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ENGINEERING HISTORY PAPER #110

"A History of Engineering in Nova Scotia and in Newfoundland and Labrador"

by Andrew H. Wilson

(previously produced as Cedargrove Series #68/2022 – Oct 2022)

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CEDARGROVE SERIES OF

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#68/2022

A HISTORY OF ENGINEERING

IN NOVA SCOTIA AND NEWFOUNDLAND AND LABRADOR

by Andrew H. Wilson

October 2022

Abstract

There are quite a few statistics in the main Macnab source paper, mostly dates and facts, but I have repeated only a few of them. There are also, often, longish lists of the engineers involved in particular projects - obviously names familiar to his local audience. (Carew's paper has no such lists.) Again, I have repeated only a few of them… those mostly associated with the early history of engineering in Nova Scotia. On the other hand, this paper has more *engineering* details (for both main source papers) than any I have recently written.

About the Series

Principally, the Cedargrove Series is intended to preserve some of the research, writings and oral presentations that the author has completed over the past half-century or so, but has not yet published.

About the Author

He is a graduate in mechanical engineering (1949) and the liberal arts (1954) and has held technical and administrative positions in industry in the United Kingdom and technical, administrative, research and management positions in the Public Service of Canada, from which he retired over 30 years ago. He became actively interested in the history of engineering on his appointment (in 1975) to chair the first History Committee of the Canadian Society for Mechanical Engineering (CSME). He was later president of CSME and of the Engineering Institute of Canada (EIC), and chaired the Canadian Engineering Manpower Council (CEMC) and the Canadian Association for the Club of Rome (CACOR).

To set the Scene…

I recently completed a paper (CGS#67/2022) on the history of invention in the American *State* of Maine, a level of discussion new to me, and wondered if similar material existed for any of the Canadian *Provinces.* I went searching in my collection of papers and found two, one for Newfoundland and Labrador, by S.J. Carew, published in 1967, and one for Nova Scotia, by Ira P. Macnab, published privately in 1943 after oral presentation by the author to the Nova Scotia Historical Society. I have used both as the principal material for this paper, along with several other sources gleaned from the Internet and my own collection. However, the origin of the Carew paper still remains a mystery.

Nova Scotia (Macnab - 1943)…

Macnab began his paper by saying that professional engineering grew out of the practical achievements of clear-headed, resourceful artisans and skilled manual workers. It might be added that many of these artisans were blacksmiths. Macnab then named three of the outstanding early British engineers: James Brindley, who built a canal system in England, initially to take coal from nearby mines to its markets in Manchester; George Stephenson, who began the world's love affair with locomotives; and Thomas Telford, who remade Scotland's highway system. The attitude of 'intellectuals' to people like these was often hostile. For example, as late as 1840, when Queen Victoria established the first Regius (Crown appointed) Chair of Civil Engineering and Mechanics at the University of Glasgow, a vigorous campaign was carried on to have it suppressed. And John Smeaton, to whom the designation *civil engineer* was apparently first applied - to distinguish him from military engineers, the first group of engineers to be formally recognized - was taken to task by fellow members of the Royal Society of London for having actually taken part in building a road! (Rumour has it that, a century later, the Principal of Glasgow University (a moral philosopher) tried to have the Faculty of Engineering removed from the University.)

Macnab commented that *engineering* could be defined as "the application of the laws of Nature, the principles of mechanics and the materials of construction, to the business and benefit of the world." He also noted that the word *engineer* had been ill-used in the past. It had been applied with as much frequency to indicate a man who operated the throttle of a stationary engine or a locomotive as it had to those who were engaged in directing works involving the design and construction of civil, mechanical, electrical and other undertakings of magnitude and cost. He added that "the engineer of today is more and more allied to the scientist, and a specialist in his own field."

Macnab went on to say that the first engineering development in Nova Scotia was in 1606-7 when, at Annapolis Royal, a river had been harnessed to operate a flour mill. And the second was, that same year, when Champlain noted from Port Royal that a road of 2000 paces had been built from a wood, along a little river with the help of the Sieur de Poutrincourt, who then had another road built, about 10 miles long, through the woods, as a direct route from Champlain's settlement to the entrance of the Habitation at Port Royal. Building practices common in Northern France were apparently followed. And since Port Royal was founded before Jamestown and Quebec, the works just described were the first engineering ones in North America. The engineers involved were apparently both French and British *military* engineers.

(I would recommend that the reader acquire maps, plural, of the Province to identify the various places mentioned in the text. I would also remind the reader that the very first university-level course in (civil) engineering in Canada was given at King's College, Fredericton, New Brunswick in 1854.)

Macnab then dealt with engineering education in Nova Scotia…

The first reference he found to it was from the calendar of the University of King's College (Halifax) for 1871-72 to the effect that "for the last 82 years, the courses of study pursued (by the College) were modelled on the system in force at the University of Oxford, but the many and growing changes in education have led the Board of Governors to adopt a new curriculum, prominent among which stood a sound training in science. Henceforth, degrees and diplomas would be granted in the sciences." The calendar for 1873-74 included the name, John E. Gram, as Professor of Engineering. The calendar for 1874-75 included under courses of study, civil engineering, with the diploma course in it extending (usually) over three years. The first diplomee was W.E. Allison, in 1875, although two men - R.J. Uniacke and C.E.W. Dodwell, both engineers - received B.A. degrees in 1872 and 1873.

The next college to offer courses in engineering was Dalhousie, also in Halifax, and the first reference to it appeared in the 1891-92 calendar, when a Faculty of Pure and Applied Science was mentioned, separate from the Arts Faculty, but without workshops or laboratories. Students were recommended to use their vacations to seek out working experience. The Faculty were drawn mostly from among local engineers and included some prominent names: Martin Murphy, F.W.W. Doane and Edward Gilpin Jr.

This same calendar stated that "the degree of Engineering will be conferred on a Bachelor of Science who has taken the degree in one or other of the Departments of Engineering at any date less than one year after graduation, but he must furnish a certificate from an engineer that he has been engaged in practical work for a period of at least two years, and he must hand in designs for some construction work in which he has been engaged."

Macnab went on to say that, throughout the years following 1892, there had been four men teaching mining engineering, showing the interest there had been in Nova Scotia in this branch of the discipline. In the Spring of 1893, the University president announced the addition of a new Department of Electrical Engineering. But the first B.Eng. degree was not awarded until September 1905. In 1905-6, a Department of Metallurgy was added to Engineering. That same year, F.H. Sexton was appointed Assistant Professor of Mining and Metallurgy. The first man to hold the Chair of *Engineering* at Dalhousie was C.D. Howe, who went on to leadership in the federal Liberal Party. He was followed by J.N. Finlayson, later Dean of Engineering at the University of British Columbia.

The third university to embark on instruction in engineering was St. Francis Xavier, at Antigonish, in the Fall of 1899. The Departments included were Physics, Chemistry, Geology and Mineralogy, Civil Engineering and Applied Mechanics, Mechanical Engineering, Mathematics and Descriptive Geometry. The Friends of the University were asked to help provide a workshop and to provide facilities for teaching engineering. A new wing was then added to the main building to provide these new facilities, which now included mining and electrical engineering and some other special skills, in 1901-02.

Around this time, also, a series of regional meetings were held to discuss cooperation between the different academic institutions in Nova Scotia, since they were in competition with one another for

students, and including the Provincial Government and the Halifax Board of Trade. At one of these, on April 19, 1906, it was agreed that a college would be established in Nova Scotia to offer courses in the junior and senior years of civil, electrical, mechanical and mining engineering degrees. The provincial government would finance it, and the other Engineering Schools in the Maritime Provinces would join in its activities. The freshman and sophomore years of engineering would be provided by the existing institutions. On April 25, 1907, the Nova Scotia Technical College was established in Halifax, with F.H. Sexton as Principal. Its first buildings were erected in 1908 and 1909, and the first senior class of 9 engineers (7 civil and 2 mining) graduated on May 25, 1910. (Macnab's paper says very little about the training of surveyors in Nova Scotia.)

To return to engineering in the industrial sector…

From the year 1498, when Cape Breton was discovered by Sebastien Cabot, no mention was made of the existence of coal there. Even Champlain, who circumnavigated the Island in 1607, does not mention it, although outcrops were visible in many places. The first record was written in France in 1672 by Nicholas Denys, who had been given a concession for the whole Island, but he made no attempt to work it. This was not done until 1720, when coal was needed to sustain the Fortress of Louisburg, which was then being built. But it was not systematic. This happened in 1784 when Nova Scotia became a separate Province, but it was still not financially successful. In 1793, a mining engineer came out from England to superintend some action, and stayed until he died in 1799. The next year, the Government took charge and worked what mines there were, until 1802. The maximum amount of coal sold annually until 1826 was only around 12,600 tons. Meanwhile, in 1825, Cape Breton Island (CBI) had become part of Nova Scotia and the company, the General Mining Association (GMA) had bought the lease for all the mines and minerals in the Province.

Also in 1825, another mining engineer was sent out from England to report on the copper deposits in the Province. He found none worth working, but collected useful information on coal, which he recommended be exploited commercially, with the result that the coal mines at Sydney on CBI were leased by the GMA in 1827 and, as they did in 1828, the coal mines in the Pictou area at Stellarton on the mainland. Richard Brown opened up both the Albion mines in 1830, and the Pictou mines. Around 1830, a four-mile horse-drawn railway was built at the Albion Mines to take coal to ships on the East River. A locomotive was brought from England in 1837 to replace the horses - and became the second railway in Canada. The story goes that, for the first engine-driven trip to the ships, the horses were loaded onto flat cars to make a farewell trip over the road they had walked for years.

The construction of St. Peters Canal, a small shipping canal on Cape Breton Island that joined Bras d'Or Lake with the Atlantic Ocean, began in 1854 and was completed in 1869. It was unusual in that the two ends of the canal had different tidal conditions. So a single, special lock was built at St. Peters, each of the two lock gates consisting of four (not two) swinging doors which formed a diamond shape when closed. Vessels transiting were also limited by size and draft. No matter which side had the higher water level, either the one pair of doors or the other would be used. (This canal is the only one of significance still working in Atlantic Canada. It operates from May to October each year.)

The city of Halifax was founded in 1748 and incorporated in 1848, and the development of Georges Island in Halifax Harbour, to defend it, was begun in 1750 and completed in 1778. The construction of the *Citadel* on a hill above downtown Halifax, to guard/defend it, was begun in 1856. The construction

of the 70-mile Shubenacadie Canal, which joined the Bay of Fundy to Halifax Harbour in the centre of the Province, began in 1826, went bankrupt in 1831, was revived in 1854, was in use by 1856, but was not completed until 1861… and was closed in 1871.

The first boilers, used at Sydney Mines around 1867, used steam pressures of between 6 and 10 pounds per square inch - modern ones use 1200 pounds or more. A hoisting engine installed around 1867 (was still working in 1943). A coal washer was built, around 1860, to improve the coal that was to become coke. A chain grate for boilers was also built in the 1860s and operated for about 40 years. It worked well all day, apparently, but tended to break down during the night, at 4 am, when no workmen were on duty. When the land-based coal seams ended, the miners began operations out under the sea. Macnab went on to say:

> (Since the early days of mining,) there have been tremendous developments in coal mining in Nova Scotia, some successful, some less so, and some not at all…In the early days, of course, it was all hand labour. Then came what might be called the pneumatic age, when air compressors forced air for several miles, to operate locomotives and mining machines, on the pit bottoms. Next came the electrical age and today (1943) many of our mines are being changed over entirely to electrical operation. There has also been tremendous improvement in mine ventilation, safety regulations and in general operating conditions, due to the cooperation of the technical personnel…

Macnab then turned his attention to the steel industry.

The first (small, mainland) development of iron ore extraction was in 1825 at Clementsport, in Annapolis County, when a few tons were made. Around 1850, the Acadian Mining Association built a charcoal furnace at Nictaux Falls. The limestone for this came from St. John's, Newfoundland. There was only one operation of any size in this area of Annapolis County before it was purchased by the Canada Iron Corporation in 1909, who eventually shipped large quantities of ore to foreign markets. But back in 1849, there began a development by the Acadian Charcoal and Iron Association near Londonderry in Colchester County. Its equipment included a puddling furnace, a steam hammer and crushing rolls. In 1852 a charcoal blast furnace was installed, which continued in operation until 1875, although five years earlier the full equipment needed to manufacture steel had been installed.

In 1874 or 1875 the first commercial experiments were made to manufacture steel in rotating furnaces, the forerunner of the modern steel-making processes. The first coke ovens were built in 1873 at the Albion Mines in Pictou County and the necessary coke in furnaces at Londonderry. Many years earlier, deposits of iron had been discovered on the East River. The GMA built a small furnace there, but little iron was made. In 1872, the Hope Iron Works was established at New Glasgow for the manufacture of marine and railway forgings. In 1878 the company's name was changed to the Nova Scotia Forging Company and the plant moved to the site it presently (in 1943) occupies as part of the Nova Scotia Steel and Coal Company, at Trenton. In 1882, that company began making steel from imported pig-iron and scrap by the open-hearth process. In 1883, the first steel ingots made in Canada were made in this plant.

In 1890 the New Glasgow Iron, Coal and Railway Company was organized and bought the iron ore deposits on the East River and built a railway from Ferrona Junction on the Intercolonial Railway to

Sunnybrae. It also erected a 100-ton-a-day coke blast furnace at Ferrona, and built the first commercial coal washing plant and retort coke oven on the American Continent. The ore for it was mined locally at first but, in 1894, the company bought the large iron deposits at Bell Island, Newfoundland. In 1900, the Nova Scotia Steel and Coal Company bought all the mines and mining rights of the GMA at Sydney Mines. It then bought furnaces and other plant for its operations at Sydney Mines and built piers for coal and ore handling, and abandoned its operations at Ferrona and its mines on the East River.

The development of the Dominion Iron and Steel Company at Sydney that began at the turn of the 20th century has occupied a large place in Nova Scotia's history. Today (1943), the Dominion Iron and Steel Company, the Dominion Coal Company, the Nova Scotia Steel and Coal Company and the Cumberland Railway and Coal Company, with the Eastern Car Works at Trenton, are all under the same management. Macnab then listed a number of senior engineers involved in the new power plants and mining electrification, and the aftermath of World War I. He also noted that Nova Scotia then had the largest steel plant in the British Empire, for which all the materials in the manufactured product were also owned by the Company.

And this was the time that social/technical progress was being made in areas such as the telephone, wireless, automobiles, water systems, and electric light and power. Also, the earliest successful transatlantic wireless station was located in Cape Breton, and the engine that generated power for the station was made by the Robb Engineering Company of Amherst. An advertisement for it in 1890 read: "Amherst Foundry and Machine Works, A. Robb & Sons, established 1840. Building Hercules engines, the very latest design. Has more points combining durability and cheapness than any engine manufacturer in Canada. Also the Monarch patented inclining fire box boiler is the simplest, and strongest and most economical and cheapest boiler for portable or brick in the world. Sawmill machinery, stoves, ranges, hot ait and hot water furnaces." Later, A. Robb & Sons of Amherst became the Robb Engineering Works.

(Macnab, himself, served an apprenticeship at Robb's, and later was on its staff.)

Gas lighting services began in Halifax in 1843, the serving company being the Gas, Light and Water Company. In the first year, 281 dwelling houses and 60 streetlights were gas lit, with tar and coke as by-products, and six miles of main were laid. Robb family members, all engineers, designed the Robb-Armstrong engine, which - for its time - was one of the best power-producing engines then made. They also designed, patented and manufactured a water tube boiler for power development within all of Canada and many other countries.

Several other developments in electrical power in Nova Scotia are of interest. The first commercial electric lighting plant supplying Halifax's arc lamps went into operation around 1883. Today, many of our mines are being changed entirely to electrical operation. There has also been a tremendous improvement in mine ventilation, safety precautions, and in general operating conditions. Another was the installation of a powdered fuel boiler plant at Waterford Lake by the Dominion Coal Company, around 1910. It was one of the first in America, and it operated successfully for many years. Around this time, in 1906, another similar plant built in the Northwestern U.S., and one by Canadian General Electric at Chignecto Mines, which operated until 1927, when it was replaced by a more modern one with pulverized coal-fired boilers.

One of the most modern steam power/electric power developments in Nova Scotia was at Black's Wharf, Water Street, Halifax, in 1883. In 1887, the first incandescent plant began operating at the Chandler Electric Light Company. The *Halifax* and *Queen's* Hotels were the first to have electric installations. And again, in Halifax, in 1920, the first line for one-man Birney street cars was lain across the Common. In 1927, the old two-man cars made their last trips across the Common and were fully replaced by the one-man service. Other small existing companies were finally purchased by the Halifax Electric Tramway Company (HETC), which was organized in 1895. The HETC also bought out the horse-car company, and its system was electrified. However, one of the most modern steam power developments was at the steel plant at Sydney, where waste gases from the blast furnaces were burned to produce steam for use in power generation.

Macnab went on to say:

> This period of development (saw the) change-over from the hydro development of the early days in which practically all of our industries were located on the streams of the Province and operated directly by small water mills, to the present condition where practically all of the plants are operated by electric motors drawing their energy from large central stations or a combination of stations feeding into one large system…Another very important development in the social and business life of the Province has been that of the Maritime Telegraph and Telephone Company. The first telephone calls in Nova Scotia were made in Halifax and at the Caledonia Mine, near Glace Bay, in 1877 and 1878...Also in 1878, a telephone was operated between Halifax and Pictou…And the first telephone office was opened in Halifax in 1879…In 1880, the Western Union Telegraph Company opened an exchange at 166 Hollis Street in Halifax. The Nova Scotia Telephone Company was formed in 1887... (the same year) that toll lines were built to Windsor, Truro, Amherst and New Glasgow…The first dial-operated exchange was opened in Halifax in 1920.

Up until Confederation in 1867, Public Works in Nova Scotia was the responsibility of the Province. After it, they were managed by the Department in Ottawa. For Example, Ottawa built the Intercolonial Railway (chief engineer, Sandford Fleming) from Montreal to Halifax, which opened in 1876. But in 1879 Railways and Canals were separated off, and in 1889 the Maritime Division of Public Works - including Nova Scotia and Cape Breton - had their own Divisions. And in 1921, Nova Scotia became a District of Public Works.

Under Railways and Canals, Halifax Harbour was rebuilt, Pier 2 was added at the Deep Water Terminals, beginning in 1910 and, in 1912, work on replacing the timber piles with concrete ones was started, as was the building of the railway lines at the south end of Halifax.

The first highway in the Province was built in 1606-7 and, prior to 1879, the building of highways in general was haphazard but remained under provincial control, as did the bridges associated with them. Beginning in 1918, about 1000 miles of trunk highway were rebuilt and gravelled. The first paving - a section of the Halifax-Rockingham highway - was done in 1919. Today (1943) Nova Scotia has over five thousand miles of graded or gravelled highways, about 1000 of which are paved.

With regard to engineering societies in the Province, in 1907, the engineers themselves decided to form the Nova Scotia Society of Engineers. It flourished until 1920, when it became a branch of the Engineering Institute of Canada (EIC), with affiliation to Societies in the United States and Britain. It was hoped that the new Institute would also regulate/register the profession (then a national problem). But this problem was not solved until 1922, when seven provinces formed Associations of Professional Engineers to do these and several other tasks, one of which was in Nova Scotia. In 1943, the EIC branch in Halifax was the fourth largest (250 members) in the country.

Newfoundland and Labrador (Carew - 1967)…

Carew began with these tone-setting words:

> The history of engineering in Newfoundland is told by relating a series of achievements in many fields which engineers carried out, often with the cooperation of statesmen, financiers, technicians and labourers. In the early years these achievements were really forms of ingenuity applied to everyday problems such as: designing cod traps; building boats to take part in the seal hunt; building wooden roads for pulling boats across the isthmus of Avalon; building lighthouses on craggy coastlines; making anchors by hand for small boats; getting supplies across the ice to build the mining complex at Buchans; building rigs to lift the catch of fish over the steep cliffs and designing river crossing ferries to operate by aid of current and cable. In recent years, engineering carried on in Newfoundland has been of the highest North American standard performed on projects of gigantic proportion.

Carew went on to say that even this would not be the whole story, because the job of providing better services has never finished and the challenge to do greater things was always there. Captain Cook made the first survey of Newfoundland's coastline in the 1760s. In the 1850s there was the first mention of fish oil factories, which today (1967) is a principal by-product, along with fish meal. And we should remember the many difficulties to be overcome, such as the sparse population along hundreds of miles of coastline, the laws of colonization, and the partial destruction by fire of the main town of St. John's in 1816, 1846 and 1892, the wars with France, the preoccupation of the people with its one, fluctuating industry - the fishery - and the boundaries of Labrador. It took Confederation in 1949 to provide solutions and to develop the province on a gigantic scale.

It should also be remembered that North America did not really 'take off' itself until the First Industrial Revolution in the late-1700s. In Newfoundland, services such as the railroads, the telephone and electricity arrived *after* the other parts of North America. On the other hand, Newfoundland managed to participate in ground-breaking advances in aviation and communications that made it well-known in both North America and Europe.

And remember, also, that Carew's 'period' ended in 1967 - 55 years ago, before the most recent advances based on electronics, and around the beginning of the Third (late 1900s, onwards) Industrial Revolution.

With regard to the fishery, by 1967 it was no longer *the major* industry in Newfoundland and Labrador. Oil and hydro-electricity had taken its place. But the fishery was in better shape engineering-wise than it had ever been. A Fisheries College and a University had been established to supply trained/skilled personnel, including engineers, with more training than before - and with product and process innovation as their main stimulus. There were now several federal research stations in the Province.

For many years, cod had been the principal catch. It was found, caught, split, salted and dried in the sun, and sold to less wealthy markets at competitive prices. But after World War II, the possibilities for rapid freezing meant that other varieties, like salmon, could be caught and processed in the growing number of modern plants that were being built round the coast, and for which local firms of engineers received turn-key and operating contracts. In other words, the predominantly small-capacity inshore fishery of yesterday has been greatly expanded.

By 1967, also, the new shipyard at Marystown had not yet been completed.

Newfoundland has always had many ore bodies suitable for mining, which began in 1830 at Notre Dame Bay, and has increased in scale ever since. The ores have been iron, copper, lead and zinc, plus asbestos, fluorspar, gypsum, and pyrophylite. The methods used have included room-and-pillar, open pit, stopeing and drifting. The mines have consistently encouraged engineers from other countries to come to help the local ones.

Submarine mines opened at Wabana in 1895, and eventually reached out three miles, with 340 feet of salt water above the miners' heads. The ore was brought to the surface by an inclined belt over 12,000 feet long - then the longest conveyor belt in the world. Between 1895 and 1966, 79 million tons of ore were mined there.

The base metals deposits at Buchans, in mid-Newfoundland, were discovered in 1905, but it was not until 1928 that suitable methods (and funds) were developed for separating the recovered ores. By 1966, the Buchans' annual mined and milled ore production reached 350,000 tons, employing 600 men. In 1933, the St Lawrence fluorspar mine began production. It continues, in 1967, to supply a material used, elsewhere, in the recovery of aluminum from its ore. It was also one of the first Newfoundland mines to use diesel engines underground. Recent developments include copper mining in Notre Dame Bay and asbestos mining at Baie Verte.

The glamorous aspect of mining in this Province is usually associated with the iron mines in Labrador, where three mines were in operation in 1967, and reserves were in the billions of tons. While these ore bodies were discovered in the late 19th century, it was 1954 before Ungava ore was shipped to the steel mills of North America, having been carried an initial 350 miles by rail (the Quebec North Shore & Labrador Railway) to tidewater. The construction of infrastructure to support the Labrador mines was also a herculean task, done partially under arctic conditions, using helicopters as well as railways.

The first (80-mile) railway was completed in Newfoundland, from St. John's to Harbour Grace, in 1884. Later, a line was built as far as Placentia. The standards of construction, however, were poor. But in 1890, railway-builder Robert Reid (later Sir Robert) arrived in the Province and contracted to build extensions, first, to Notre Dame Bay and later to Porte aux Basques. Essentially, Reid completed in 1896 a 547-mile, technically difficult, but well-engineered, narrow gauge railway across the island, taking in

the mining and other industrial activities in the Notre Dame and Grand Falls industrial areas at the centre of it, the work having been done on schedule and through winter storms. 149 bridges were also designed and built by the Dominion Bridge Company. The railway was taken over by the CNR after Newfoundland and Labrador joined Confederation in 1949.

The paper mill at Grand Falls was built between 1905 and 1909, and the one at Corner Brook between 1923 and 1925, with the assistance of engineers from Britain and the United States. Corner Brook became one of the largest plants of its kind in the world, and both were still in full operation in 1967. They have constantly been 'modernized.'

For many years, the sea was the main means of transport between settlements round the coast. There were, of course, snow and dogsleds in winter. The logging industry also provided challenges getting the logs to the mills, but the acquisition of new equipment improved this situation. However, the building of roads in the Province (Labrador, as well as the Island) has always been slow and costly, and an on-going challenge for the engineers involved, given the rock outcrops, bogs, large bodies of water, weather, and the scarcity of road materials. It was the coming of the horse and carriage that made roads essential. Up until 1930, all roads were gravelled, and it was not until that year, also, that the streets of St. John's were paved. But by 1966 there were 1000 miles of paved road in the Province, including the Trans-Canada Highway sections of it. Newfoundland also developed its own cadre of bridge-builders and its own Department of Highways. Concrete was the main material used for the highway bridges. The bridges themselves may be divided into three groups: those designed for narrow roads and light loads (1926-1934); flat slab, girder and slab, and arch bridges (1935-1949); and pre-stressed, concrete bridges (post 1949). In 1967, the one at Steady Brook near Corner Brook was the longest one (over 1200 feet) over the Trans-Canada Highway.

Carew has noted that falling water has been one of the Newfoundland's principal sources of primary energy, and the Province has had it in abundance. Its first hydro plant was built in 1896, at Petty Harbour, near St. John's, to operate the city's electric railway. In 1902, another plant was built at Carbonear on the Avalon Peninsula. By 1967, there were 15 small plants in this area alone.

For the paper mill at Grand Falls, two hydro sites have been developed, at Grand Falls and Bishop's Falls, on the Exploits River. In 1926, at Deer Lake, a plant - the largest at that time - was developed for the Corner Brook mill. Its dam was of reinforced concrete, and there was a canal seven miles long. In 1967, a new plant generating 300,000 horsepower will be completed at Bay d'Espoir on the South Coast. But by 1972, the largest plant in the Province will be in Labrador, at Upper Churchill (formerly Hamilton) Falls. The first hydro development in Labrador, however, was the Menihek - for the Shefferville area - built in 1954, followed in 1962 by the Twin Falls plant, for Labrador City and Wabush, which will also serve the construction of the plant at Churchill Falls. The early hydro developments were based on earth-filled dams, surge tanks, canals etc. The later developments included river diversions, huge surge tanks, underground powerhouses, and 100,000 hp turbines.

However, steam and diesel plants have also been used in Newfoundland to generate electrical energy. A Newfoundland and Labrador Power Commission was set up in 1954. One of its projects had to do with the transmission of high voltages over long distances…from Churchill Falls to the Island, including the underwater section between the two parts of the Province.

F.N. Gisbourne Introduced the telegraph to Newfoundland in 1852, with a line from St. John's to Carbonear. Four years later, he had completed a line across the Island, which was also connected to a cable from Cape Breton and Canada. American Cyrus Field brought two Atlantic cables to Newfoundland, one to Bay Bulls Arm in 1858 and the other to Heart's Content in 1866. By 1967, more than 30 lines joined the Province to the rest of the world.

Avalon Telephone, one of two such companies in the Province completed a construction program in 1966 that will raise its total investment in plant and equipment to $39-million and include a cross bar type exchange at St. John's. The first telephones in the Province were installed in the early 1880s, and the first switchboard several years later. Newfoundland is now linked to Europe by several telephone cables and to mainland Canada by over 100 radio telephone circuits.

Radio was famously first linked to Newfoundland when Marconi's message came from England to him at the Cabot Tower at St. John's harbour in 1901. The first of the Island's radio stations was set up in 1932. The first reception of live TV by means of the Canada Microwave System took place in 1959.

In 1942, Trans-Canada Airlines introduced the first regular passenger flights to Canadian cities, with a Lockheed *Lodestar* plane. In 1945, the province's own airline, *Eastern Provincial,* began operating and quickly grew to be Canada's third largest. Airfield maintenance, however, has been the responsibility of the Federal Department of Transport.

Up until 1949, public works construction and maintenance was Newfoundland's responsibility. After it, the Federal Public Works Department (DPW) took over charge of wharves, lighthouses, breakwaters, federal public buildings, and so on. Local consulting engineers helped, as required. New and recent DPW projects have included ferry docks at Argentia and Port aux Basques, and a variety of projects associated with roads and buildings in the new National Parks, and the development of St. John's harbour. The Provincial DPW assists with small building design, with school and hospital design, with consulting services, and with running and maintaining all government buildings. Private engineering consultants may also assist. In fact, one of the benefits of Confederation has been an increase in the participation of private consultants in the Province's engineering projects. Municipal engineering has been done mostly in St, John's. Since 1860, for example, Windsor Lake began supplying water to St. John's - privately until 1888, when the municipality took over.

The Island has been a user of fuel oil and other oil products for a long time. The first record of the use of kerosene is from 1850. In 1961, the first oil refinery was built, at Hollywood, to process crude from Venezuela and in 1966 its capacity was increased to produce 12,000 barrels-a-day. One of the largest storage tanks in Canada was built at Hollywood.

So far, manufacturing has not provided the support for engineering in Newfoundland that other Provinces have, but this could change. An exception has been the iron and steel manufacturing company established in 1848 by the senior John B. Angel. This company built the first water wheel, the first steam engine and the first steel ship in the Colony/Province. It also made stoves and nails. During World War I, it also made shell cases from rough forgings produced in New Glasgow (Nova Scotia), from Bell Island (Newfoundland) iron ore. The heavy construction industry has also been growing since the Province joined Canada. Newfoundland has also largely produced its own Portland cement, bricks, pre-cast concrete and paint.

Military Forces have been present in the Province for two periods: during the British-French Wars (1662-1796 and up until 1860) and from the 1940s to the present (1967 and after). In 1936, the British began the construction of the airport at Gander. Strategic airfields were later built at Torbay, Stephenville, Argentia and Goose Bay, which now (1967) are all heavily used by civil aviation.

The Engineering Institute of Canada (EIC) was formally established in Montreal on 1918. In 1948, it established a Branch in Newfoundland, its main purpose being the transmission of technical information and the provision of a social hub for professional engineers and engineering students. (Its members were instrumental in the formation of the APEN, below.) By 1967, EIC had three branches: at John's, Grand Falls and Corner Brook.

In 1952, the Association of Professional Engineers of Newfoundland (APEN) was established and a year later became part of what is now (2022) Engineers Canada, which was formed originally in 1936 as the Dominion Council of Professional Engineers (later the *Canadian* Council), to regulate the practice of engineering in the Province and to ensure the quality of engineering services in it. In 1965, APEN added two days of technical sessions to its Annual Meeting. By 1966, it had 334 members.

Towards the end of his paper, Carew wrote:

> … in the fall of 1930, Memorial University College in St. John's, which was but five years old, started a three-year diploma course in engineering. At that time there were but 137 students enrolled at the University College and the number of graduate engineers in the whole Province was probably not more than two score. The first classes in engineering at Memorial had but six students in the second year, and seven in the first. All of the original second year students completed the degree course, five at the Nova Scotia Technical College (NSTC) in Halifax, and one at McGill University in Montreal…
>
> Mr. T.H. Winter was the first lecturer…he was (also) given the job to organize and inaugurate the course in engineering. The course he set up was similar to the one at NSTC, and in 1933 Memorial affiliated with the NSTC which offered which offered to provide Memorial students with the last two years of the baccalaureate course…
>
> Mr. C.A.D. McIntosh followed Mr. Winter as head of the engineering Department, and served from 1931-1934.
>
> In 1944, when the university became a degree-granting institution, engineering was placed in the Faculty of Applied Science and the head of the Engineering Department was made Dean of that Faculty. (Dr. Carew became the first dean.)
>
> Over the thirty-six years (1931-1967), the engineering course changed from one having strong emphasis on drafting in the subjects of drawing, surveying and mechanics to one stressing problem-solving and laboratory work in graphics, mechanics, materials, electric circuits, thermodynamics and fluid

> mechanics… scholarships, prizes and bursaries have encouraged and helped many of our students to continue their studies…
>
> In 1966, the Senate and Board of Regents approved the offering of a full degree program in civil, electrical and mechanical engineering, on a cooperative basis, with work and university terms alternating; the undergraduate degree would be B.Eng.
>
> Engineering, which was not singled out for special commendation by our early historians, has now come of age and will be one of the main forces that will provide the industrial leadership to help our Province in the future.

(Anticipatory notes: In 1968, Dr. Angus A. Bruneau, of the Faculty of Engineering at the University of Waterloo, was appointed the founding Dean of Memorial's new Faculty of Engineering. The Faculty began its operations in 1969.

Also, Carew's paper was written decades before the formal discovery and development of Newfoundland's offshore oil.)

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