Joliet or Kirk Yard)						
• Bypass one yard (80%)	292	12,848	4,625	5,151	$22,624	$77.48
• Same number of yards (20%)	1168	16,352	1,150	11,773	$29,275	$25.06
Interchanged to or from CN	800	16,000	8,400	8,640	$33,040	$41.30
Total per day, **CN traffic**	**4910**	**80,380**	**36,850**	**44,716**	**$161,946**	**$32.98**
Average per CN car or intermodal unit		$16.37	$7.51	$9.11	$32.98	
Total per day, **other traffic**	**70,000**	**$80,000**	**$37,000**	**0**	**$117,000**	**$1.67**
Total per day, *all traffic*	75,000	$160,000	$74,000	$45,000	$279,000	$3.72

The operating benefits will be realized in part by CN, in part by other railroads, and in part by customers. Changes in travel time will result in improved equipment utilization, which will have varying impacts depending upon who owns the equipment. For railroad-owned freight cars, which will be covered by car-hire agreements among the railroads, any reduction in travel times will improve the net car hire position for the operating railroad. If cars are owned by the customer, then the benefits will accrue directly to the customer in terms of faster turnaround of the equipment, less need to supplement their fleet with other cars when car supply is tight, and less need to acquire new equipment. If cars are owned by a car supply company, then whoever is leasing the cars may be able to reduce the size of their fleet and of their monthly lease payments. Since approximately half the fleet of freight cars is owned by railroads, they will capture about half the benefits while customers will capture the other half.

The locomotive utilization benefits will be realized immediately by whatever railroads operate trains, with CN clearly having the clearest, most visible benefits. Other railroads would expect to have a slight improvement in locomotive performance that might be masked by the normal variations in day-to-day performance or obscured by continuing growth in traffic through the region.

The improvements in labor efficiency will benefit the railroads. If traffic growth continues, then CN would likely be able to reduce the workforce through attrition without actually laying off many or perhaps any employees.

Nearly 40% of the total benefits can be related to traffic that originates or terminates within the Chicago region (Table 9). The total operating benefits amount to $100 million per year, with nearly $40 million related to local traffic. Historically, the rail industry has passed on essentially all its productivity savings to its customers via lower prices. If that trend continues, then the benefits shown in this table will eventually accrue to Chicago industries and their customers.

Table 9 Benefits Related to Traffic Originating or Terminating in Chicago Region

	Daily Traffic Volume	Total Daily Benefits	Related to Chicago Traffic	% Related to Chicago Traffic
CN Intermodal				
• To or from Canada	720	$21,538	$14,344	67%
• Other	1,080	0	0	67%
CN Run-Through Trains	300	$10,374	0	0%
Local, to CN lines				
• Bypass one yard (80%)	440	$39,372	$39,372	100%
• Same number of yards (20%)	110	$5,724	$5,724	100%
CN, through general freight (classified at E. Joliet or Kirk Yard)				
• Bypass one yard (80%)	292	$22,624	0	0%
• Same number of yards (20%)	1,168	$29,275	0	0%
Interchanged to or From CN	800	$33,040	$3,304	10%
Total per day, CN Traffic	4,910	$161,946	$62,743	38.7%
Total per day, other Traffic	70,000	$117,230	$45,418	38.7%
Total per day, all traffic		$279,000	$108,000	
Total per year, all traffic		$102 million	$39 million	38.7%

The expected allocation of annual operating benefits will initially be as follows:

- Car Utilization ($29 million for CN traffic plus $29 million for other traffic): 50% to the operating railroad and 50% to customers.
- Locomotive Utilization ($14 million for CN and $14 million for other railroads): 100% to the operating railroad.
- Employee efficiency ($16 million from the reduction in EJE positions and in CN T&E positions): 97% to CN (including its share of IHB or BRC operations) and 3% to BNSF, UP, CSX, and NS.

Putting these together another way, the $102 million of estimated annual operating benefits will initially be distributed as follows:

- CN: $44 million (43%)
    - Car utilization: $14.5 million
    - Locomotive utilization: $14 million
    - Employee efficiency: $15.5 million
- CN Customers: $14.5 million (14%)
    - Car utilization: $14.5 million
        - Chicago customers: $7 million
        - Other customers: $7.5 million
- Other railroads: $29 million (29%)
    - Car utilization: $14.5 million
    - Locomotive utilization: $14 million
    - Employee efficiency: $0.5 million
- Customers of other railroads: $14.5 million (14%)
    - Car utilization: $14.5 million
        - Chicago customers: $5 million
        - Other customers: $9.5 million

There will also be logistics benefits to customers that result from the improvements in service and which will allow reductions related to in-transit inventory and safety stock. This memo has not attempted to estimate those benefits, but they would be on the order of the total savings estimated for car utilization. All of these benefits would initially benefit the customers rather than the railroad.

The benefits outlined here may or may not remain with the parties who initially benefit. Historically, competition among railroads has kept downward pressure on rates, so that productivity improvements eventually get passed on to customers in the form of lower rates. If this happens in the future, then many of the benefits cited above would show up as lower rates for customers. In the last few years, higher fuel prices, congested highways, and capacity limits in the rail industry have helped the industry increase its average price levels for the first time in many years. If these conditions continue, then conceivably the railroads could capture some of the benefits assigned to customers, as customers perhaps would be willing to pay more for the improved service.

Estimating the Effects of The Proposed CN Purchase and Operation of the EJE on Railroad Mode Share

September 20, 2008

by
Carl D. Martland
16 Post Road
Sugar Hill, NH 03586
martland@mit.edu

Abstract

This study estimates the potential for the proposed CN purchase and operation of the EJE to divert traffic from highways. By creating a high-capacity route that avoids the heavily congested central portion of the Chicago rail terminal, CN will be able to reduce transit times through the terminal by at least 14 hours for nearly all of its traffic that goes to, through, or from the region. Most traffic moving to or from local industry will save more than an additional day by by-passing one or more yards in the region. Consolidating CN yard operations at Kirk Yard will enable a portion of through traffic to move through the region with classification at one rather than two yards, thereby saving an estimated 30 hours per car and also reducing operating expense.

CN's application to the STB identified a small amount of rail traffic that would be diverted to the CN/EJE route, because that route would become more direct than prior routes. CN did not expect to capture any traffic from highways as a result of the service and productivity improvements.

This study uses a methodology developed at MIT and applied previously in various studies, including recent studies conducted for the International Railway Congress (UIC) and for the Coalition Against Bigger Trucks (CABT). The UIC methodology has been updated and adapted for examining rail mode share for a set of generic origins and destinations under various assumptions concerning changes in CN service once the EJE route is fully operational.

There is some potential for increasing overall CN traffic by at most 5-7% as a result of the service and productivity improvements that CN anticipates. However, CN will not immediately pass cost savings onto customers, and the actual impact is likely to be much lower.

Estimating the Competitive Effects of Larger Trucks on Rail Freight Traffic

1. Introduction

This study assesses the competitive impact of changes in service similar to what is expected to result from the CN's proposed acquisition, upgrading, and operating of the EJE. Once the CN's proposed operating plan is fully implemented, service improvements are expected for all traffic that moves across the region; the only traffic that would not see any significant benefits would be intermodal shipments from the south and east that would continue to move on trains that operate in and out of Markham Yard with little or no benefit from the availability of the EJE route. All other traffic is either moving into, out of or through the region using the heavily congested inner routes within the Chicago Terminal, and the minimum savings from using the EJE route is estimated to be 14 hours. An additional 30 hours is estimated to be saved by 80% of the local moves and 20% of the general freight moves, because rationalization of the routing through the region reduces the number of times this traffic must be classified. Thus, most CN traffic that moves through the region will enjoy reductions in trip time ranging from 14 to 44 hours.

The new operating plan will also provide CN and its customers substantial reductions in cost. Improvements in equipment utilization and yard productivity have been estimated to reduce costs per car or intermodal shipment by $30 to $90 for each loaded or empty movement. For local customers, who have both an empty and a loaded move to or from their location in Chicago, the total savings would therefore be $60 to $180 per shipment.

The basic question that is addressed by this study concerns mode share: to what extent will service improvements such as those predicted for CN result in diversions of freight from truck to rail? These savings will potentially be most important for general freight that could move by truck, intermodal or rail depending upon the relative prices and services that are offered. For bulk traffic, such as coal or grain that is moving through Chicago with little or no yard work required, the proposed service changes are less likely to affect mode share, as rail unit trains already have a very marked advantage over trucks.

This paper therefore considers competition among truck, intermodal, and rail for general merchandise traffic. The basic conclusion is that saving time by avoiding the congested center of the Chicago terminal region will provide a clear advantage to rail, both for general freight and for intermodal containers or trailers. Whether or not the service improvements and cost savings lead to changes in mode choice depends upon CN's pricing strategy, as well as external factors such as the price of fuel.

2. Methodology

These conclusions are based upon analysis of the competitive balance between rail and truck for sets of hypothetical origin-to-destination (OD) movements. The OD movements were structured to represent a typical mix of commodity and customer characteristics. For each OD movement, the estimated mode share was based upon a comparison of the total logistics costs for using rail, intermodal, and truck transportation. In addition to direct transportation costs, the total logistics costs included inventory costs, loading and unloading costs, and loss & damage. Transportation and logistics costs were estimated using models developed in prior studies. The methodology used was based upon studies of rail/truck competition conducted recently by MIT for the International Railway Congress (Union International de Chemins-de-fer or UIC) (Martland 2001, 2003). Costs were updated to reflect current rail equipment costs, fuel prices and truck-driver wages.

The purpose of the UIC study was to identify the most promising technologies for the international rail industry. To do this, MIT developed and applied a methodology known as "performance-based technology scanning". Basically, this methodology provided a means of comparing various technologies by first estimating their impact on performance and then estimating how improvements in performance would affect market share. In the UIC study, the focus was on technologies that would improve rail market share, but the same methodology can be used to investigate the effect of changes in operations or technology on market share.

Structure of the UIC Study

The UIC study of the effects of technology on modal competition (Martland, 2001) considered 24 OD movements that were suitable for movement by rail, intermodal, or truck. The movements were structured as follows:

- Trip distances: 400, 800, and 1200 miles
- Value/pound: $1.00, $0.50, and $0.25
- Annual use rate: 500 to 2000 tons/year

A base case used typical unit costs and operating parameters for each mode. Logistics costs were estimated as a function of commodity characteristics, trip times and reliability, and modal factors related to loading, unloading and loss and damage. Mode share was estimated based upon a comparison of total logistics costs for each mode.[1] If two modes had the same total costs, then the model predicted that they would share equally in the traffic. If one mode had substantially lower costs, then the model predicted that it would capture all of the traffic. The UIC study was aimed at identifying the technologies and operating strategies that would have the greatest potential for improving railroad market share and financial performance. Toward that end, the study considered the effects of various changes in rail performance on market share, including various combinations of the following:

- Larger freight cars

[1] In technical terminals, a logit model was used to predict mode split based upon a comparison of the total logistics costs of shipping by rail, intermodal or truck. Given the total logistics costs of shipping by rail (LR), intermodal (LI) and truck (LT), the rail share is estimated as $e^{-LR}/(e^{-LR} + e^{-LI} + e^{-LT})$.

- Double stack intermodal service
- Better service (faster or more reliable)
- Cheaper service

<u>Structure of the CABT Study</u>

The CABT base case was established based upon the general merchandise traffic handled by the short line industry, which in fact is a cross-section of the general merchandise traffic handled by the entire industry. A hypothetical set of 100 OD movements was created as follows:

- Trip distances: 50, 200, 400, 600, 800, and 1200 miles
- Value/pound:
    - General traffic: $1.00, $0.50, and $0.25 ($2000, $1000, and $500 per ton)
    - Bulk traffic: $0.10, $0.05 and $0.01/pound ($200, $100, and $20 per ton)
- Density: 15 pounds/cu. ft. for high value, 20 pounds/cu. ft. for medium value and 30 pounds/cu. ft. for low value merchandise and all bulk commodities
- Annual use rate:
    - General traffic: 2, 8, and 25 thousand tons/year
    - Bulk traffic: 8, 25, 50 and 100 thousand tons/year

The number of shipments in each category was selected so that the predicted rail traffic had characteristics of short line traffic. The percentage of short line shipments by commodity group was based upon a study of short line shipments for the period July 2005 to June 2006. During that period, 45% of short line shipments (other than intermodal) were general freight and 55% were bulk.

The CABT study was focused on the negative effects of very large trucks on rail mode share. Bulk traffic was very important in that study, because that traffic was subject to diversion if regulations were relaxed to allow any of the more extreme increases in size weights that have been proposed.

The percentage of shipments in each distance and annual use rate category were based upon the results of a recent study sponsored by the American Short Line and Regional Railroad Association that analyzed trip times and reliability for a representative sample of 39 OD movements originating or terminating on short lines during a three-month period in the first half of 2006 (Martland and Alpert, 2006). Table 1 shows the highway distance for these movements and the number of shipments observed in the three-month study period.

Commodity characteristics were based upon the actual traffic handled by short lines in the 12-month period from July 2005 to June 2006 (Martland and Alpert, 2006). The commodities were aggregated into six groups based upon estimated value, as shown in Table 2. The percentages shown are the percentages of traffic for which the waybill included a valid STCC (standard transportation commodity code). The tons/car are typical numbers for each category based upon tons and shipments handled by the Class I railroads in 2003 (as reported in "Railroad Facts"). The value of the commodity is a critical factor in estimating inventory costs, so each category was assigned a value per pound between $0.01 and $1, a range that was intended to be representative of the commodities shipped by rail.

Table 1 Characteristics of Short Line Rail Movements
(based upon a sample of 39 OD movements)

Distance (Miles)	**Shipments (total for 3 months)**					
	<11	**11-40**	**41-100**	**101-200**	**>200**	**Total**
< 100	0	0	0	0	4	4 (10%)
100-300	1	0	0	1	3	5 (13%)
300-500	0	4	1	1	1	7 (18%)
500-700	2	3	2	1	1	9 (23%)
700-900	1	1	1	2	2	7 (18%)
> 900	0	5	1	1	0	7 (18%)
Total	4 (10%)	13 (33%)	5 (13%)	6 (15%)	11 (28%)	39 (100%)

Source: Martland and Alpert, 2006

Each of the 100 generic OD movements was used to represent multiple customers. Weights were assigned to each of the 100 movements so that the predicted rail share of the traffic would approximately match the above distribution of commodities. Each weight was calculated as the product of three factors representing the type of commodity, distance, and the annual use rate plus a fourth factor needed to translate predictions of mode share of OD movements into predictions of mode share of tonnage (because the predicted mode share for one generic low volume movement will represent many more actual movements that the predicted mode share for one generic high volume movement).

The factors used were as follows:

- Type of commodity:
  - 0.45 for merchandise
  - 0.55 for bulk

- Distance category(% of OD movements with distance of 50, 200, 400, 600, 800 or 1200 miles)
  - Merchandise (1%, 4%, 25%, 30%, 15%, 25%)
  - Bulk (25%, 25%, 10%, 10%, 25%, 5%)
- Annual Use Rate Category (% of OD movements with 4, 16, 50, 100, and 200 million pounds per year)
  - Merchandise (30%, 50%, 20%, 0%, 0%)
  - Bulk (3%, 7%, 10%, 30%, 50%)
- Weight for annual use rate (a factor proportional to 1/annual use rate)

Table 2 Aggregating Short Line Traffic into Six Generic Categories

Commodity Type	Commodities Included	Tons/car	% of short line shipments	Assumed Value/Pound
High value merchandise	Motor vehicles & equipment Food & kindred products Grain mill products	70 (other than motor vehicles)	16%	$1.00
Medium value merchandise	Pulp & paper products Stone, clay & glass Farm products except grain	80	13%	$0.50
Low value merchandise	Metals & products Lumber & wood Primary forest products	80	15%	$0.25
Liquid bulk	Chemicals Petroleum Products	85	12%	$0.10
High value dry bulk	Grain Sand & gravel Waste & scrap Coke	100	26%	$0.05
Low value dry bulk	Coal Ores	110	18%	$0.01

The percentages used were round numbers, which was consistent with the generic nature and limited scope of the CABT study. The weights are quite different for merchandise and bulk traffic because a) rail is competitive for merchandise traffic only for long distances and b) annual use rates are much higher for bulk customers.

The base case of the CABT study used the same rail cost and service parameters that were used in the UIC study, except that the cost of fuel was increased from $1.20/gallon to $2.68 per gallon. The other rail costs, which were typical of the period 2000-2002, were assumed to be reasonable for use in 2007. The rail parameters were the same in all of the scenarios considered in the UIC and the CABT studies. To reflect the recent increase in rail rates, rail rates were increased by 10% over the rates used in the prior study (i.e. 10% above the long-run average costs used in the model).

The truck parameters used in the CABT study were based in part upon the prior study and in part upon estimates of current and proposed trucking capabilities. Fuel economy, fuel costs, equipment costs, driver costs, maintenance costs, and overhead costs were all updated using estimates provided by CABT. Truck size and weight limits were also based upon information provided by CABT. Other operating parameters were left unchanged from the UIC study, including various parameters related to trip times and reliability, loss & damage, and loading/unloading costs. Truck rates were assumed to be equal to the average long-run truck costs used in the model.

Structure of the Chicago Study

The methodology used in the UIC and CABT studies was adapted to investigate the impacts of changes in CN service through Chicago on rail market share. This study considers only general merchandise traffic, which is represented by 46 of the 100 OD pairs in the CABT study. Certain cost factors were updated to reflect current conditions:

- Fuel costs were increased from $2.68 to $4 per gallon
- Truck driver wages were increased from $0.30 to $0.40 per mile
- Locomotive costs were increased from $450 to $600 per day ($25 per hour)
- Car costs were increased from $18 to $24 per day ($1 per hour)

The model estimates the costs of shipping by rail, truck or intermodal based upon a great many factors related to operations, productivity, and unit cost. Mode share, however, depends upon prices offered rather than the costs of the competitive rail, intermodal and truck services. The model initially assumes that prices equal the average variable costs, but it is possible to increase prices to be X% above average costs. This feature can be used to explore the effects of pricing on mode share. In the general freight market, depending upon current conditions, there may be a great advantage for either rail or truck, in which case one of the modes may be able to price above long-term variable cost. In recent years, as the cost of diesel fuel quadrupled, railroads suddenly had pricing power and for the first time in more than 25 years they were able to sustain rate increases over a period of more than a year or two.

The base case for the study used the 46 general merchandise ODs, modal characteristics, and unit costs (other than those cited above) from the CABT study. The rail and intermodal rates were set to be 10% above variable costs in order to produce a base case in which approximately half of the traffic moved by truck, a third by rail, and the rest by intermodal. Thus, the base case considers representative shipments that might or might not move by rail, depending upon the relative prices and service levels.

The CABT study was focused on traffic moving to or from short line railroads, which means that it was focused on general freight rather than intermodal or unit train services. The short lines mix of general freight traffic is similar to that for the entire North American rail system, because short lines originate or terminate 37% of the general freight traffic carried by the system. However, short lines are less involved in unit train and intermodal services. In a mode split analysis, intermodal traffic is more important than the unit train traffic, since intermodal traffic is by definition very competitive with truck whereas unit trains services compete primarily with rail carload and multiple-carload service rather than with truck.

To represent the greater importance of intermodal traffic to CN and Chicago customers, the base case for the CN/EJE study doubled the number of customers with high- or medium-value shipments, leaving the same distribution of customers with low-value shipments. The intermodal option provides trip times of a couple of days rather than a week or more, and the better service is more valuable as the value of the shipment (and the costs of in-transit inventory) increase.

Two alternative scenarios were considered:

- Better Access: trip times were reduced by 14 hours for all rail and intermodal movements to reflect the time saved by moving on the EJE rather than through the center of the region
- By-Pass: trip times were reduced by 44 hours to reflect both the better access and the 30 hours saved by by-passing a yard. The buffer required for 95% reliability was reduced by 12 to 24 hours to reflect the better reliability resulting from eliminating one classification. The model automatically calculates the savings in car-hours and cars handled at terminals, and the unit costs for terminals were reduced another $20 per car to reflect the other expected efficiencies in operations. Note that the savings will apply to both the loaded and the empty movements associated with a shipment.

These two cases are consistent with, even though they do not align precisely with the estimated cost and service benefits estimated for Chicago.

3. Results

The results are shown in Tables 3 - 5. The first table shows the mode split if the ratios of price to variable cost remain the same. With Better Access, there would be an 8% increase in rail share of tons shipped and an 18% increase for intermodal (i.e. rail's share of the total tons shipped by this set of hypothetical shipments would increase from 29.4 to 31.7%, while intermodal would increase from 10.1 to 11.9%). With Bypass, the rail share would increase by 40% and the intermodal share would increase by 5% relative to the base case. The results in this table provide an upper limit for the extent of traffic diversion that might be caused by the improvements estimated for operating via the EJE. In practice, railroads would be unlikely to pass on all of the productivity savings to customers in the form of lower prices. The average revenue per load in the base case is $1942; in the Bypass case, the average revenue per load drops to $1446. The sharp decline in revenue reflects three factors: 1) the roughly $180 savings per shipment, 2) an increase in market share in shorter-distance markets that have lower costs and therefore lower rates, and 3) an increase in markets for higher value commodities that are moving in smaller shipment sizes.

Table 3 Mode Split – Lower Prices
(Mode share of ton-miles for 46 hypothetical general merchandise OD movements)

Mode	Rate Factor	Base	Better Access	By-Pass
Rail	1.10	29.4%	31.7%	41.1%
Intermodal	1.10	10.1%	11.9%	10.6%
Truck	1.00	60.5%	56.5%	48.3%

Since railroads currently have pricing power relative to their competition, it is unlikely that they would immediately reduce rates so as to give customers the full benefit of the productivity improvements. One option would be to raise prices so as to keep the same volume of traffic, but shifting to the most profitable traffic. Table 4 indicates that the railroads would be able to enjoy substantially higher rates for general freight while maintaining the same market share. In the Better Access case, the aggressive pricing strategy results in price factors 10% higher for general rail freight and 6% higher for intermodal for the Better Access case. In the By-Pass case, there are substantial further improvements for general freight, but the service for intermodal remains the same as in the Better Access case. Since intermodal competes both with carload and with truck service, the railroad has some leeway in the relative prices for intermodal and general freight services. In Table 4, the By-Pass rates for general freight are increased to 1.5 times variable costs, while intermodal rates remain at 1.1 times variable costs. The resulting market share is slightly higher for rail and intermodal and slightly lower for truck. Despite the sharp increase in the ratio of price to variable cost, the average revenue per load for the Bypass case was $1960, barely above the $1942 per load in the base case.

Table 4 Mode Split – Aggressive Pricing
(Mode share of ton-miles for 46 hypothetical general merchandise OD movements)

Mode	Rate Factor	Base	Better Access	By-Pass
Rail	1.10, 1.21, 1.50	29.4%	29.4%	30.6%
Intermodal	1.10, 1.16, 1.10	10.1%	10.2%	12.2%
Truck	1.00	60.5%	60.4%	57.4%

Another option would be to share the savings with customers by raising rates by a smaller amount that would allow them to increase market share. Table 5 shows one possibility that is intermediate between Table 3 (most benefits to the customer via lower prices; much higher rail market share of tons) and Table 4 (most benefits to the railroad via higher prices; no change in market share of tons; shift to traffic with highest revenue per shipment). In this table, the pricing factor for the Better Access case is increased from 1.1 to 1.15 for both rail and intermodal, resulting in an increase in market share of about 4% for each service. For the Bypass Case, the pricing factor is increased to 1.3 for the rail service and to 1.13 for intermodal. In this case, rail market share increases about 4% for intermodal and 22% for general rail freight. The average revenue per rail shipment is

$1706 for the Bypass, which is about halfway between the $1446 for the Lower Prices scenario (Table 3) and $1960 for the Aggressive Pricing scenario (Table 4).

Table 5 Mode Split – Customers and Railroads Share Benefits
(Mode share of ton-miles for 46 hypothetical general merchandise OD movements)

Mode	Rate Factors (Base, Access By-Pass)	Base	Better Access	By-Pass
Rail	1.10, 1.15, 1.30	29.4%	30.6%	35.8%
Intermodal	1.10, 1.15, 1.13	10.1%	10.4%	10.5%
Truck	1.00	60.5%	59.0%	53.7%

<u>Discussion</u>

The potential for aggressive pricing of rail service is consistent with rail rate-making since 2005, as the industry increased revenue per ton-mile by 24% from 2003 to 2006 (AAR, “Railroad Facts”).

Fuel cost is one major factor that allows railroads to be more aggressive with their pricing, as fuel costs per ton are much higher for truck than for either rail or intermodal. Capacity of the network is another factor that at times requires railroads to be aggressive in pricing: there are bottlenecks that cannot handle more traffic without sharply increasing marginal costs. Railroads therefore have the opportunity to ration capacity by raising prices.

The absolute value of the percentages in these tables are not intended to reflect the overall mode share for all freight, because the sample OD movements only include moves where rail, intermodal, and truck are all viable options. Many other moves would be needed to represent the very common situations where rail is dominant (e.g. coal or service to large grain elevators), where intermodal is dominant (e.g. long-distance moves of international containers), or where truck is dominant (e.g. short distance non-bulk moves and low-volume general merchandise moves). The sample of 46 OD moves is intended to reflect the types of general freight shipments that are routinely carried by the rail industry and that are susceptible to mode shifts depending upon prices and services offered by the competing modes.

4. Interpretation of the Results

What is of interest in this study is the magnitude of the change in market share for rail and intermodal as a result of changes in truck capabilities. If everything stays the same except service levels and variable costs, then how much will the rail market share increase? There appears to be an opportunity for attracting some traffic, especially in situations where a yard is by-passed. However, it is likely that CN would keep increasing prices so long as its traffic volumes held steady.

The information in the tables needs to be interpreted in the context of CN's traffic mix in Chicago. In a separate memo "Analysis of operating and economic impacts of proposed CN purchase and operation of the EJE", I have estimated the number of loaded and empty cars or intermodal units that would be affected by the changes:

- No change in service: 1080 intermodal units (22% of total CN traffic)
- Improvements in access: 720 intermodal units/day and 2218 freight cars/day (60% of total CN traffic)
- By-pass one yard: 892 freight cars/day (18% of total CN traffic)

The great bulk of the traffic would have at most a half-day saving in trip time and some efficiency improvements in yard operations. Judging from the mode split analysis shown above in Tables 3-5, there could be a slight increase in mode split, but CN could also choose to make a slight increase in price (5-10%) while retaining the same market share.

The traffic that by-passes a yard would receive a much greater boost in service and a much larger reduction in cost (approximately $180/car). This traffic includes 892 cars: 440 local cars, 292 general merchandise cars moving through Kirk Yard, and 160 cars moving to new interchange locations. Tables 3 and 5 indicate that a 20 to 40% increase is possible for this traffic, which would be 165 – 350 cars per day or a 3.3-7% increase in total CN traffic through the Chicago region. On the other hand, Table 4 indicates that CN could choose to raise prices without increasing market share at all.

Table 5 provides a reasonable estimate of the magnitude of traffic increases that might result from the estimated improvements in service. Applying the increases in mode share from this table to the traffic that would be impacted provides an estimate of the potential for traffic growth relative to the traffic volumes considered in the draft EIS:

- No change in service: no change in mode share (1080 intermodal units)
- Improvements in access: 4% increase in mode share
  - 720 intermodal units/day would increase by 21 units per day.
  - 2218 freight cars/day would increase by 90 cars per day.
- By-pass one yard: 22% increase in mode share for truck-competitive traffic
  - 892 freight cars/day would enjoy the service improvement, but a large portion of this traffic is low-value bulk traffic that is relatively non-competitive with truck. Assuming that two thirds of the traffic is truck competitive, there would be an increase of about 130 cars per day.

The total daily increase would be 30 intermodal units and 220 general freight cars. This would be 1.1% increase in CN's intermodal traffic and a 6.8% increase in CN's other traffic within the region. The intermodal units would be equivalent to an additional train per week operating along the EJE between the Waukesha subdivision and Markham yard. The increase in general freight traffic would be equivalent to a bit more than two 100-car trains per day (15.6 trains per week), most of which would be operating along the EJE between Kirk Yard and intersections of the EJE with BNSF, UP, or the Waukesha subdivision of CN.

These analyses do not consider the costs of the CN acquisition and upgrading of the EJE. The investment cost of $100 million implies an equivalent annual cost of $10 million or a daily cost of $27,400 assuming a discount rate equal to cost of capital of 10%. Since CN moves approximately 5000 cars and intermodal shipments per day, the average investment cost that would be allocated to each unit is less than $6 (perhaps $10 per loaded shipment, since approximately half of the general freight movements involve empty cars). This cost is well under the average savings of more than $30 per movement (or $60 for the combine loaded and empty movement, if there is an empty return movement along the same route). It is unclear how much of the $300 million purchase price represents the value of the existing EJE facilities and operation to CN and how much represents a portion of the ultimate value of the EJE to CN. The carrying costs for the purchase would be $30 million per year and $82 thousand per day, so the average cost per load would be in the range of $30. Further expenses required for mediation would also cut into the benefits to be gained by CN and require more aggressive pricing for CN to recoup their investment, thereby limiting the ability to divert traffic from the highways.

Bibliography

Martland, C.D. "Analysis of operating and economic impacts of proposed CN purchase and operation of the EJE", memo dated September 10, 2008

Martland, Carl D., "Performance-Based Technology Scanning Applied to Containerizable Freight Traffic", UIC/MIT-WP-2001-04, August 2001

Martland, Carl D., "Performance-Based Technology Scanning Applied to Bulk Freight Traffic", UIC/MIT-WP-2003-02, September 2003

Martland, Carl D. and Steve Alpert "Research Priorities for Regional and Short Line Railroads", Research Report Prepared for the American Short Line and Regional Railroad Association, Department of Civil & Environmental Engineering, Massachusetts Institute of Technology, December 2006

Martland, C.D. "Estimating the Competitive Effects of Larger Trucks on Rail Freight Traffic" Report Prepared for CABT, September 10, 2007

Martland, C.D. and Steve Alpert, "Origin-to-Destination Performance for General Merchandise Traffic Moving to or from Short Line Railroads", Journal of the Transportation Research Forum, Fall 2007