

#### 4) The Application of Science to Engineering

Improvements in engineering are very important to the industrialization and prosperity of a country. Although engineering improvements sometimes come through trial and error they are most often achieved by applying pure science and mathematics to engineering. Canadian engineering was improved a great deal in this manner. The engineering associated with building materials and long distance communication, two of Canada's most important industries, was improved through the application of pure science.

One of the most important scientific discoveries of all time was the law of electromagnetic induction discovered by an Englishman, Michael Faraday, in 1831. This discovery was applied to mechanical generation of electricity which made tremendous improvements to communications throughout Canada. The electric telegraph, first discovered in 1837 by Samuel Morse, was a great improvement over the mechanical telegraph which required the use of a telescope and was much less effective. It encodes messages electrically, transmits them over facilities such as copper wire, coaxial cable, and fibre optics to their destination where they are decoded into their original form. Combinations of long and short bursts of electric current are sent through a circuit thereby encoding each letter of the alphabet. More efficient transmission facilities were developed as the mining industry developed. The discovery of electricity sped up the development of mining through electric lighting and better machinery and ventilation, which led to better materials for wires and cables. Telegraph lines were set up along the CPR in 1885 as a convenient route, but also to relay information about the position of each train along the track to avoid collisions. The telegraph was also the main source of information for newspapers.

Like the telegraph, the telephone wouldn't have been possible without the discovery of electricity. The telephone was discovered by Alexander Graham Bell in 1876 and is much more advanced than the telegraph. It encodes variations in sound waves into variations of electric waves through vibrations of a diaphragm which are then transmitted. Electromagnets are used to send these vibrations through a cable, which are received on the other end by another diaphragm. For its first few years the telephone was for public use only (for calling fire stations, doctors...). A central exchange system was then set up and wealthy people began to gain access. The telephone quickly became essential in unifying and further developing the country.

In the construction industry there were several huge advances in the technology of building materials. Two related materials with similar methods of production are cement and bricks. Cement production in Canada began in 1889 in Hull, Quebec. Portland cement was the principle type and consisted of lime, silica alumina and iron. This type of cement and others were produced using rotary kilns. Through chemical studies it was discovered that the kilns had to be heated up to temperatures of 1400 to 1650 degrees Celsius in order to cure the cement properly. To heat the kilns to these high temperatures new materials had to be developed to insulate them. It became possible to manufacture cement strong and durable enough for manufacturing. Sand, gravel and crushed rock were added to the cement to produce concrete. Concrete became crucial in the construction of such things as the foundations of buildings, roads, bridges, dams, irrigation, and sewage systems.

Near the same time as the development of cement was the introduction to brick manufacturing to Canada. Through chemical studies, clays were found to be good materials for making building blocks. Scientists discovered the proper temperatures to subject the clays to in order to get a uniform and durable brick. Different kilns, such as the downdraft and tunnel kilns were experimented with in order to achieve the appropriate temperatures and air circulation to produce these bricks. At this time brick manufacturing became extremely important in the construction of buildings. Bricks were used not only as a veneer but also to support the whole load of the building.

The most important discovery for the construction industry in period two was that of steel.. The first process to manufacture steel was invented by a man named Sir Henry Bessemer in 1856. He created the Bessemer converter which was a pivoting container lined with silica clay or dolomite. Iron was smelted in the furnace and carbon and limestone added to the alloy iron. During early stages of steel production air was blown into the furnace as a carbon source. Latter coke was burned in the furnaces and some of the carbon reacted with the iron. Many other people have contributed to the process of steel production since Bessemer, among these people was Thomas Basic. In 1877 he designed a brick lined converter that could attain the temperatures needed to produce better steel. He also used limestone to absorb unwanted phosphorus and other impurities because of it's basic nature. Up until Hamilton began to produce steel in 1890, Canada imported all that they needed. Steel was found to be strong, durable and resistant against corrosion and therefore had many uses to the worlds industrializing nations. Therefore it had many uses and it influenced technological growth profoundly. It also had a huge impact on the mining and the transportation industries

It doesn't really matter that many of the scientific discoveries applied to Canadian engineering did not occur in Canada. What really matters is that Canadian engineering was greatly improved through the application of scientific knowledge.