

how and where to live. There has been developed within this period a new potentiality, which had through all the previous history of the world been practically dormant. The impulse given by it to the material and industrial progress of the world is such as to stamp it as one of the grandest events of our world's history, and it will be so spoken of in future ages. It is the development of transportation.

In its broadest sense, transportation may be said to include all means of communication; but of its various phases the transportation of material objects by means of the railway train will be the one treated of in this book.

The railway had its birth in England, and a fierce struggle took place between it and the canal for supremacy, while in North America the canal systems not being far advanced, and the extent of territory to be traversed rugged and vast, the result was never in doubt; to-day, the canal is a useful regulator of rates, and a means of transportation of heavy bulk freights in which time is not a factor, but it cannot be said to be a competitor of the railway to any serious extent.

By 1850 the people of North America had grasped the fact that the rapid extension of our railways to the remote and unsettled regions westward, was the key to that marvellous growth that has peopled a continent in so short a time. The capital available was small, and the country fairly rough, so that different methods of construction and operation from those in vogue in England, and a consequent different class of equipment, were imperative.

At the present day, in Canada, our railways are developed along the same general lines as those of the United States, and in it we have done our fair share, but it must be recognized that to the civil engineers of the United States is due the credit of those essential departures from early forms which have defined our continental types so distinctly, and are the glory and the boast of North Americans. These departures took place gradually, the gap becoming wider every year, until now it has passed its maximum, and the slow conservatism of English engineers is yielding. Bogie trucks, equalizing levers, Westinghouse brakes, and American cars are becoming familiar in England, while on the other hand increased wealth and traffic are enabling American railways to introduce block-signalling and interlocking systems, to abolish many grade crossings, and make their road-beds more solid and permanent.

The distinctive features of the railway system of North America that have enabled it to extend to a length of over 200,000 miles (including Mexico and Central America), that have given Canada a system of over 16,000 miles, moving 22,000,000 tons of freight, 14,000,000 passengers, 60,000,000 newspapers, 100,000,000 letters, besides much express, etc., each year, having a capitalization of \$900,000,000, and employing an army of perhaps 55,000 men, are as follows:

(1) A frank recognition of the fact that curvature is not a great drawback, and can be introduced freely to economize construction.

(2) The introduction of bogie and swivelling trucks and equalizing levers, enabling lines of poor surface and sharp curvature to be operated safely and economically.

(3) The use of long wheel-bases on engines for freight work, enabling greater weight to be put on the drivers of engines operating over quite inferior track.

(4) The consequent hauling of increasingly heavier loads of freight per engine and per train crew.

(5) The lowering of freight rates to a point that enabled coarse freights to be worth moving, thereby increasing the volume of freight enormously.

(6) The acceptance of a timber-construction period, enabling roads with meagre early traffic to pay their small fixed charges and survive until their finances and credit are such as to enable them from their earnings or by increased bonding to replace such structures with permanent ones. The Canadian Pacific Railway is a striking example of this.

(7) The use of increasingly heavier freight cars, in which paying freight is a larger percentage of the gross load—and also giving a less co-efficient of rolling friction—which the following table illustrates:

1875	.. 20,000 lbs. car,	20,000 lbs. freight,	50 per cent. dead load
1880	... 24,000 "	40,000 "	37 "
1890	... 28,000 "	60,000 "	31 "
1896	.. 36,000 "	80,000 "	31 "

From which it appears that the limit has been reached.

ARTICLE 2—PROJECTS.

A company of limited liability, but whose capital is inelastic and non-circulating, must do business or break down; it cannot contract its business in hard times except at a sacrifice; business at starvation wages is better than none, and this is the exact condition of a railway company which is a manufacturer and seller of transportation. In this it is different from a store, or more particularly a banking house, therefore all the more carefully should the project be studied before money is embarked in it.

No considerations of a general character will cover all cases, and therefore it will be necessary to exclude roads which have been or may be built (a) for purposes of blackmail, to force rival companies to buy them out; (b) for speculation of the builders, not owners. These are not legitimate enterprises, but ones which projectors start by the expenditure of a small sum for charter, issue of bonds, etc., expecting to charge a margin for selling the bonds, to form construction companies, and let the contracts of construction to themselves at high prices, getting all the money out of the bondholders, running no risk themselves, but controlling all management by means of valueless stock. This gives them all the voting power, and any extra profit remaining after the bond coupons have been paid. Even such roads as these, however, will profit in the same way, as legitimate enterprises, by the application of true economy in location and construction.

Cost is the basis of all business, and most particularly in the case of railways must this always be so. An engineer may insist on technical accuracy and massive work, to such an extent as to bankrupt his company before the road is on a paying basis or even built, or he may, in an ill-directed effort toward economy, give it such a miserable constitution of grades and position, relatively, to its customers, that it will never secure traffic, and could not handle it economically if it did. Between these two extremes, the intelligent engineer should strike a happy balance, so that the project may be where it can obtain most traffic, at least first cost consistent with moderate working expenses, so that it will be profitable to the present owners or promoters, who usually build the road on borrowed money up to a certain safe mortgagable amount.

The promoters of roads are always sanguine, and probably the most common error into which such men