Profitability of a New National High Speed Rail System

Thomas L. Atwood, Ph.D.

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Introduction

This document is a cursory examination of the economics of a national high speed rail system, designed primarily for hauling long-haul truck traffic. The model for this analysis is a 500-mile high-speed railway connecting two dockyards in major cities. The railway consists of two high-speed tracks, one for each direction, and two auxiliary tracks, one for each direction. The auxiliary tracks handle miscellaneous shuttle traffic and provide sidings to route the high-speed trains off the mainline in the event of equipment failure or other emergencies.

The Model

For this analysis the length of the right-of-way between the two dockyards is

$$L = 500\, miles.$$

Assume the average speed of each train is

$$V = 150\, miles/hour.$$

The time to travel between the two dockyards is then

$$T_{Trip} = L/V = 500/150 \simeq 3.5\, hours.$$

Assume the interval between train departures in one direction is

$$T_I = 30\, min.$$

This is the maximum time that any trucker would be delayed by the process of truck loading and train make-up.

Thus, the number of trains operating somewhere along the 500-mile line in one direction is

$$N_{Trains} = T_{Trip}/T_I = \frac{3.5\, hours}{0.5\, hour} = 7.$$

Consequently, at any given time there will be 7 trains running in each direction, spaced out along the mainline at 30 minute intervals. There will also be an additional train being made up in the yard, giving a total of 8. Additionally, railcars will occasionally need to be sidelined for regular maintenance, and there will be occasional unforseen delays in railcar turnaround. So assume we will need enough railcars for 10 trains in each direction.

A train will depart in each direction every 30 minutes, regardless of how many trucks have been loaded. This timing is essential. Assume an average number of trucks in a train to be

$$N_{Trucks} = 60.$$

This means that the average number of railcars in each train is 60. There can be additional cars for passenger service or other cargo, but these are irrelevent for this analysis. Clearly, making up a train of 60 or more railcars in less than 30 minutes is a tall order. This will require careful dockyard operational design. Train assembly would be much simpler and much faster if the railcars were self-propelled within the dockyard instead of requiring a separate switch engine for train assembly.

Since we must have enough railcars to support 10 trains in each direction, or 20 trains total, and with an average of 60 cars in a train, the total number of railcars required to operate this 500-mile railroad would be

$$N_{Cars} = 20 \times 60 = 1200\, railcars.$$

In addition to the railcars there would need to be a sufficient number of small switch engines in each dockyard, assigned one to each railcar being loaded and made up into a train. With an average of 60 railcars for each train being made up, this would require 120 small switch engines. We would also need 20 heavy duty high-speed locomotives to pull the trains. (The 120 switch engines could be eliminated if it were feasible to make the individual railcars self-propelled while in the dockyard.)

Savings in Long-Haul Trucking Operations

The cost of operating a freight hauling truck is somewhere around $1.50/mile. Of this, assume $.50/mile for fuel and maintenance, $.50/mile for driver and the rest for other things.

Since the driver would not be driving and the truck would not be consuming fuel during the train trip, this means a potential savings of $1 per mile or $500 for each truck trip. To get the net savings to the trucking company, the cost of the railway ticket would have to be subtracted.

To get the cost of the train ticket, we need to analyse the cost of constructing and operating the high-speed railroad.

To calculate the tme savings, the railroad trip takes 3.5 hour plus up to a half hour train make-up and another half hour to get the truck back on the road. Thus, the total trip time is 4.5 hours.

Assuming an average highway speed of 55 miles/hour for long-haul trucks on interstate highways, the total trip time assuming no stops along the way would be $500/55 \simeq 9\,$hours. Thus the truck travelling by rail would arrive in half the time.

Acquiring Right-of-Way

The following information was gathered from a short search of the internet

In 2003 an Australian railroad covering 1420 km was built for A$1.3 billion. This amounts to $1.3 million/mile. In Canada agricultural land goes for about C$89,000/ha. For a 60 foot right of way this would amount to about $243,000/mile.

Allowing for a more expensive situation in the United States, assume a right-of-way acquisition for a 4-track railway 200 feet in width. This amounts to about 25 acres per mile of roadway. Using a right-of-way acquisition cost of $200,000 per acre, gives an ROW acquisition cost of $5 million per mile. Most of this land acquisition would be open country worth much less than this figure, but acquiring property within cities and suburbs would be considerably more expensive.

For this analysis the length of the right-of-way between the two dockyards is

$$L = 500\, miles.$$

So the total cost for the right-of-way would be

$$C_{row} = 500\, miles \times \$5,000,000/\text{mile} \; = \; \$2.5 billion.$$

Cost of Rolling Stock

In 1990 a new boxcar cost $60,000. In 2006 it was about $80,000. So assume a cost of $150,000 for a streamlined railcar capable of carrying a single truck..

If the cost of the railcars is $150,000 each, this needs to be multiplied by the number of cars per train times the number of trains:

$$Cost\,Of\ Railcars = \$150,000 \times N_{Cars} = \$150,000 \times 1200 = \$180\,million.$$

Assume the small yard switch engines, assigned one per railcar and operated by a computer, could be acquired for $150,000 each. Then

$$Cost\,Of\ Switchers = \$150,000 \times 120 = \$18\,million.$$

Assuming the heavy-duty, high-speed locomotives could be acquired for $5,000,000 each, their total cost would be

$$Cost\,Of\ Locomotives = \$5,000,000 \times 20 = \$100\,million.$$

The total cost of the rolling stock is then

$$C_{RS} = \$180\,million\ +\ \$18\,million\ +\ \$100\,million \simeq \$300\,million$$

Construction Costs

Assuming a cost of $10 million per mile, the cost of building this railroad would be

$$Building\,Costs = C_{row} + 2 \times Cost\,Of\ Dockyard + C_{RS}$$

Assume each dockyard costs $500 million to construct.

$$Building\,Costs = \$2.5\,billion + \$1.0\,billion + \$0.3\,billion = \$3.8\,billion$$

Even if these figures are off considerably, it is evident that the major cost is the building of the rail lines. The rolling stock would not be a large factor even at two or three times the estimated cost.

Operating Costs

It is conceivable that each train could be fully computer operated without the need for any human crewmen. However, there could be an average of 60 truckers on the train, so assume a crew somewhat like that of an airplane, say 5 employees. There would also be labor costs associated with operating the dockyards, even though all the railcar movement within the yard would be computerized. Assume there were 20 employees working in each dockyard. This would need to include maintenance and administrative personnel.

Assume an average labor cost of $100,000 per year. Then the total labor cost would be

$$Employees = 20 \times 2\,dockyards + 5 \times 20\,trains = 140$$

$$Labor = 140\,employees \times \$100,000/year = \$14\,million/year.$$

Assume an equipment depreciation cost of 10% per year.

$$Depreciation = 0.1 \times (2 \times Cost\,Of\ Dockyard + C_{RS}) = \$130\,million/year.$$

Assume a fuel consumption rate of 500 revenue-ton-miles per gallon, which is typical of a modern freight-hauling railroad. Assume an averaged loaded truck weight of 60,000 pounds, or 30 tons. With an average of 60 trucks per train, this gives an average total weight of 1800 tons. The fuel consumption of a single train would therefore be

$$TrainFuel = 500\,RTM\,/\,gal\;\div\;1800\,tons = 0.28\,miles/gal.$$

Assuming a cost of diesel fuel of \$5/gal, the fuel cost of a single 500-mile train trip would be

$$TripFuel = 500\,miles\,/\,0.28\,miles/gal = 1,786\,gal.$$

$$TripFuelCost = TripFuel \times \$5.00/gal = \$8,930.$$

If the railroad operates 24/7 with a train departure every half hour in each direction, there will be $24 \times 2 \times 2 = 96$ train trips per day. Thus, the annual fuel cost would be

$$AnnualFuelCost = 96 \times 365 \times \$8,930 = \$313\,million/year.$$

Ignoring other expenses, such as right-of-way maintenence, administrative, legal, advertising, etc., the annual cost of operating this 500-mile railroad would be

$$AnnualOperatingCost = Labor + Depreciation + Fuel$$

$$= \$14\,million/year + \$130\,million/year + \$313\,million/year = \$457\,million/year.$$

We can round this up to $\$0.5\,billion/year$.

Results

The Revenue Flow

Assume that the maximum amount that the trucking companies can be charged is their savings from riding the railroad. They will still arrive in half the time needed to drive on the interstate highway. We found this savings to be about \$500 per trip, or $\$1/mile$ for each truck.

Assuming the railroad operates at full capacity 24/7, it will depart two trains per hour in each direction for a total of 96 train trips per day. Assuming an average of 60 trucks per train, the daily revenue flow will be

$$DailyRevenue = 96\,trains \times 60\,trucks \times 500\,miles \times \$1/mile = \$2.88\,million/day.$$

The annual revenue would then be

$$AnnualRevenue = 365 \times \$2.88\,million = \$1.05\,billion/year.$$

Note: I computed the fuel and labor costs assuming 24/7 operation. Running fewer trains per day than this will reduce revenue, but it will also reduce fuel and labor costs. I kept the full operating rate here for consistency. On the other hand, by expanding the yard, it would be possible to dispatch more than two trains per hour. Ultimately, the operating rate would depend upon demand from the trucking companies.

Analysis

The annual profit from this model would be

$$Annual\ Profit = Total\ Annual\ Revenue - Annual\ Operating\ Cost$$

$$= \$1.05\,billion/year - \$457\,million/year \simeq \$600\,million/year.$$

Without factoring in interest costs, this would give a return on investment on the order of

$$ROI = \frac{\$600\,million}{\$3.8\,billion} = 15.8\%$$

This number would be proportionately reduced depending upon how much of the revenue is refunded to the trucking companies as lower ticket prices as inducements to use the railroad instead of the highway.

This still doesn't consider the savings in highway construction and maintenance, as well as other indirect savings resulting from high speed freight transport over long distances. These numbers suggest that it would make good sense to invest in a serious economic study of this proposal.

Thomas L. Atwood, Ph.D.

TomAtwood@Earthlink.net