Railway Capacity Background & Overview

Railway capacity is often believed to be solely a function of the amount of rail infrastructure a railway has in place. In fact and in very simple terms, railway capacity is a function of managing three basic areas of influence – the efficient use of assets and resources, the management of flow and operations and the overall basic track structure (infrastructure). While no strict formulaic approach can be prescribed, a combination of these three areas determines what the capacity of any railway operation can and will be.

Asset and Resource Efficiency

Capacity of Railcar Fleet

This refers to the capability of a railcar to handle lading, as measured in terms of volume (i.e. tons), the capability of the car to move at a higher speed and in longer trains[1].

Example: *A typical railcar used in the 1940's and 1950's had a gross capacity of 180,000 lbs. or the ability to carry 74 tons when the weight of the car is taken into consideration. Trains would consist of an average of 60 cars and hence, have a carrying capacity of 4,440 tons. A modern railcar has a gross capacity of 286,000 lbs or 125.5 tons moving in trains consisting of 100 cars or more, yielding a total carrying capacity of 12,500 tons, an increase of over 181% in carrying capacity.*

Power of Locomotives

Light duty – low horsepower vs. heavy-duty – high horsepower

Example: *A railroader's "rule of thumb" prescribed that in order to move 1 ton, 1 horsepower (HP) of locomotive power was required. A low horsepower locomotive has 1500-2000 so in order to move 60 cars loaded at 180,000 lbs. moving in a train, 3-4 locomotives would be required. Through advances in technology higher horsepower locomotives have been developed whereby 4000-5000 HP locomotives are capable of moving 1 ton with .80 HP. These factors combined yield improvements that see two locomotives capable of moving 100 cars loaded at 263,000 lbs. each.*

Crews to operate trains

Railway operating crews are highly skilled employees whose level of knowledge can greatly contribute to operational efficiency. A typical learning curve for these positions can run over 5 years from the entry level (a " rail yard switchman") to a senior mainline conductor or engineer. In the past twenty to thirty years, technological and process advances have enabled railways to reduce the size of a trains crew from 3-4 down to two (conductor and locomotive engineer).

Rest rules and union agreements predicate the physical positioning and capability of a crew and hence, railways must plan to ensure that sufficiently trained and experienced crews are positioned in order to handle trains and traffic that are scheduled to move.

Operational Management

The Balance of Traffic Flow

Railways must ensure that any type of resource remains in a consistent cycle

- Balance of locomotives and crews in a corridor
- Balance of car fleet
- Balance of crews

Management of known bottlenecks

Bottlenecks exist in every operational process and the severity of their impact is dependent on how well they are managed.

Example: *A rail yard in the centre of a series of subdivisions has the capability of holding only two trains at one time. It is incumbent on the railway operation to ensure that no more than two are in that terminal at*

[1] The structural integrity of older cars limited the number that could move in one train. The introduction of modern design and materials has strengthened the integrity of the cars structure thereby enabling more cars to move in longer train lengths.

one time because, if an event occurs that two are "stuck" at the terminal, then congestion will occur. The short-term management practice would then be schedule train movement to, around and through that terminal to ensure congestion does not occur. The longer-term alternative, dependant on an economic assessment of costs, may be to expand the number tracks to allow a greater number of trains to be held at the terminal.

<u>*Coordination of efforts between stakeholders*</u>

As in any process that consists of multiple participants and stages, the opportunity for sub-optimization in any rail related logistics chain is high.

- The capacity of the whole logistics chain relies on many processes working together:
  - The consistent delivery of cars – both loaded and empty – reduces the occurrence of bunching, thereby reducing the chances of congestion
  - Rapid loading and unloading – the faster cars are loaded and unloaded, the faster the whole of the cycle.
  - Optimal use of systems of communications – Advances in information technology has greatly improved railway efficiency and also leant to enhanced communications with the industries it serves
- Stakeholders with opposing schedules and objectives most often have the greatest impact

<u>Example:</u> *Railways are typically operated on a 24-hour, 7-day a week basis. If one assumes that this type of operation represents 100 percent of capacity, an origin or destination industry that accepts traffic on an 8 hour, Monday to Friday basis, constricts this capacity to a level as low as 23% of total potential. Through close communication and coordination, these constraints can be overcome. However, in the past, these types of issues have been the cause of congestion at ports and at itinerant rail yards as railways hold back traffic to accommodate loading and unloading schedules.*

<u>Infrastructure Management</u>

1. Track Structure

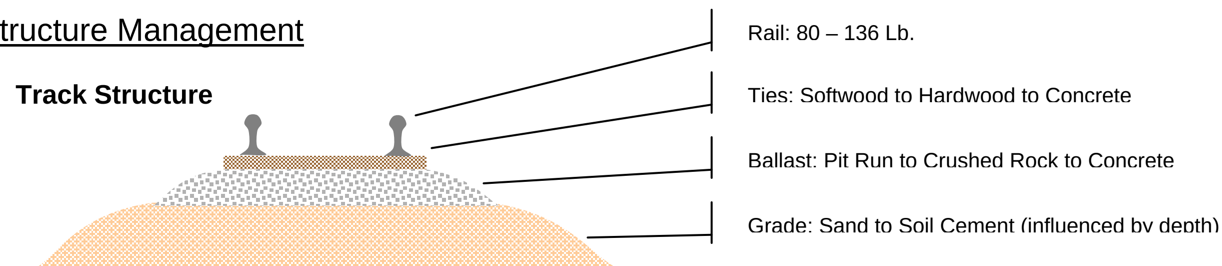


Figure 1 – Basic Track Structure

In simple terms, track structure determines loading capacity and the speed of movement of train running over it. The four primary variables (rail, ties ballast and grade) can be enhanced to gain exponential increases in capability and capacity. For example, track with 80 lb rail, softwood ties, pit run ballast and a "silt mix" grade would probably be capable of 180 – 220,000 lb car loading with a maximum track speed of 15-25 mph, where track with 136 lb rail, concrete ties, crushed rock ballast and a soil cement/ gravel grade that was three feet thick would be capable of 286,000 lb loading at speeds of up to 55mph.

2. Sidings

Sidings are typically added to a railway line in order to allow two trains to pass one another and are the base and most common method used to expand capacity.

Basic railway operating rules state that no more than one train can be on a section of track at one time. A section of track is commonly referred to as a “Sub Division”. In early railroading times, a sub division was the section of track placed between two railway stations though which one train would pass. The simplest way to expand physical capacity under those conditions is to add a siding, allowing one train to pass another (whether the trains are moving in the same or opposing directions). In the figure shown above, with one siding, the section of track would be capable of handling two trains at any one point in time. Sidings are typically built at a length that would allow a normally operated train to come to a full stop inside the siding (remaining clear of the switches at either end)

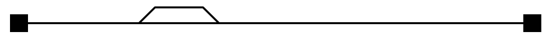


Figure 2 – Subdivision with one siding

This could be expanded to three trains by adding a second siding – by ordering the trains to pull into a siding and not to proceed until another “known” train has passed them.

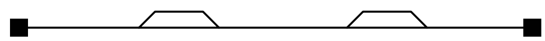


Figure 3 – Subdivision with two sidings

3. Intermediate signals

The use of signals allows for a section of track to be divided into smaller sections and for flow to be controlled. By adding the signal, the effective capacity of the same section of track moves to four.

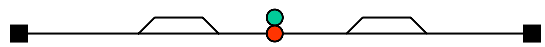


Figure 4 – Subdivision with two sidings and one intermediate signal

By adding more sidings and intermediate signals the same section of track capability for trains continues to be doubled. In the example above, and dependant on the direction of the trains, up to seven trains could be handled.

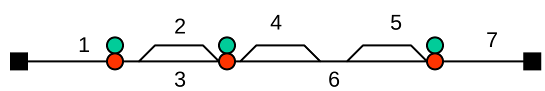


Figure 5 – Subdivision with three siding and three intermediate signals

4. Double Track

Normally the last step in infrastructure management is to take sidings and join them to create double track, effectively allowing two trains to pass without either stopping.

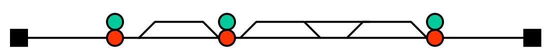
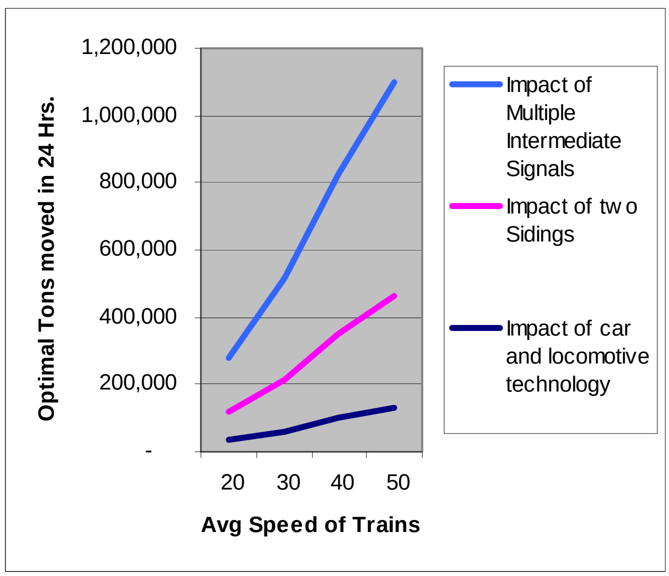


Figure 6 – Subdivision with one siding and double track

Summary

As mentioned above, railway capacity is not a formulaic science but rather a coordinated effort in the management of all aspects of the railways operation – assets, infrastructure and resources.

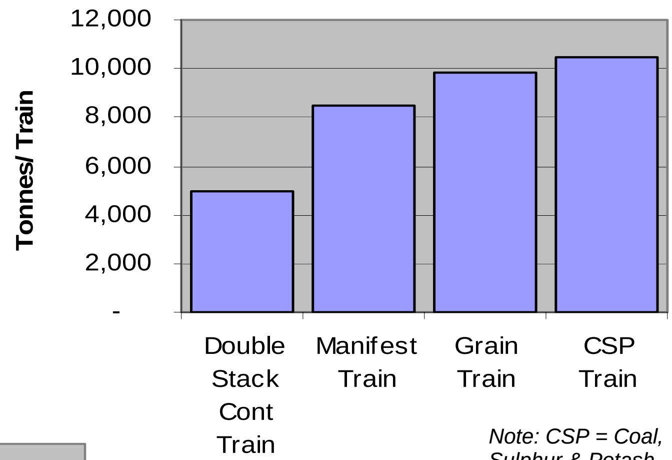
The chart shown on the right displays the cumulative impact of optimal capacity as varying types of asset and infrastructure are added. The introduction and combination of infrastructure, assets and management approach has a significant impact on the total capability and capacity of a railway system.



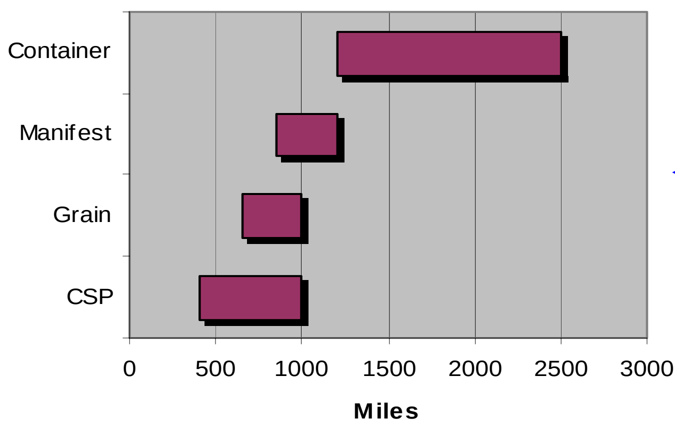
It is important to note that a railways capacity will always be variable, influenced by the manner in which is managed, the timing of traffic entering each part of the system and outside influences ranging from mechanical failures to labour disruptions to severe weather, to mention only a few.

Train Capacity & Distance

Based on an average train length of 6,000 ft., this represents the average tonnage of lading a train of each type would be capable of hauling

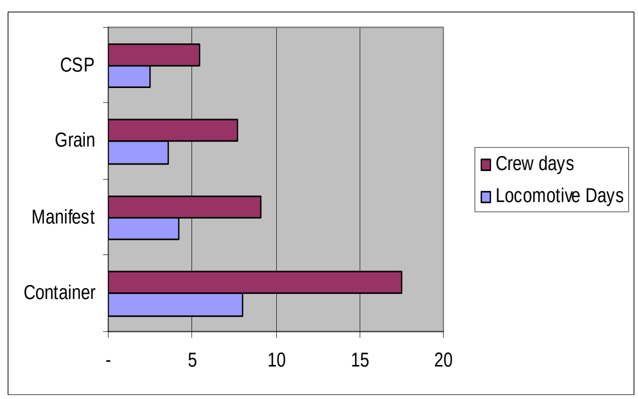


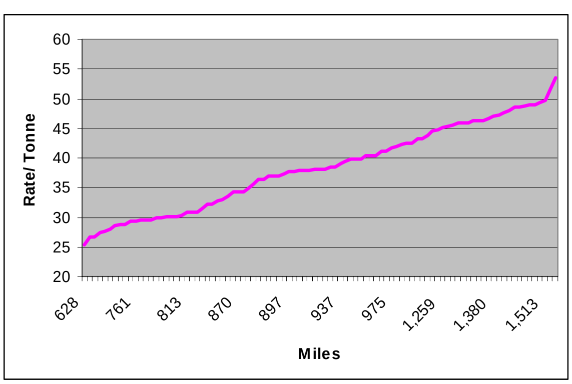
Note: CSP = Coal, Sulphur & Potash



The destination of trains is a determinant of the traffics demand on resources such as crews, locomotives and railcars. This represents the min/ max miles each type of train moves.

The longer the length of haul the greater the pull down on resource capacity. The impact of longer hauls on locomotive capacity and manpower requirements is proportional to the number of miles it must move.





The applicable freight rate most often also increases proportionally as the length of haul increases, as can be seen in this graph, which portrays an average of Canadian grain rates to the Port of Vancouver