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“150 Years of Canadian Engineering:

Timelines for Events and Achievements”

by Andrew H. Wilson

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**150 YEARS OF CANADIAN ENGINEERING:
TIMELINES FOR EVENTS AND ACHIEVEMENTS**

by Andrew H. Wilson

May 2019

Abstract

The research for this paper was done as part of a sesquicentennial project on *150 Years of Canadian Engineering*. Some of its material has also been presented orally.

This paper covers briefly and selectively Canadian engineering events and achievements in four time periods: one up to the time of Confederation in 1867, and three others between then and 2017. Associated with the three later periods are corresponding economic/political/social timelines to help put the engineering in context. There are no comments in it on the quality of the design, construction/manufacture, origins and uses of the items listed.

This paper took a whole lot longer than expected to research and write, so that it carries a date in 2019 rather than late in 2017, when the chronological material in it ends. There are no maps or photographs.

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. It is, therefore, the modern-day variant of the privately-published books and pamphlets written by his forebears, such as his paternal grandfather and grandmother and his grandfather's brother John.

About the Author

He is a graduate in mechanical engineering and the liberal arts and has held technical, administrative, research and management positions in industry in the United Kingdom and the public service of Canada, from which he retired over 30 years ago.

He became actively interested in the history of engineering in 1975 on his appointment to chair the first history committee of the Canadian Society for Mechanical Engineering, and served both CSME and the Engineering Institute of Canada in this capacity for varying periods until 2003. He has researched, written, edited and presented historical material for both organizations and for the Canadian Society of Senior Engineers. He is also a past president of CSME and EIC.

Preamble

In his article in the January/February 1989 issue of *Engineering Dimensions*, Norman Ball writes that:

Canadians have read and been taught that Canada's engineering is second-rate. If engineers do not set the record straight, (this) myth could become reality. After all, how long can engineering remain excellent in a society convinced it is mediocre?

This paper - by an engineer - is intended to help dispel this myth (as have several of the companion papers in the Cedargrove Series). It is also intended to help counter the disinterest of many Canadian engineers in their professional history, of the political people who make use of engineering, of the historians who ignore it, and of the public in general that finds it convenient to use but is apathetic towards it.

During 2016, 2017 and 2018, I undertook - as a 'sesquicentennial' research project - one that has examined aspects of the history of engineering in Canada, from before Confederation in 1867, up until the end of 2017, as a result of which a number of papers have been prepared. Although this particular one was written during 2018 and early 2019, its contents end with 2017. Some of the material in it has already been used in oral presentations to the Canadian Society of Senior Engineers and to the Friday Luncheon Discussion Club of Ottawa.

You, the reader, already know there is a verb to 'engineer' and that engineering is *an activity* that designs, builds and makes things, and usually looks after what it designs, builds and makes. Science and technology, on the other hand, are bodies of knowledge. The verbs appropriate to them are: to 'research' and to 'develop.'

In what follows, note is initially taken of Canadian engineering-related achievements in place at the time of Confederation in 1867. This is followed by three sets of parallel post-Confederation timelines, the first of which covers the principal economic/political/social events (a sort of socio-political overlay) and engineering events and achievements in Canada from 1867 until 2017. A short summary is given at the end of each period. For the purposes of this paper, I have assumed events and achievements in Newfoundland and Labrador's engineering history prior to it joining the Canadian Confederation in 1949.

The listings included in this paper are certainly not definitive. To make them so, would occupy several books and involve the work of many people. Also, using the economics terms 'macro' and 'micro,' it tends to place emphasis on those that are larger and more complete and includes fewer that are component parts or sub-assemblies. For example, it includes information about the big bridges, not the small ones. It does not cover Canadian achievements abroad. Also, most of the Information about industries, individual companies, engineering consultants, government departments and education involving engineering - and about Canadian disasters - has been included in the 'economic' timelines.

No comments have been made in this paper on the quality of the engineering done on each of the events and achievements mentioned, nor about the environmental, economic or other hazards that may (or may not) have resulted from their conception/manufacture/construction or during their operating history.

This paper recognizes that even well-designed engineered structures, machines and devices, big and small, costly and inexpensive, have limited lives, become obsolete, can wear out and break down, and some can be badly made in the first place. It recognizes that there may have been related research and development done earlier in university or other laboratories, that this applies particularly to the post-WWII years, but that most such endeavours need separate recognition. It also recognizes that not all of the events and achievements are purely Canadian, that American and other influences may have been in play. Nevertheless, the paper's main premise is that we can learn useful things from the history of what has actually been engineered.

This paper recognizes that museums all across Canada contain engineering artifacts (often presented as the fruits of *science*) and that one way to appreciate the continuous impact of engineering on daily life is to visit some of them. It also appreciates that the (contemporary, engineered) Internet holds a great deal of information about engineered structures, machines and devices that can be accessed easily.

But how do you get a feel for how long 150 years is? I did this by using family statistics. My maternal grandfather lived for 61 years. He was born in 1871 and died in 1932, when I was four. So if we disregard the four-year overlap, we may assume his date of birth was 1867. And if we add his 61 to 89 of my 91 years, we get 150! Also, grandfather was born several years *before* Alexander Graham Bell did his Brantford telephone experiments. I was born one year *after* the last Model-T Ford destined for Canada rolled off the assembly line in Detroit.

At the same time, we have to remember that Canada and its 'culture' around the time grandfather was born were quite different from what they are now. Charles Camsell gives an example of this in a paper he read to the EIC in 1928 about a journey his father had made 70 years earlier from Kingston to Winnipeg...about 1,000 miles as the crow flies. He said:

...a small detachment of the Royal Canadian Rifles, of which my father was an officer, left Kingston on 20 June 1858 and, travelling by vessel by way of Hudson Straits and Hudson Bay, landed at York Factory. From there, the detachment travelled by York Boat up the Hayes and Nelson Rivers, across Lake Winnipeg, and up the Red River to Fort Garry, arriving at that point on 15 October. In other words (in 1858, seven years before Confederation) it could take four months to get from Kingston to Winnipeg, a journey we now make (in 1928, by rail) in less than two days.

A direct commercial flight from Ottawa to Winnipeg in 2017 would occupy about two-and-a-half hours.

This paper describes many *Canadian* engineering events and achievements. A companion paper in the sesquicentennial part of my CGS Series (#47/2018) lists some of those made internationally that have influenced the directions engineering has taken in Canada.

I should acknowledge that at least one other extensive *engineering* timeline has already been published...for the period from 1716 to 1987...in the September/October, 1987 (Centennial) Edition of APEO's *Engineering Dimensions*. I should acknowledge the great value to this present paper of Norman Ball's book *Mind, Heart and Vision: Professional Engineering in Canada 1887 to 1987*, also published to commemorate the Centennial of Engineering as a Profession. Indeed, I would recommend that Ball's book should be read to supplement the information given in this timeline. And I should mention the series of articles published by the Ontario Society of Professional Engineers during *Canada 150* which describe in detail many past and recent Canadian engineering innovations.

Finally, I should say that, for a variety of reasons, and with regret, there are no pictures/sketches/photographs in this paper. Indeed, to do justice to Canada's engineering/photographic image, they should have another book (in addition to Norman Ball's) all to themselves!

Engineering in place by 1867...

The earliest Canadian engineers were beavers, who famously built dams and lodges. It should also be remembered that there were no horses in post-Ice Age North America until the Spanish brought them back in the early 1500s.

Indigenous contributions to engineering in what is now Canada began before there was a country or 'formal' engineering, and well before 1867: for example, the kayak, dugout and birchbark canoes, toggle-headed harpoons for catching whales and big fish, longhouses and palisades, igloos, teepees, lodges, plank houses, sod houses, moccasins, snowshoes, snow goggles and travois, plus tools and weapons of bone and metal, dogsleds, toboggans, and weirs, dams and other devices for trapping fish, beaver and other animals. The French, and later the British, made use of what the indigenous people had engineered. But they also had to learn to adapt European engineering practices to Canadian conditions and to devise new construction and manufacturing techniques. Rivers and lakes were still the highways, and roads were few and primitive. Before 1867, for example, French military engineers built masonry fortifications and battlements, of which those at Québec and Louisbourg are examples, as were Forts York and Henry, built later by the British. Both French and British also needed bigger port facilities and deeper waterways for their bigger boats and ships. They brewed beer. In the Maritimes, they drained coastal marshes to grow food using, for example, *aboiteaux* tide gates.

All told, there were very few professional engineers here in 1867, probably around 200, most of them were civils, a few of them mechanicals, working on railways, canals and public works. They had learned

their business principally through the apprenticeship/pupillage route. The first university level engineering classes were held at the University of New Brunswick in 1854, but it was not until the 1870s that university classes led to degrees. Engineering as a profession was then unregulated. Jobs were either plentiful or scarce, and political opinions and connections often determined whether or not they could be found.

In 1841, the Province of Canada authorized the establishment of what became the Geological Survey of Canada. Its first director was W.E. Logan. The following year, the Royal Navy established a dockyard at Esquimalt, B.C..

In the early 1800s, a rag-based paper industry was developing in the Canadian colonies. By 1844, Charles Fenerty had developed newsprint made from woodpulp. By 1846 Abraham Gessner had made kerosene, which was used to replace whale oil in lamps. Meanwhile, manufactured gas was being used for city street illumination and the lighting of public buildings.

For most of the 19th century, squared timbers, in cribs, were floated down the Ottawa and St. Lawrence Rivers for shipment to Britain. Special timber slides were built to allow them to pass waterfalls. Fish ladders were developed to help salmon 'climb' dams to get to their spawning grounds.

A telegraph line was built between Toronto and Hamilton in 1846, much of it parallel to the railways, and it began a communications revolution that spread across the country. By 1861 there were 3,000 kilometres in use.

In the 1850s, a number of settlers' (and military) trails were established in Canada West - for example, the Opeongo, Addington and Bobcaygeon. In the Far West, the Carlton Trail ran from Fort Garry to Edmonton. Railways and steamboats helped to stimulate manufacturing industries, as well as agriculture, forestry and mining.

In 1852 F.N. Gisborne laid the world's first submarine telegraph cable between Prince Edward Island and New Brunswick. Black powder explosive was first manufactured at Hamilton, Ontario. In 1858 the first transatlantic cable was laid, to Heart's Content, Newfoundland, but it failed prematurely. A second, successful, attempt was completed in 1866. Robert Foulis invented the world's first steam foghorn, in the Bay of Fundy, in 1859.

By 1853, James Good had built the first Canadian locomotive, in Toronto, and Montréal was connected by rail to Portland, Maine. By 1854 the rail line from Niagara Falls to Windsor was complete. Also, in Montréal, the Grand Trunk Railway had opened its legendary Point Saint Charles Shops, and a line ran from Prescott to Ottawa. Completed in 1854, the short Brockville railway tunnel was the first tunnel built in Canada and the first railway one in North America. In 1855 there was a railway line from Toronto to Collingwood and, by 1860, one from Montréal through to Sarnia. Until 1858, all the rails were imported from Britain and the United States. A major engineering consulting and contracting firm at this time was Britain's Peto, Brassey, Jackson and Betts.

By 1867, approximately 3,000 kilometres of railway had been built in the colonies. And as the railway lines grew, so did the number of bridges. For example, in 1855 the first (Roebing) Niagara Falls Railway Suspension Bridge was opened, and was among the world's first such bridges. In 1860 the Prince of Wales came to Canada to open the spectacular new Victoria Bridge across the St. Lawrence at Montréal. Not far away was the tubular Sainte-Anne-de-Bellevue Bridge, built a few years earlier. The Prince also laid the cornerstone of the new Centre Block of Parliament in Ottawa. The building of an Intercolonial Railway, notable for its earth embankments, from Québec to the Atlantic coast began before Confederation.

In 1863, the Geological Survey of Canada published a large volume summing up its knowledge in its field, followed by two geological maps in 1865 and 1869, and which greatly expedited the search for minerals in Canada.

By 1867, the Lachine, St. Lawrence, Rideau, Ottawa River, Welland, Chambly, Sault Ste. Marie and Shubenacadie Canals had been built and were working, but the Trent-Severn Waterway was only partially complete. They each had their spectacular components. The Rideau, for example, had the Jones Falls and Hogsback Dams. Beginning in the 1830s, a 57-mile canal had been built between Brantford and Dunnville to provide better access to markets served by Lake Erie, and especially Buffalo, New York. It had a relatively short and financially-troubled career before ceding its business to the railways and falling into disrepair.

Before Confederation, schooners, Durham boats, bateaux and other sail- and steam-driven craft were sailing the St. Lawrence and Ottawa Rivers and Lake Ontario in large numbers, and several had crossed the Atlantic. The first steamboat arrived on the west coast from England in 1836, but these vessels only began to travel the Fraser River after the discovery of gold in the late 1850s. The first steamboat on Manitoba's Red River appeared from the United States in 1859. York boats were in common use in the Hudson Bay Company's operations in the rivers of the west and north. The problem with interior river transport, however, was that it could not operate in winter, although thick ice could carry heavy loads pulled by animals. There were shipyards and lighthouses on both coasts and along the St. Lawrence. By mid-century, there were 25 shipyards in Québec. In 1865, 572 new wooden-hulled boats/ships were built in Nova Scotia, New Brunswick and Prince Edward Island.

In the years before Confederation, the largest and most impressive buildings were public ones, such as Notre Dame Basilica in Montréal, St. Michael's Cathedral in Toronto, and the Parliament Buildings in Ottawa, which were opened in 1866. For smaller buildings, the advent of brick-making provided an alternative to log and frame construction.

By 1867 there were few relatively large cities in Canada, and the lumbering town of Ottawa had only recently been named the capital. Fewer still had water and sewer systems in operation for domestic use and fire protection and to curb the spread of infectious diseases such as cholera. Notable among them was the Hamilton Water Works, designed by Thomas Keefer and opened in 1859, with pumping beam

engines made to Watt's design by John Gartshore of Ancaster. Prior to Confederation, snow was either left where it fell or was removed using shovels, horses and carts. Skis were attached to horse-drawn carts and cutters.

The Corps of Royal Engineers and their contractors completed the Cariboo Road up the Fraser Valley to the goldfields at Barkerville in the Big Bend area of British Columbia in 1866. The first Alexandra Bridge over the Fraser River had also been built by J.W. Trutch. The Dewdney Trail was built across Southern B.C. to encourage settlement and mining. Road-building was still primitive. The main road vehicles were horse-driven stagecoaches, cutters and farm wagons in the east, and Red River carts and covered wagons in the west. Winter was the best time of the year to move heavy loads. Rivers were crossed by ferries and fords as well as bridges.

Mechanical and locomotive engineering were in their infancies, concentrated mainly in railway machine and repair shops in cities like Montréal, Kingston and Toronto, and in blacksmiths' shops everywhere. Steam engines were being built mainly in Canada East and Canada West, for agricultural, stationary and marine applications. For example, the Ontario Foundry opened at Kingston, Ontario, in 1848 to make steam engines and boilers. Ten years later, as the Kingston Locomotive Works, it was building locomotives. James Good has already been mentioned. By 1867 Toronto had a rolling mill, and water-driven flour, grist, lumber and other mills were everywhere.

Mining and metallurgical engineering had been underway since the opening of *Les Forges de St. Maurice*. By 1867 gold had been mined in British Columbia, coal in Cape Breton, iron in southern Ontario and silver in Northern Ontario. There was an oil boom at Petrolia, Ontario, in the 1860s. In the broader picture, and increasingly after Confederation, mining activities opened up remote regions of the country to road- and railway-building. The reverse was also true.

In forestry, sawmills were being built in the early 1860s by the likes of the Waterous Company at Brantford, Ontario. Plows and other agricultural implements were also being made. By 1867, there were something like 250 small agricultural implement manufacturing businesses, at first using manufacturing rights to American designs. Among the larger and better known were those owned by the Massey and Harris families in Newcastle and Beamsville, Canada West. While the first wheat crops had been grown in what are now the Prairie Provinces since the late 18th century, the shipment of bulk crops was only beginning.

Electrical, chemical, geotechnical and aeronautical engineering hardly existed until well after Confederation.

In other words, by 1867 quite a lot of engineering had already been done in what became the Dominion of Canada. The following summary by Michael Bliss in his book *Northern Enterprise: Five Centuries of Canadian Business* (page 225) speaks of the situation in manufacturing:

It was not just a nation of hewers of wood and drawers of water, of farmers, fishermen and fur traders (in 1867). The colonials began manufacturing very early in their history. The origins were often humble: in backwoods sawmills set up to cut trees into deals or planks; in seigneurial grist mills for grinding grain into flour; and the tanneries and cooperages and woollen mills that grew up alongside them; in shoemakers' and tailors' shops when machinery was added and new hands were hired; in John Molson's little brewery in Montreal and distilleries everywhere. Growth was uneven, driven by technological leaps and bounds, influences from abroad, and rapid changes in the market. By the 1850s little water-powered country mills existed side by side with big steam-driven factories set up by companies of capitalists to build railway carriages and locomotives, with large furniture factories and foundries and textile operations employing hundreds of workers...

...In the Confederation era, Canadian manufacturers dominated the domestic market in almost all fields, including carriages, foundry goods, and machinery...

150 Years: The Three Post-Confederation Periods

As noted above, the 150 post-Confederation years between 1867 and 2017 have been divided conveniently into three, roughly 50-year, periods, each with quite different characteristics in both engineering and economic/political/social terms:

...from 1867 until the end of World War I in 1918, when all but one province and one territory were in place;

...from 1919 until the end of World War II in 1945; and

...the longest, from 1946 until 2017.

In what follows, only some of the main economic/political/social and engineering events for each of the periods have been included. Otherwise, this paper might become a very long book! Also, the majority of the engineering achievements listed are from the civil discipline, in large part because they were more 'visible' initially, were built to last, and did so.

As already noted, industrial and consulting company, government and education information, and a few disasters, have been included as have some economic/political/social events, even though they may not always have had consequences for engineering.

Economic/political/social timeline: 1867 to 1918

At the time of Confederation, two of the old colonies did not join. What are now the provinces of Manitoba, Saskatchewan and Alberta, the mainland of British Columbia, and the Territories had indigenous peoples, but few settlers. There were roughly 3.5 million people living in the new Dominion, 130,000 of them in Montréal, 45,000 in Toronto and 25,000 in Halifax. An estimated 79% of the people living in Canada in 1867 had been born there. By then the American Civil War, which had affected life in the Canadian colonies, was over - except for the Fenian raids, which continued until 1871 - and peaceful trade and political relations between the two countries were resuming. At the time of Confederation, no one compiled figures for GNP or GDP, but 'goods' exceeded 'services.'

In 1867, Canada had 181 MPs and a federal public service of 2,600. Conservative Sir John A. Macdonald was prime minister. The new federal government's main plans included the development of domestic industry, railway building to the east and to the west, the encouragement of immigration, and the opening up of the west to settlement. However, in the immediate post-Confederation years the economy slumped, due in part to an international recession, to protectionist policies in the United States and Britain, and to the fact that unsettled farmland was still plentiful in the northern United States. But settlement in Canada was never easy for its new farmers. The hardships included cold winters and bug-infested summers, trees and rocks to be cleared, and thin soil. The early years after Confederation also saw net emigration from Canada to the United States. Lacrosse became a national sport in 1867.

Essentially, the railways were the signs of technical progress, although the west remained undeveloped, and capital and manufactured products were imported from Britain and the United States, with Britain still the largest export market, although the cost of British imports, in particular, were encouraging more domestic manufacturing.

The 'staples' economy of fish, fur, timber and wheat was coming to an end. The British Corn Laws, giving the Colonies easy access for the Colonies to Britain, had ended in 1846, and the subsequent Reciprocity Treaty with the United States had only lasted a dozen years. What engineering-related manufacturing there was in Canada was dominated by small companies in the agricultural sector.

In 1867, two-thirds of Canada's coal production came from Nova Scotia.

Canada's start was also marred, in 1868, when D'Arcy McGee, a father of Confederation, was assassinated in Ottawa and, in 1869, when the Red River Métis rebelled, led by Louis Riel.

In 1868 the Dominion Telegraph Company was established. That year, also, the first Dominion Militia Act established a Canadian Army. The first *Canadian* Patent Act was passed in 1869, and has been amended from time to time since then.

In 1870, the Dominion Government purchased Rupert's Land and the Northwest Territories from the Hudson Bay Company and created the Province of Manitoba in the southern part of the present-day

province. By then, also, there were 21 producing collieries in Cape Breton (almost all of which had closed by the early 20th century).

The Canadian Manufacturers' Association was founded in 1871.

British Columbia, along with the promise that a railway would be built from the east, joined Confederation in 1871. In 1872, Liberal Oliver Mowat began his 22-years as premier of Ontario.

The negotiation of the first seven Treaties between Canada and its First Nations began in 1871 and was completed in 1877. These treaties were principally concerned with European settlement across the Prairies and with the CPR. Treaties 8 thru 11 were negotiated between 1899 and 1921 and were principally concerned with resource extraction.

A Bank Act was passed in 1871. In 1872 the Dominion Lands Act was passed to encourage western settlement, although the northwestern United States were still attracting settlers. In 1873, Prince Edward Island joined Canada on the promise that its railway debt would be paid and a ferry would be operated between the Island and New Brunswick. The North-West Mounted Police was formed to keep order in the then emerging Northwest Territories, and the Pacific Scandal involving the financing of the Canadian Pacific Railway toppled the Macdonald Government in Ottawa. Liberal Alexander Mackenzie replaced Macdonald as prime minister. The Supreme Court of Canada was established in 1875.

The 1870s saw the beginnings of professional engineering education at McGill and L'École Polytechnique in Montréal, the University of Toronto, Queen's University and the Royal Military College in Kingston. They also saw the establishment of a uniform Canadian dollar.

The recession lasted through the 1870s. However, Macdonald's Liberal-Conservative Party won the 1878 General Election on a platform that involved a National Policy to protect manufacturing industry through tariff increases, to reduce the duties on imported raw materials, and to broaden the base of the economy generally. Subsidies were also given to steamship lines to speed the carriage of Canadian products to Europe and Asia. The building of the CPR began, as did serious immigration to fill up the West.

As farming was becoming increasingly mechanized, the Guelph Agricultural College was founded in 1874. The first university in Western Canada, Manitoba, was established in Winnipeg in 1877 by the provincial Legislature. The first telephone exchange was opened at Hamilton, Ontario, in 1878, and the first residential phone book appeared (and the last big city one in 2010). Ice hockey, using a flat puck, was first played in Montréal in 1879.

In 1880, the British ceded sovereignty over the Arctic Islands to Canada. That year, also, the Bell Telephone Company of Canada was chartered. In 1882, the Dominion Bridge Company opened its first plant at Lachine, Québec, and a shipyard was established at Collingwood, Ontario. The Locomotive and Machine Company of Montréal, which later became the Montréal Locomotive Works, was established.

The Polson Iron (and shipbuilding) Works was established in Toronto, and the Cockshutt Plow Company was incorporated at Brantford which was, at this time, the third largest manufacturing centre in Canada.

From 1880 until 1905, the Northwest Territories were administered from Regina.

In 1883, nickel-copper deposits were discovered in the Sudbury Basin during the construction of the CPR. The Municipal Water Pumping Station was built at Fredericton.

In 1885 the Battle of Batoche, Saskatchewan, took place during the Northwest Rebellion. That year, also, the CPR line reached the West Coast. Along the way, railway construction also stimulated the discovery and development of further mineral deposits.

In the Spring of 1886, the city of Montréal experienced massive flooding caused by huge ice jams on the St. Lawrence River. By then, some 38 banks had received charters in Canada, and the insurance industry was growing quickly. The Central Experimental Farm was opened at Ottawa. The new town of Vancouver became the western terminus of the CPR.

In 1887 there was an explosion and fire underground at a mine at Nanaimo, B.C., that killed 150.

In January 1889, in a violent windstorm, the Niagara Falls Suspension Bridge broke loose and was destroyed.

In 1891, Sir John A. Macdonald died and, over the next five years, the Conservatives in Ottawa were led by Abbott, Thompson, Bowell and Tupper. There was an underground disaster at the Springhill mine in Nova Scotia, in which 125 miners lost their lives. The Massey and Harris agricultural implements manufacturing companies merged and the Canadian Pacific Steamship Company was founded. (Its ships were, however, built in the U.K.) James Naismith invented basketball.

In 1892, iron ore was discovered in the Labrador Trough.

In 1892 the General Electric Company of Canada was founded in Peterborough. In 1893 the Canadian Electrical Association was formed. The Northern Electric and Manufacturing Company was founded in Montréal in 1895, and Westinghouse Company of Pittsburgh established a plant in Hamilton, Ontario, in 1897.

In 1893 a number of Nova Scotia coal companies merged to form the Dominion Coal Company. Governor General Lord Stanley donated a cup to the sport of hockey.

The Liberals, led by Wilfrid Laurier, won the general election of 1896 and formed the Dominion government.

The Crow's Nest Pass Agreement between the Canadian Government and the CPR was negotiated in 1897 and covered rates on east-bound grain and flour, reducing farmers' export costs, and west-bound ones on settlers' effects at the beginning of the western settlement boom. The CPR gained access to

mining and smelting activities in the B.C. interior. Also in that year, the Davie Shipbuilding Company was established at Lauzon, Québec as a repair yard, but added new ship construction ten years later. The Shawinigan Water and Power Company was founded in 1897 to develop the potential of the St. Maurice River. Hanlan's Point Baseball Field was opened at Toronto.

In 1898 the Yukon Territory was separated from the Northwest Territories - one result of the 1896-98 Klondike Gold Rush.

Between 1899 and 1902, Canadian troops fought on the British side in the Boer War in South Africa.

A Canadian Patent Office was established in 1900. There was also an extensive fire that destroyed 15,000 homes in the cities of Ottawa and Hull.

During years on both sides of 1900, and before World War I, sod houses were used as dwellings across the Prairies.

By 1901, Canada's population had reached 5.4 million and the settlement of the Prairies was in full swing. There were around half-a-million farms in the whole of Canada. Historically, the decade that followed brought the highest number of immigrants to date.

The International Nickel Company (INCO) was established by merger in 1901.

The Northern Aluminum Company Ltd. was founded at Shawinigan, Québec, in 1902. (In 1925, it became the Aluminum Company of Canada - or Alcan.) Also founded in 1902 was the Montréal Locomotive Works (MLW), but it was controlled by the American Locomotive Company (ALCO).

While building the Temiscaming & Northern Ontario Railway in 1903, silver deposits were discovered at Cobalt. By 1905, there were 16 mines in the area. The Northern Ontario mining boom had begun. It lasted for 30 years.

In 1904, the army regiment of Royal Canadian Engineers was formed. The first Ford Motor Company plant was established at Windsor, Ontario. The Russo-Japanese War began in 1904 and ended a year later.

In 1905, Saskatchewan and Alberta became provinces. In 1906, Adam Beck created the Hydro-Electric Power Commission of Ontario, then the largest such company in Canada. That year, also, the smelter at Trail, B.C., was purchased by the CPR and renamed the Consolidated Mining and Smelting Company Ltd (Cominco, for short; in 1966 it became Cominco Ltd.). Also in 1906, Amundsen was the first to sail the Northwest Passage.

The Reid, Crowther consulting engineering partnership began in Calgary in 1906, and the Wallace Shipbuilding Company was founded at Vancouver. The consulting firm, Montréal Engineering, much later Monenco, was founded in 1907, and the first automobile gas station was opened in Vancouver.

Canadian sovereignty in the High Arctic was established in 1909, and the International Joint Commission was created by the Boundary Waters Treaty between Canada and the United States. In British Columbia, Cominco's Sullivan lead-zinc-silver-tin mine opened at Kimberley. The Dominion government formed a (small) Department of External Affairs in Ottawa. The first Grey Cup football game was played in Toronto.

The Steel Company of Canada Limited was formed in Hamilton in 1910 from the merger of Montréal Rolling Mills with a handful of small steel-making companies in Ontario, allowing the new company to invest heavily in new steel-making technology. The Foundation Company was established in Canada.

In 1911, the Royal Canadian Navy was established, with two old ships, one in the Atlantic and the other in the Pacific. Swiss-born Arthur Surveyer began his consulting practice in Montréal (which later became SNC).

The Laurier Liberal Government, in office from 1896 to 1911, retained the general tariff but reduced some import duties, especially those on natural products, and made a Reciprocity Agreement with the U.S.. But it lost the 1911 Election to Borden's Conservatives. The National Policy and the growth years in Central and Western Canada continued. The Maritime Provinces, however, grew much more slowly. Also in 1911, the Canadian Vickers Shipyard was opened, its first ship being an icebreaker.

In 1912, the SS *Titanic* sank off Newfoundland. Clifton W. Sherman founded the Dominion Steel Casting Company at Hamilton to make castings for the railways. It became better known as Dofasco.

In 1913, a number of Ontario and Québec shipping companies were merged to form Canada Steamship Lines. The farm boom effectively ended in Western Canada. And the Stefansson expedition explored the Arctic.

In 1914, the SS *Empress of Ireland* sank in the St. Lawrence and over 1,000 passengers and crew drowned. A dust explosion in an Alberta coal mine killed 189 miners. And Canada went off the gold standard. By then, also, there were 50,000 registered motor cars in Canada. The Dominion Coal Company in Nova Scotia was producing 40 % of Canada's coal.

A Department of Highways was established in Québec in 1914 and, in 1916, in Ontario.

The so-called 'Great War' began in August 1914 and did not end until November 1918. Canada was committed to it through its existing ties to Britain. The first Canadian Army contingent reached England in October. 1915 brought the first German Zeppelin raids on England. Canadians fought at Ypres, and experienced poison gas. John McCrae wrote *In Flanders' Fields*. 1916 brought the first use of tanks and the rolling artillery barrage, 1917 the Battles of Vimy Ridge, Hill 70 and Passchendaele, and the United States into the War. 1918 brought the Battles of Arras, Amiens and Cambrai. The Canadian Navy spent much of the War on convoy duty in the North Atlantic. Canadian airmen served with Britain's Royal Flying Corps, some with great distinction. With European goods and services cut off, Canadian industry

had to fend for itself to a greater extent than before the War. At the same time, it became the breadbasket for the Allies in Europe, and a source of material and production for the War. The Russian Revolution began in 1917 and ended that country's participation in World War I. The most serious domestic political issue in Canada during World War I was the 1918 conscription crisis. This War also changed the political context of Europe, gave rise to the Soviet Union and Communism...and to an unhappy Germany.

Canadian Government Railways (CGR) was established in 1915 to manage several companies that were in financial trouble and guide their contributions to the War: for example, the Intercolonial Railway; the National Transcontinental; and the PEI Railway. In 1918, the CGR became Canadian National (CN) Railways. In 1915, also, Teck-Hughes Gold Mines Ltd. opened at Kirkland Lake, Ontario. In 1916, the Centre Block of the Parliament Buildings in Ottawa burned down. Beginning in 1916, the Palliser Triangle in Alberta and Saskatchewan was plagued by drought and the loss of a great deal of investment in farming. The first Dominion income tax was introduced. The provinces began expanding the voting rights of women in 1916, and the Dominion government in 1918. Borden's Coalition won the 1917 General Election. The collision of two ships in Halifax harbour in December of that year and the explosion that occurred killed 2,000 people. In 1918, the McLaughlin and Chevrolet companies amalgamated to form General Motors of Canada, and Daylight Saving Time was first used in Canada.

Before the end of World War I, the number of institutions providing professional training for engineers had increased to include the Universities of Manitoba, Saskatchewan, Alberta and British Columbia, and the Nova Scotia Technical College.

Engineering timeline: 1867-1918

1867: The first groundwood pulp mill and the first phosphate fertilizer plants were established.

1868: H.S. Taylor built Canada's first steam (horseless) carriage.

1869: Canadian Patent #1 was granted under the domestic patent system. J.W. Elliot developed a compound revolving 'snow shovel' for the railways. Newsprint production began, based on woodpulp rather than rags.

1870: Canada's first steel was produced in Nova Scotia. The first course in mining engineering was given at McGill. Rock drilling by compressed air was introduced in the mining industry. The two-man crosscut saw was introduced into the forest industry.

1871: The building of the Intercolonial Railway to the Atlantic began, with Sandford Fleming as chief engineer. Fleming insisted that the ICR's bridges be built of iron rather than the usual wood. The Dawson Road was completed between Lake Superior and the Red River.

1872: The Ottawa River Canals were enlarged. Elijah McCoy developed the lubricating cup for steam engines.

1873: The first electric arc lamps available in Manitoba. By then, there were about 200 cheese factories in Canada.

1874: The *William D. Lawrence*, the largest wooden ship ever built in the Maritimes, was launched at Maitland, Nova Scotia. Matthew Evans and Henry Woodward invented and patented an incandescent electric light bulb and later sold the patent to Thomas Edison. Charles Barnes invented the rotary vane pump.

1875: 37 railways operated over 5,000 miles of track laid with iron or steel rails and owned 1,000 locomotives, many of which had been built in Canada. Parliament standardized the railway track gauge at 4 ft. 8 ½ in.

1875-76: A.G. Bell carried out telephone experiments at Brantford, Ontario. The Intercolonial Railway was completed, from Rivière du Loup to Halifax.

1877: A copper mine was opened at Orford, Québec. The steamboat *Selkirk* delivered the first railway locomotive to Manitoba by way of the Red River.

1878: Montréal's City Hall was completed, and J.A.I. Craig introduced that city to electric street lighting. Asbestos mining began in Québec. The first telephone exchange was established at Hamilton (7 lines; 50 subscribers).

1879: William Hespeler built the first grain elevator, at Niverville in Manitoba. Sandford Fleming made his standard time proposals (the zones were adopted worldwide in 1884).

1880: Industrial textile production began when the Dominion Cotton Mills Company was formed from a half-dozen smaller companies. The first district heating system was installed in London, Ontario.

In the early 1880s, following Edison's lead, Toronto, Winnipeg, Halifax, Victoria, Vancouver, Montréal, and Saint John got public electric lighting, initially the direct current variety.

1881: West Montrose covered bridge built across the Grand River in Ontario.

1882: Grain elevators were built at the Lakehead. Thomas Ahearn, in Ottawa, cooked the first 'all electric' meal. The first electric dynamo was installed at the Chaudière Falls on the Ottawa River.

1883: The CPR was completed between Port Arthur and Winnipeg. A drydock was built at Collingwood. The first successful streetcar demonstration took place in Toronto, and the Electric Railway Company began service in Ottawa. The Parliament Buildings in Ottawa became the first legislature to have incandescent lighting, powered by a steam-driven dynamo. By then, the factory production of cement was well established in Canada. The Reversing Falls Bridge was built at Saint John.

1884: At Victoria, B.C., an electric power system was built, based on a 25 hp steam engine and two Brush dynamos. O. Jull, at Orangeville, Ontario, built the first self-powered, locomotive-driven snow-removal machine. The street railway service began in Toronto. Electric lighting was installed in the weave sheds of the Canadian Cottons Ltd. plant at Cornwall, Ontario. The city of Pembroke, Ontario, installed electric street lights, using water power from the Muskrat River. The first (steam-driven) electric plant in New Brunswick went into operation at Saint John.

1885: The Canadian Pacific Railway from Montréal to the West Coast was officially completed at Craigellachie, B.C.. The use of enormous wooded trestles in the Fraser Valley section of this railway (and later in regard to the Kettle Valley Railway) attracted world-wide attention. Steamboats were involved in the Battle of Batoche, on the Saskatchewan River, during the Northwest Rebellion, the railway having been used for the first time to bring troops from the east to deal with the Rebellion. In 1885, also, the sulky plow was patented by J.G. Cockshutt of Brantford. The first sulphite pulp mill was established at Sheet Harbour, Nova Scotia.

By the late 19th century, the steam shovel had become an essential tool in railway and foundation excavations, among many other uses.

1886: The first trans-Canada telegraph message went out over CPR lines; it took three minutes to complete. Mining began on the Sudbury ore body. The renovation and strengthening of the Niagara Falls Suspension Bridge was completed. The Central Experimental Farm was established at Ottawa. The city of Montréal installed electric street lights downtown. The first electric power was generated on Prince Edward Island using steam.

1887: The first graving dock at Esquimalt, B.C. was commissioned. The third Welland Canal was opened. The iron-hulled RMS *Segwun* (then the *Nipissing II*) was built at Glasgow, Scotland, disassembled, shipped across the Atlantic, and reassembled at Gravenhurst. (It is still sailing the Muskoka Lakes.)

1888: The first CPR Snowsheds were built near Revelstoke, B.C.. Coal mining began at Canmore, Alberta. The clamp skate was patented.

1889: The Baillie-Grohman Canal and Lock was built at Canal Flats in south-eastern B.C. joining the Upper Kootenay River with the headwaters of the Columbia. There were discoveries of lead-gold-silver-copper at Rossland and lead-zinc-silver at Kimberley, B.C., which led to mining and refining operations. The first steel-hulled, propeller-driven Canadian ship (the SS *Manitoba*) was built at Owen Sound on Georgian Bay by the Polson Iron Works. A new suspension bridge was built at Niagara Falls to replace the one destroyed earlier in a violent windstorm. The lockless Murray Canal was completed, providing improved access from the Bay of Quinte to Lake Ontario (and later from the eastern end of the Trent-Severn Waterway to Lake Ontario). The CPR's Windsor Station and headquarters building opened in Montréal.

The later 1880s: The development of the railways, and especially the CPR to the West Coast, encouraged the building of wooden grain elevators, spaced roughly 8- to 10-miles apart, on railway lines. The building of grain elevators at the port of Fort William also began.

The early 1890s: The steam tractor and threshing machines were introduced into agriculture. The growth of western agriculture also encouraged the growth of eastern farm implement manufacturing. The first d.c. electric motor, and later the Tesla a.c. one, were introduced and 'game-changed' both engineering and economics. Linotype typesetting machines were introduced, as was filmmaking.

1890: Thomas Ahearn chartered the Ottawa Electric Railway to operate Ottawa's first streetcars and invented the first (electric) heating system for them. Electric street cars began operating in Montréal.

1891: Winnipeg Electric Railway received a franchise to run electric trolley operations in the city, with power generated by a plant located on the Assiniboine River. Hobson's St. Clair Railway Tunnel opened between Sarnia, Ontario, and Port Huron, Michigan.

1892: The Chateau Frontenac Hotel was opened at Québec. The Singer Sewing Machine Company opened a factory at St. Jean, Québec. The General Electric Company of Canada began building large electrical dynamos and motors at Peterborough. T.L. Willson produced acetylene.

1893: The first public payphone was installed at Hamilton, Ontario. Two 1000 hp electric dynamos were installed at Niagara Falls.

1894: The introduction of irrigation improved the production of wheat in parts of the Prairies. The building of the original Massey Hall was completed in Toronto.

1895: The first foundry and lead-zinc smelter went into operation at Trail, B.C.. The modern Canadian lock opened at Sault Ste. Marie. The first self-supporting, framed 'skyscraper' - the Robert Simpson department store in downtown Toronto - was built. It had only six floors...and elevators. The first three-phase alternating current plant in Canada was installed at St. Hyacinthe, Québec. The Bell Island iron mines opened in Newfoundland. The American Tobacco Company of Canada produced 'Sweet Caporal' cigarettes. Frederick Creed invented the teleprinter.

By 1896 there was an electric street railway operating in Halifax, Nova Scotia. The provincial Mining Institutes began the process of amalgamation that led to the founding of the Canadian Mining Institute (now the Canadian Institute of Mining, Metallurgy & Petroleum).

1897: The Whirlpool Rapids Bridge was opened at Niagara Falls. The Canadian Westinghouse Company began manufacturing heavy electrical equipment at Hamilton. The manufacture of plastics began in Toronto.

1898: The first a.c. motor-driven mine hoist went into operation at Rossland, B.C.. Two steamships (*Moyie* and *Minto*) were built initially in Toronto, dismantled and shipped by rail to British Columbia

where, instead of being assigned to service on the Stikine River in support of the Klondike Gold Rush, they were rebuilt for service on the Kootenay and Arrow Lakes. The De Cew Falls hydraulic plant at Niagara, Ontario, using transformers, began transmitting a.c. power the 32 miles to Hamilton. A covered wooden bridge was built at Fort Coulonge, Québec.

1899: The first major irrigation project in Canada was completed at Magrath, in Southern Alberta. 'Old' City Hall opened in Toronto.

The most intensely developed hydro-electric site in Canada in the 1890s was the Chaudière Falls on the Ottawa River, between the cities of Ottawa and Hull (now Gatineau).

The late 19th and early 20th centuries brought the opening up of the Canadian Prairies to agriculture and the extensive use of ploughs drawn by steam tractors to break the soil initially. Companies such as Sawyer-Massey built and supplied them.

By 1900, a total of 133,000 kilowatts of hydro-electric capacity had been installed in Canada, most of it in Ontario and Québec. Its growth continued at a modest rate until the 1920s. The early 1900s also saw the development of gold mining in Northern Ontario, at Porcupine, Timmins, Larder Lake, Kirkland Lake and Red Lake, as well as across the provincial border at Val d'Or and Chibougamau in Québec. Beginning around 1900 and lasting also until the mid-1920s, Canada's pulp and paper, and especially newsprint, production soared in mostly new mills, especially in Northern Ontario and Québec, the Maritimes and British Columbia, thanks to plentiful supplies of timber and water power. Gradually, the large number of small producers became a small number of large ones. The Humboldt two-cycle, make-and-break gasoline engine had 'revolutionized' the inshore fishery of Nova Scotia.

1900: The narrow-gauge White Pass and Yukon Railway was completed. The first water reached Lethbridge, Alberta, from the St. Mary River irrigation scheme. The Alexandra Bridge between Ottawa and Hull was opened and Ottawa's Union Station built. The Sydney (Nova Scotia) Steel mill was completed, and blast furnace operation began a year later. The Petty Harbour hydro plant began providing the St. John's, Newfoundland, Street Railway Company with electric power. The first domestic electric dishwashers, refrigerators and washing machines became available. The first phonograph records were made in Canada. Canadian engineer Reginald Fessenden delivered the first voice message by radio.

1901: Marconi received the first transatlantic wireless message at St. John's Newfoundland. A shipyard was established at Collingwood, Ontario. Steel production began that same year at Sault Ste. Marie, Ontario. A unique five-arch stone bridge was built at Pakenham, Ontario, a wooden bridge at Hartland, New Brunswick (which became a covered one in 1922).

By 1902, The first metal refining was being done at Trail, B.C..

1903: The original rope-and-plank Capilano suspension bridge in North Vancouver was replaced by a

wire-and-cable one. The Cobalt silver mining discoveries, as well as those made for gold, led to Northern Ontario becoming the birthplace of hardrock mining in Canada. Cobalt also gave rise to the largest collection of silver mining camps in the world. Hydropower was transmitted the 100 miles from Shawinigan to Montréal. An electric motor car was made by the CCM Company.

1904: The Ford Company, at Windsor, introduced the first assembly line manufacturing in Canada. The Peterborough Lift Lock was opened on the Trent-Severn Waterway. The 80 hp Victoria Power Plant at Carbonnear, Newfoundland, generated its first electrical power.

1905: Canadian Niagara Power and Ontario Power plants were producing electricity at Niagara Falls.

1906: The Cominco plant at Trail, B.C., added a lead-zinc smelter. The building of the Hudson's Bay Railway began (but was not completed until 1929). The James Avenue High-Pressure Pumping Station was completed at Winnipeg. Power was transmitted at 60,000 volts from the Pinawa Generating Station on the Winnipeg River (one of the first year-round hydro plants in a cold climate) to the city of Winnipeg. Reginald Fessenden broadcast the first radio program.

1907: The curtain dam and lock were completed at St. Andrews, Manitoba. The Kirkfield Lift Lock was completed on the Trent-Severn Waterway. Canada Dry ginger ale was made and marketed in Toronto. Marquis wheat was developed by Charles Saunders. The first Québec Bridge disaster led to the redesign of the bridge. The sulphate pulp process was introduced into Canada at East Angus, Québec, for the making of newsprint.

1908: Peter Robinson developed the square-headed screw and screwdriver. Casey Baldwin became the first Canadian to fly a heavier-than-air aircraft (at Hammondsport, N.Y.). He and Alexander Graham Bell also developed the first successful hydrofoil.

1909: The 1000-yard long CPR spiral tunnels under Cathedral Mountain and Mount Ogden were completed in the Kicking Horse Valley of B.C.. The mile-long Lethbridge Viaduct was opened in Southern Alberta. The ring dam was built at the Chaudière Falls on the Ottawa River. J.A.D. McCurdy flew the *Silver Dart* over the ice at Baddeck, Nova Scotia.

1910: In British Columbia, the Estevan Point Lighthouse was completed, incorporating innovative steel-reinforced concrete. The Calgary Power Company's development on the Bow River at Horse Shoe Falls began operations. The Legislative Buildings were completed in Regina. The Polson Iron Works in Toronto built the SS *Bigwin* and SS *Trillium* (both of which are still in service in 2017). Massey-Harris developed the reaper-thresher, the predecessor of the combine harvester. The Chateau Laurier Hotel was built in Ottawa.

During the early 1910s, the three largest B.C. steamboats (*Bloomington*, *Sicamous* and *Nasookin*) were built there for service on the Arrow and Kootenay Lakes.

1911: A Pratt truss bridge was built across the Columbia River at Trail, B.C., and the High-Level Bridge

Was completed at Edmonton. Canadian Vickers Shipyard was established at Montréal to provide ships for the new Canadian Navy. The University of Toronto installed a district heating system.

1912: Canada's second transcontinental railway, the Canadian Northern Railway (Mackenzie and Mann, begun 1903) was completed. The building of the PGE Railway in B.C. began (but was not completed until the 1950s). The American-designed and -built Dredge #4 began its 46 years of service on the Yukon rivers. The first Canadian plywood was produced at New Westminster, B.C.. The Osborne Street Bridge over the Assiniboine River was opened in Winnipeg. The Grand Trunk Railway's Central Station opened in Ottawa (later the Union Station).

1913: Scottish shipbuilder Yarrow established a yard at Victoria, B.C... The Transcona grain elevator was completed in Winnipeg, experienced foundation failure when being loaded, but was subsequently righted on a new foundation. Work began on the fourth Welland (the Ship) Canal (but was not completed, for a variety of reasons, until 1932).. A bascule bridge was built at Smiths Falls, Ontario (in 2017 the oldest surviving of its type).

1914: The Brooks Aqueduct, which included an extended elevated section, completed as a Southern Alberta irrigation project. (By 1979 it had been replaced by a canal). The Grand Trunk Pacific's part of Canada's third transcontinental railway was completed to the West Coast. Sundback designed a 'zipper' and a process to make it. Prior to World War I, a number of 'skyscrapers' were built in Toronto and Vancouver.

1914-18: World War I, the Great War. The Canadian military engineers in France developed reputations for their work in railways and tunnelling, in aviation and in signals. The Canadian Ross rifle, however, gained notoriety for malfunctioning and had to be replaced. Manufacturing benefitted from orders from the Imperial Munitions Board, mainly for supplies of ammunition, in the production of which women participated in large numbers. Several thousand aircraft were built, principally by the Curtiss Aeroplane and Motor Company (including the first one mass-produced in Canada, the JN-4), which began with a small plant in Toronto in 1915. Shipbuilding also expanded significantly. For example, Canadian Vickers built submarines for the British Navy. It also built the 8000 hp ship, *J.D. Hazen*, Canada's first icebreaker. In all, several hundred ships, many with steel hulls, were built and repairs were done on the east and west coasts and the St. Lawrence. Aerial photography began. Dr Cluny MacPherson invented a military gas mask. R.W. Boyle developed the ASDIC underwater detection device. R.D. MacLaurin developed the straw gas car to save gasoline. A.G.L. McNaughton invented a cathode ray direction finder which anticipated the later invention of radar.

1916: After six years of the most difficult and expensive construction through the mountains of Southern B.C., from Hope to Midway, the famously-trestled Kettle Valley Railway was completed, to carry both passengers and freight. The CPR's Connaught Tunnel, at Roger's Pass, B.C., was completed. The Centre Street Bridge was opened in Calgary, as was the University Bridge in Saskatoon. The Centre Block of Ottawa's Parliament Buildings was destroyed by fire, and subsequently rebuilt. The National Research Council was established to assist in the encouragement of university research, but without

laboratories. The first trans-Canada telephone call was made (via the U.S.).

1917: The Ogden Point Breakwater and Docks built at Victoria, B.C.. The NTR (Eastern) Section of the third transcontinental railway completed to the Atlantic Ocean. The Québec Bridge (finally) opened for service.

1918: The Mount Royal Railway Tunnel opened at Montréal.

Summary: 1867-1918

These were the 'emerging' years for Canada and its engineering. When the period began, the country could still be described as 'rural' economically, connected by rivers, lakes and railways. Large-scale immigration was still a generation into the future. When it ended, there were established primary and secondary industries, a larger population, and more country-wide settlement. During them, the country travelled from early skills development and reliance on foreign designs and expertise to a much greater range of built and made products and domestic designs and skills, thanks in part to the exigencies of World War I. The railways were completed and the automobile had arrived. New engineering disciplines had emerged, most notably electrical, chemical and aeronautical engineering, and Canada had acquired an international reputation in the engineering of railways and hydro-electric systems. The electric motor was a 'game-changer.' The transportation, water, sewer and lighting systems in the larger cities improved. Wheat, mining and pulp and paper products had replaced timber in the export market. The speed of scientific discovery and technology change, generally, was increasing and the universities were graduating more engineers. International activities and connections had swung towards the United States and away from Britain. On the positive side, Canada became a skilled adapter of technology that originated abroad. On the negative side, the economy was still significantly resource-based, research to back up engineering practice was almost non-existent, and - according to Michael Bliss - the railways were overbuilt.

Economic/political/social timeline: 1919-1945

The immediate post-war years, and the re-adjustments they involved, at first brought recession to the Canadian economy. They also brought a pandemic of 'Spanish flu' that killed millions around the world and 50,000 in Canada alone in 1919 - almost as many as the number of servicemen killed in action during the War. Domestically, 1919 was not a happy year. Troops in Europe fought delays in getting home, and had difficulty getting jobs when they did. There was a 37-day general strike in Winnipeg that crippled the city and led to violence, and there were disruptions in other parts of the country. Commercial and industrial competition from the United States increased. The much admired Wilfred Laurier died, and was replaced as leader of the Liberal Party - for the next 30 years - by W.L. Mackenzie King.

On the brighter side, in 1919 Canada was a participant in the Conference that led to the War-ending Treaty of Versailles. The Canadian National Railway was created as a Crown Corporation to consolidate a number of lines that were in financial trouble, including the second and third transcontinental lines. The Historic Sites and Monuments Board was created to help preserve Canada's heritage. The Group of Seven held its first art exhibition in Toronto.

In 1920, Canada joined the League of Nations, the year Arthur Meighen replaced Borden as prime minister. That year, also, the CN Railway absorbed the Grand Trunk Pacific Railway (and, in 1923, the GTR itself).

By 1921 the country's population was 8.8 million. Life expectancy at birth was 57 years. By then, also, the economy was modestly back on a growth track. The Liberals under King won the General Election of 1921, that saw the election of the first woman M.P. (Agnes Macphail) and the first socialist (J.S. Woodsworth). Regular radio broadcasting began in 1921 and two years later there were 34 radio stations

Throughout the decade of the 1920s, the mining and hydro-electric sectors were the most active from the engineering point of view, followed by newsprint and the growth of lumbering in B.C.. In Québec, Alcan's aluminum work began at Arvida and Noranda's copper work at Rouyn. Again, it should be remembered that the railway, hydro, pulp and paper, mining other resource-based industries in Canada generated secondary industry support systems that made machines, tools and other pieces of equipment needed for their engineering.

The Royal Canadian Air Force was established in 1924. So was the consulting engineering partnership between H.G. Acres and Richard Hearn, which evolved into an international practice.

In June of 1926, Governor General Viscount Byng refused the prime minister's request to dissolve Parliament, and the King government resigned. It was replaced by Arthur Meighen and an 'acting' Conservative government, which was quickly defeated in the Commons. An Election was then granted. It took place in September and Mr. King was returned to power.

In 1927, the first Old Age Pension legislation was passed. Britain's Privy Council awarded Labrador to Newfoundland.

The INCO and Mond companies, in the Sudbury Basin, controlled the world's nickel supplies during the first quarter of the 20th century. The companies merged in 1928.

The modest growth of the 1920s lasted until the economic collapse that began in 1929. World, and U.S., demand for Canada's principal exports of wheat, lumber and products of the mines fell, as did profits, while unemployment soared. The Depression effectively ended with the beginning of World War II.

R.B. Bennett and the Conservative Party defeated King's Liberals in the August 1930 Election, and

governed through the worst years of the Depression.

By 1930 the U.S. had raised its tariffs (the Smoot-Hawley Tariff Act) and Canada had retaliated, with the result that, between 1929 and 1932, Canadian exports to the U.S. fell by over 60 per cent. On the plus side, accommodations were negotiated by treaty with Britain and the Empire. In 1930, also, Cairine Wilson was the first woman 'called' to the Senate.

By 1931 the country's population had only grown to 10.4 million as both immigration and birth rates had been falling. Canada had taken over full responsibility for the Royal Mint. In 1931 Britain went off the gold standard, followed by many other countries.

Back in 1926, the Balfour Declaration had been approved at an Imperial Conference held in London, which Mackenzie King had attended. It defined the British Dominions as 'autonomous and equal in status.' In 1931, based on this Declaration, the British Parliament passed the Statute of Westminster. It clarified the powers of Canada's Parliament and those of the other Dominions and granted them full legal freedom. (The Judicial Committee of the Privy Council, however, remained the final court of Appeal for Canadians until 1949.) The Governor General became the Crown's Canadian representative, rather than the British government's. In 1932, the Ottawa Agreements provided for preferential trade between the Commonwealth countries.

In 1932 relief camps were established by the Dominion government to employ single men. A new national political party, the Co-operative Commonwealth Federation (CCF) was formed in Calgary. Eldorado Gold Mines began treatment of radium-bearing ores at a new plant at Port Hope, Ontario. Franklin Roosevelt defeated incumbent Herbert Hoover in the U.S. Presidential Election.

The Depression reached its height in 1933, when the GNP had declined by 40 per cent from its 1929 level, and 30 per cent of the labour force was out of work. Manufacturing, in particular, suffered, as did agriculture. The numbers of unemployed vagrants multiplied. There were riots and marches. There was then no Canadian social safety net, and no equivalent of the Roosevelt U.S. 'New Deal' policy. The Prairies suffered a double blow. As well as the Depression, farmers had to cope with drought. Unemployment became endemic. Gas-less motor cars pulled by horses were christened 'Bennett buggies.'

The Dionne quintuplets were born in 1934, Mitchell Hepburn began eight years as Liberal premier of Ontario, and William Aberhart was elected the premier of Alberta on a social credit platform.

The Canadian Broadcasting Corporation was founded in 1932, as was the Trans-Canada Telephone System, the Bank of Canada (with a mandate to be the sole issuer of banknotes) in 1934, the Canadian Wheat Board in 1935, as was the Prairie Farm Rehabilitation Administration (PFRA), Trans-Canada Airlines in 1937, as a subsidiary of the CNR, and the National Film Board in 1939.

In 1935, the Workers' Unity League organized a protest 'mass march' by freight trains from Vancouver

to Ottawa. It was stopped in Regina. However, eight of the protesters were taken to Ottawa to meet with Bennett. But talks went badly and they returned to Regina. An attempt to arrest the WUL leaders resulted in the Regina Riot. Two years later, in Vancouver, the WUL was involved in the Bloody Sunday Riot.

In 1936, Maurice Duplessis became premier of Québec, at the head of the new Union Nationale Party. This was also the year of 'the three kings.' George V died in January and was replaced by his son, Edward VIII, who abdicated in December in favour of his brother, George VI. Engineers Lalonde and Valois formed consulting company in Montréal (which later was named Lavalin).

In 1937, Arthur Surveyer formed his engineering consulting partnership with Emil Neningen and Georges Chênevert (which later became SNC). Between 1937 and 1940 the Rowell-Sirois Royal Commission examined federal-provincial relations.

In 1938, the Niagara Falls Bridge Commission became responsible for the administration and maintenance of the international bridges crossing the Niagara River.

U.S. President Roosevelt became the first sitting American president to visit Canada officially, in 1938. Their Majesties the King and Queen visited Canada during the summer of 1939.

Throughout the inter-war period, no new engineering schools were established.

Recovery from the Depression had begun slowly in the mid-1930s, but needed World War II to be completed and for severe unemployment to disappear. Canada declared war a week after Britain did. After September 1939, membership of the Armed Forces increased significantly, as did employment associated with war production and material. More women entered the labour force than ever before. Canada again became the Allied breadbasket, and even helped Britain financially. And again, Canadian industry made products it could no longer obtain from abroad. Canada negotiated leadership in the Commonwealth Air Training Plan. Companies such as the Canadian Car & Foundry turned their production lines to the manufacture of aircraft for the War from designs licenced from British and U.S., but usually with modifications for cold-weather flying and for different power plants. Ships, merchant and warlike, were built on both coasts and on the St. Lawrence. By 1944, the manufacturing sector - in addition to advancing its skill and scope, and again employing women in large numbers - reached its all-time high level of 29 per cent of the economy. The Dominion government also established a number of engineering-based companies to strengthen the war effort, for example, Turbo Research, to undertake work on aero-engines, Victory Aircraft, to build planes, and Research Enterprises Ltd., to build electronic and optical instruments.

The United States and Japan entered World War II in December 1941. Beginning in 1942, Canada interned 22,000 Japanese Canadians.

Late in 1941, the Canadian Army fought at Hong Kong, in 1942 at Dieppe, in Italy in 1943, in 1944 at the Normandy beaches, and in Holland and Germany in 1945. The Navy's main continuing work was to

provide support for the Atlantic convoys. The Air Force bombed Germany alongside the R.A.F and kept watch over the North Atlantic and the Gulf of St. Lawrence. Many Canadian servicemen spent months and years as prisoners-of-war. Many died in action. Once again, conscription caused political problems for the government. The Royal Canadian Electrical and Mechanical Engineers Regiment was formed, based on Britain's REME.

In 1941 the CPR purchased Canadian Airways and several other regional carriers. That year, also, the first national unemployment insurance program took effect. In 1942, the RCMP's *St. Roch* became the second ship to sail the Northwest Passage. In 1942 at the time of the building of the Alaska Highway, largely by U.S. military people, Northwest Industries Ltd. was established at Edmonton (City) Airport. It later became the service hub for aviation in the Northwest. The company started by Joseph-Armand Bombardier to manufacture snowmobiles at Valcartier, Québec, was incorporated in 1942. That year, there were almost three-quarters of a million farms in Canada. In 1943, Conservative George Drew began five years as premier of Ontario. Two high-level strategic conferences were held by Allied Leaders at Quebec in August 1943 and September 1944. In 1944 the CCF won power in Saskatchewan. Tommy Douglas became premier and began social medicine in North America. Federally, in 1944 the Family Allowance Act was passed. In 1944, also, Hydro-Québec was founded to manage two Montréal area power companies that had been nationalized by the province, and Canadair Ltd. was established to build *Canso* aircraft for the RCAF. U.S. President Roosevelt died in April 1945 and was replaced by Vice-President Harry Truman. Germany surrendered unconditionally in May 1945. Canada joined the United Nations in June. Japan surrendered in August, after the U.S.A.F. had dropped two nuclear bombs on its mainland. In September 1945, Igor Gouzenko defected from the Soviet Embassy in Ottawa and revealed details of a Russian spy network in the country. And the first Canadian 'baby bonus' cheques were mailed. It had been predicted that the end of Canada's Second War would involve an economic downturn, as had happened in after the First. But this did not materialize as the country adjusted more successfully to peacetime activity, to the re-integration of servicemen into the economy, and to the exit of many women from it.

Engineering timeline: 1919-1945

Canada exited from World War I with enhanced technical and manufacturing capabilities, to which were added, for example, new skills in aerial photography and a relative abundance of pilots and planes that could begin the expansion of industrial activities across the country and into the North.

In 1919, Alcock and Brown flew the Atlantic successfully in one 'hop,' starting out from Newfoundland. The Bell-Baldwin HD-4 hydrofoil broke the world water speed record (which it held until the 1930s). A 160 km aqueduct from Shoal Lake in Northern Ontario to the city of Winnipeg was completed. Following the postwar slump in the nickel market, INCO aggressively began engineering new uses for the metal, and saved its markets.

1920: Construction of the Esquimalt Drydock, then the second largest in the world, was completed. The first water was delivered under the Bow River, Alberta, irrigation project. The Hunter Street Bridge was opened at Peterborough, Ontario. The building of radio networks began. There were still only 1600 or so kilometres of paved highways in Canada. The horse-pulled combine harvester was introduced into farming. The Trent-Severn Waterway was finished.

In the 1920s, the problems associated with the development and use of alkali-resistant concrete in construction in Western Canada were first studied at the University of Saskatchewan by Professor Thorbegur Thorvaldson, under the watchful eye of Dean C.J. Mackenzie.

1921: The Research Council of Alberta was founded (without its own laboratories until 1954).

1922: The *Charles Dick*, the first Great Lakes self-unloading vessel, was built. The Queenston-Chippewa Generating Station (later the Sir Adam Beck I) was completed at Niagara Falls. The Mint began making five-cent 'nickels.' Rupert Turnbull, who built Canada's first wind tunnel, began the development of the variable pitch aero-engine propeller. The teleprinter was introduced by telegraph companies.

1923: Banting and Macleod shared a Nobel Prize for the discovery of insulin. Canadian Vickers supplied the new Canadian Air Force with Vickers flying boats. A pulp mill was opened at Bathurst, New Brunswick, to make use of the process for the clarifying of green liquor developed by John Bates, improving the kraft method of making pulp. The Saint John Drydock was completed, then the largest in the world.

1924: The Chateau Lake Louise Hotel was built in Alberta. The Amy Street thermal generating station opened in Winnipeg, and the first commercial district heating system was installed in downtown Winnipeg. The original Montréal Forum was built. (Sir) William Stephenson invented the wire photo.

1925: The first Second Narrows Bridge was completed at Vancouver. Courtaulds (Canada) Ltd. built the first synthetic fabric plant in at Cornwall, Ontario. Edward Rogers developed his battery-less radio and Arthur Sicard developed his snowblower. The first traffic light was installed at Bloor and Yonge in Toronto. The Île Maligne hydro plant, one of the world's largest, was completed on the Saguenay River in Québec.

Generally speaking, around the mid-1920s, the popularity of the automobile had begun to change road surfaces significantly, especially in cities and on highways. Paving with asphalt and concrete became common and, in winter, the snow from streets and highways was plowed.

1926: The CPR's Banff Springs Hotel was built. Radio broadcasting services were expanded into Canada's North. A giant aluminum smelter was built at Arvida, Québec, by Alcan, the bauxite from South America being unloaded at the deep-water port of Bagotville. Bombardier built the first of his snowmobiles.

1927: The False Creek Bridge was built at Vancouver. The third Union Railway Station Building opened in Toronto. Morse Robb developed the electric organ, but not surprisingly failed to exploit it commercially.

in Canada. Rogers started the first 'all-electric' broadcasting station (CFRB). The first nation-wide radio broadcast was made.

1928: The *St. Roch* navigated the Northwest Passage west to east. The Royal York Hotel was built in Toronto. The Ontario Research Foundation laboratories established, also in Toronto. In spite of its name, much of its work was concerned with engineering. The CNR introduced the first diesel-engine locomotive in Canada.

1929: Karl Clark of the Alberta Research Council received a patent for a method of extracting oil from the tar sands in the province. The Hudson Bay Railway (HBR) completed from The Pas to Churchill, Manitoba, over peat and permafrost. Air photos were used for route alignment for the HBR and for the Ambassador Bridge, which was opened from Windsor to Detroit. The Jacques Cartier Bridge opened over the St. Lawrence at Montréal.

Although the Great Depression occurred in 1929 and for a decade afterwards, engineering did not stop. Large construction projects well underway were usually completed. But it did slow down, by quite a bit.

The 1920s and 1930s saw the development and expansion of 'bush' flying to support mining, forestry and other northern camps. These years also saw the building of concrete grain elevators across the Prairies. By the 1930s, horse-drawn scrapers and graders had given way to steam shovels and rollers in highway construction. The first ice roads were built in the 1930s in the Northwest Territories.

1930: Labine discovered pitchblende at Great Bear Lake, NWT, which led to the first Canadian uranium mine. The Kettle Valley Railway in British Columbia, including some spectacular wooden trestles, was completed. Calgary Power Company completed its Ghost hydro-electric development on the Bow River. The first experimental oil sands plant at Bitumont, Alberta, began operations. The Island Falls hydro plant was completed in Saskatchewan. The Seven Sisters Falls power plant and dam were completed on the Winnipeg River. The Smelter Complex was opened by INCO at Copper Cliff, Ontario, and involved Canadian contributions to the metallurgical engineering of nickel. An Ontario engineer pioneered the use of dotted white lines to mark the centrelines of roadways. Britain's R-100 airship visited Canada to test the possibilities for world-wide travel by air. Sliced bread went on sale for the first time.

1931: Nickel was produced using the Orford process at INCO, Copper Cliff, Ontario. The Maple Leaf Gardens Stadium and the Canadian Imperial Bank of Commerce Building were completed in Toronto, and the Sun Life Building in Montréal. The Chats Falls generating station was built on the Ottawa River.

1932: The Fraser River Delta Channel stabilization was completed. The Burrard Street Bridge opened in Vancouver. The Depression-inspired Broadway Bridge was opened at Saskatoon. The Fourth Welland (the Ship) Canal opened. The NRC's laboratories opened on Sussex Drive, Ottawa. NRC's engineers contributed to streamlining of Canadian-built locomotives. The Ontario Northland Railway began operations. The Beauharnois hydro-electric Dam in Québec was completed. Irwin Mackie, of the DOSCO

Company in Nova Scotia, developed a process for stopping cracking in steel rails.

1933: The Glenmore Dam was completed on the Elbow River at Calgary. The first of the northern community, service-providing 'utilidors' was built at Flin Flon, Manitoba.

1934: The Mercier Bridge opened at Montréal. Gideon Sundback developed an improved process for making zippers.

1935: Karl Lorch developed his Prairie *Snowplane*, an aircraft-engine-driven passenger machine on skis. The rugged bush plane, the Noorduyn *Norseman*, was designed and built without the help of a wind tunnel, at Montréal.

1936: Vancouver's new City Hall was opened. The Île d'Orléans Bridge was opened across the St. Lawrence below Québec. A soil mechanics conference held in the United States, attended by Canadian engineers, effectively launched the profession of geotechnical engineering in Canada.

1937: Donald Hings created a handheld, two-way portable radio transceiver or *walkie-talkie* for use in the mining industry in British Columbia, which was later adapted for military use. The Thousand Islands (Ivy Lea) Bridge was completed over the St. Lawrence River. The first *Skidoo* was patented by Bombardier, its sprocket wheel and track being a prime feature. A Rural Electrification Act was passed in Nova Scotia.

1938: The Mackenzie Highway in the Northwest Territories began as a winter road (and was completed to the Yukon in 1961). The Lion's Gate Bridge opened at Vancouver. The self-propelled combine harvester was developed by Thomas Carroll for the Massey-Harris Company. The first commercial electron microscope was developed by Burton, Hall, Hillier and Prebus at the University of Toronto.

1939: The Queen Elizabeth Way was opened between Toronto and Hamilton by H.M. The Queen. Norman Breakey produced the first paint roller.

1939-1945: Canadian engineering activities during World War II included the building of merchant as well as Navy ships, aeroplanes ranging from the *Hurricane* and the *Mosquito* to the *Lancaster*, participation in the research, development and production of radar, remote sensing and sonar equipment, proximity fuses, RDX explosives, high velocity artillery, gas turbine engines, the de-icing of aircraft propellers, the development of tracked vehicles for the Army, and participation in the construction of the Alaska Highway (by the U.S. Army Corps of Engineers), and in atomic research in support of the Manhattan Project. Indeed, Canada's first prominent lady engineer - Elsie MacGill - played a significant part in the production of aircraft for the War. The Polymer Corporation was established to make synthetic rubber at Sarnia, and was the forerunner of later chemical engineering plants across the country. Several other engineering-related companies (such as Victory Aircraft) were set up to serve the war effort. Dr. Bill Franks developed his anti-gravity flying suit. The NRC developed the *Weasel*, a tracked military snow vehicle. The manufacture of aluminum at Arvida, Québec, was

stepped up with the building of a major smelter and the construction of the Shipshaw hydro-electric plant in support of it. Canada also participated in the Habbakuk (ice vessel) Project, one of the strangest engineering experiments of the whole war.

1941: British Columbia opened a major highway, the Crowsnest, from Hope to the Alberta Border. The Rainbow Bridge was finished at Niagara Falls. The National Research Council published the first Canadian National Building Code.

1942: George C. Laurence built Canada's first (primitive) nuclear reactor at the NRC Laboratory in Ottawa. Later, a nuclear laboratory was established at Montréal. The first nylon plant in Canada was built by DuPont. The Chromasco Magnesium Plant was opened at Haley Station, Ontario, to apply the refining process developed by Dr. L.M. Pigeon.

1943: The Steep Rock Iron Mines at Atikokan, Ontario, were first opened (and were closed in 1979). The Montréal Central Railway Station Building was opened.

1944: The British Columbia Research Council established its laboratories.

1945: Construction of the nuclear research laboratories at Chalk River and the beginning of Canada's involvement with nuclear power reactor development, including the ZEEP reactor, the first to operate outside the U.S.. The NRC Associate Committee on Soil and Snow Mechanics was established, leading to the study of permafrost and muskeg, for example, and the beginning of organized geotechnical engineering research in Canada.

Summary: 1919 to 1945

This period began with a post-war economic 'hiccup' but soon settled down to steady, if unspectacular, economic, social and technical growth. This ended quickly with 'Black Friday' and the beginning of the decade-long Great Depression and the various disruptions it caused. Engineering was affected, especially in the manufacturing and resource industries, although some of the civil and building projects that had begun in the 1920s were completed. Engineering education evolved slowly during this period. By the mid-1930s, however, there were some signs of recovery, and these were confirmed with the beginning of World War II in which Canada participated, and its industries recovered, and during which the country and its citizens learned many new skills.

World War II undoubtedly saved Canada from regressing from the engineering point of view. It emerged from the War with the fourth largest Allied manufacturing sector and with its high technology fields supported by research and development in federal and crown agency laboratories.

Economic/political/social timeline: 1946-2017

The first 25 years after World War II were essentially boom years for the Canadian economy, with notable expansions in the domestic production of capital and consumer goods, and it became more closely integrated with the similarly expanding U.S. economy. The country's infrastructure and communications systems, which had received little attention during the Depression and World War II, required attention. Immigration, in the immediate post-war years was 'massive,' and birth rates increased. This time around, returning veterans were better pleased by their job prospects, and quite a few took advantage of veterans' grants to pursue post-secondary education. And a social safety net was falling into place. Also, long before these 25 years were up, the term 'Dominion' to describe Canada was no longer used, and 'federal' described the activities of the government in Ottawa. The 'British Empire' became 'the Commonwealth.' These years were notable for the rapid increase in the numbers of professional engineers in Canada, many of them returning veterans or recent immigrants, and for the establishment across the country of new schools of engineering and of colleges devoted to the training of technical people for the business of engineering.

By the Citizen Act of 1946, Canadians were no longer British subjects.

In 1947, the federal government established the Defence Research Board, giving it some of the responsibilities that the NRC had carried throughout World War II. Dr. Omond M. Solandt was its founding chairman. Saskatchewan became the first province to introduce Medicare. (In 1950, Alberta was the second.) Canadian Aviation Electronics Ltd. was formed to manufacture flight simulators for aircrew training. Internationally, the General Agreement on Tariffs and Trade (GATT) came into force. The so-called 'Cold War' began, effectively when Winston Churchill's made his famous 'iron curtain' speech at Fulton, Missouri. In February, Canada's coldest day in history was set at minus 63 degrees Celsius at Snag, Yukon Territory.

Prime Minister Mackenzie King stepped down in 1948 and was succeeded as PM and Liberal leader by Louis St. Laurent. That year, a new Income Tax Act was enacted (replacing the one that had originated in 1917). The Berlin 'airlift' - the first international crisis of the 'Cold War' - began in June (and ended 11 months later). Newfoundland joined the Canadian Confederation in 1949 and Liberal Joseph R. Smallwood was elected premier. Conservative Leslie Frost was elected premier of Ontario. The Supreme Court of Canada became the final court of appeal for Canadians. A massive earthquake, the largest in Canadian experience, struck the Queen Charlotte Islands. There was a serious strike in the asbestos mining industry in Québec. The Russians acquired nuclear bomb capability. The Communist Party took over the government of China.

In the late 1940s, the Iron Ore Company of Canada was formed and began the development of its mineral rights in the Québec/Labrador region, including building a 560 km railway to the shipping port of Sept Îles.

The Korean War began in June 1950 and Canadian Forces participated. (It ended three years later.) The

Inuit won the right to vote in federal elections. The Canadian Overseas Telecommunications Corporation (now Teleglobe Canada) was established. COTC became one of the owners of the first long-distance, multi-purpose underwater cable, between Scotland and Newfoundland and, later, of a similar cable across the Pacific. (These cables became obsolete with the subsequent development of satellite communications.) Very serious spring flooding occurred in the Red River area of Manitoba. The Park Royal Shopping Centre, Canada's first suburban shopping mall, opened at West Vancouver, B.C.. The firm of James F. MacLaren & Associates, consulting engineers, was established in Toronto.

From the 1950s onwards, the use of coal for domestic heating purposes gave way to oil, gas and electricity. As well, some of the facilities built for the Commonwealth Air Training Plan during World War II were used to expand aviation services in Canada.

By 1951, Canada's population had reached 14 million, with both immigration and an increased birthrate contributing. The Massey Royal Commission (one of whose members was an engineer) reported on Canadian arts, letters and sciences, noting that these were strongly influenced by the United States. Charlotte Whitton of Ottawa became Canada's first lady mayor. In 1952, the second round of Old Age Security legislation was implemented. There was an outbreak of foot-and-mouth disease among cattle in Saskatchewan, which strongly influenced the development of herd health regulation in Canada. Vincent Massey was appointed the country's first native-born Governor General. General Dwight D. Eisenhower won the U.S. Presidential Election in November. In Toronto, that same year, the consulting firm of Marshall, Macklin & Monaghan was established. Also, the Prairie consulting engineering company of Underwood, McLellan & Associates was formed, based on the partnership established 40 years earlier in Saskatoon by J.E. Underwood and Roy McLellan. The Ford Motor Company opened a new plant at Oakville, Ontario in 1953, and the Stratford Festival began its long and distinguished contributions to Canadian theatre.

The National Library (now Library and Archives Canada) was established in Ottawa in 1954. The Newfoundland Electric Power Commission was set up to assist with rural electrification within the province. In 1954, after using airborne magnetic surveys, Norman Keevil Sr. began the development of high-grade copper ores in the Temagami region of Northern Ontario, and founded the Teck Resources Corporation. HMCS *Labrador* was the first deep draft ship to navigate the Northwest Passage. Hurricane *Hazel*, the worst inland storm in Canada up until then, devastated parts of Toronto. The Canadian Labour Congress was founded in 1955. That same year, Hatch Associated Ltd. began operations as consulting engineers. In 1956, the consulting engineering firm of Beauchemin-Beaton-Lapointe was established. Orenda Engines was formed as a limited company, to build the eponymous engines until 1958, and thereafter to build engines under contract and provide repair and overhaul facilities.

The Suez Canal Crisis erupted in 1956, its solution earning Canadian Lester B. Pearson the Nobel Peace Prize. At home, the Liberals used closure in the 'pipeline debate' in the House of Commons, a move that affected the results of the 1957 General Election in which the federal Conservative Party, under John Diefenbaker, won minority election to the House of Commons. Ellen Fairclough became the first female

federal Cabinet minister. Louis St. Laurent retired from politics and was replaced as Liberal leader by Lester Pearson. One of the M.P.'s who lost his seat in 1957 was C.D. Howe. American-born, MIT engineering graduate, former professor at Dalhousie University, head of the company that built grain elevators all across Canada and abroad, he was one of the very, very few engineers ever to join the federal cabinet, in which he served from 1935 until 1957 and was among its most influential members, having brought to his political work experience in both engineering and business.

In 1957 the federal government began the system of equalization payments to (and from) the provinces, initially to assist the slower growth Atlantic provinces. A tax-deferrable Registered Retirement Savings Plan was also introduced by Ottawa. The Canada Council for the Arts, a Massey Commission recommendation, was established that year to provide support for artistic endeavours and university research. Manitoba Hydro and Ontario Hydro connected for the first time. A disaster occurred at a mine at Springhill, Nova Scotia, killing 74 miners.

The Conservatives under Diefenbaker achieved majority status in the House of Commons following the 1958 General Election. That same year, NORAD was established in the United States with Canadian participation. The Canadian dollar rose to its highest level of the post-war period against the U.S. dollar. The Gordon Royal Commission reported on Canada's economic prospects (good!). Part of the Second Narrows Bridge, then under construction, collapsed at Vancouver. The American submarine, USS *Nautilus*, passed under the North Pole. In 1959, Canada concluded a Production Sharing Agreement for military materials with the United States. The National Energy Board was created. In February, the *Arrow* (CF-105) aircraft project was cancelled. In June, the Royal Yacht *Britannia* was the first steamship to pass through the St. Lawrence Seaway, which was opened by H.M. The Queen and President Eisenhower. R.M. Hardy & Associates, consulting engineers, was established at Edmonton.

Potash mining began in Saskatchewan in the 1950s. In the late 1950s, the Elliot Lake mines became important suppliers of uranium for weapons and reactors (and during the 1970s for reactors).

A Canadian Bill of Rights was approved in 1960. Jean Lesage was elected Liberal prime minister of Québec and initiated the so-called 'Quiet Revolution.' As part of this, the new government mandated Hydro-Quebec to acquire existing private power companies and to develop new Hydro-electric sites. Hydro-Québec also decided to employ engineering consultants widely in its work, which effectively led to the growth of private consulting engineering firms in the province, whereas the other large provincial hydro organizations developed consulting work internally.

Beginning in the 1960s, opencast mining allowed mineral production in Canada to expand. The sites included Pine Point (N.W.T. - lead, zinc), Highland Valley (B.C. - copper), Northern Saskatchewan (uranium), Thetford Mines (Québec - asbestos), Bathurst (N.B. - lead, zinc, copper), and at Québec/Labrador (iron ore). Canada also began to supply Japan with metallurgical coal from mines in Alberta and B.C..

John F. Kennedy won the U.S. Presidential Election in November 1960. The Canadian Medical

Association concluded that cigarette smoking caused cancer. Manitoba Hydro was formed from the merger of the Power Commission and the Hydro-Electric Board. Golder & Associates were incorporated as consulting engineers in Toronto. In politics, in 1961, the CCF became the New Democratic Party and John Robarts succeeded Leslie Frost as Ontario's premier. In Europe, the Berlin Wall went up.

The Cuban Missile Crisis happened in October 1962, involving Russia and the United States, and claimed the world's attention. Beginning in 1962 (and until 1971), the Canadian dollar maintained its most stable value against the U.S. one. The Glassco Royal Commission reported on the organization of the federal government. Avro Canada was closed down. In June 1962, the Diefenbaker Conservatives lost seats in a General Election but governed with minority status until April 1963, when the Liberals under Lester Pearson formed a minority government. U.S. President Kennedy was assassinated in Dallas in November. Lyndon B. Johnson replaced him.

Canada began its peacekeeping involvement in Cyprus in 1964. That year, *Northern Dancer* became the first Canadian horse to win the Kentucky Derby. In 1965, Bruce and Jack Nodwell formed Foremost Industries, to manufacture a variety of large tracked and tired vehicles for use in opening up Northern Canada....and Antarctica. In November, there was a major power blackout in eastern North America.

The Liberals were returned to power in 1965 with their second minority government and the continuing support of the Social Credit and New Democratic Parties. The Pearson governments were, however, responsible for the new Canadian flag, national Medicare legislation, the Canada and Québec Pension Plans, social insurance cards, the Royal Commissions on Bilingualism and Biculturalism and the Status of Women, the Canada-U.S. Auto Pact, the establishment of the Order of Canada and the Economic and Science Councils, the unification of the Armed Forces, and the 1967 national Centennial celebrations, which included the building and operating of EXPO 67 at Montréal. Queen Elizabeth II cut the country's birthday cake in Ottawa on the 1st of July. The Centennial also coincided with a peak in the country's annual GNP growth rate (6.5 per cent). On the negative side were the 'Québec libre' affair involving French President de Gaulle, and the so-called 'Munsinger affair' involving federal politicians. The Six-Day War was fought in the Middle East between Israel and four Arab countries.

In 1966, the Consolidated Mining and Smelting Company of Trail, B.C., became Cominco Ltd.. Laurent Beaudoin took over the management of the Bombardier Company, following the earlier death of its founder. SPAR Aerospace Ltd. was formed in 1967 from the de Havilland Special Projects and Applied Research Division to manufacture space hardware. Oil sands exploitation began in Alberta. The Six-Day War took place in June 1967 between Israel and its Arab neighbours, Egypt, Jordan and Syria. Lester B. Pearson stepped down as prime minister in the spring of 1968 and was succeeded as party leader and prime minister by Pierre Elliott Trudeau, who won a majority for the Liberals in the General Election that followed. In Québec, former Liberal and journalist René Lévesque founded the sovereigntist Parti Québécois. Richard M. Nixon won the U.S. Presidential Election in November. In 1968 the federal government established the Canadian Radio and Telecommunications Commission to regulate the broadcasting sector. The three Services within the Canadian Forces were merged.

On 20 July 1969, two U.S. astronauts who had travelled to the moon in the Apollo 11 spacecraft landed safely on it.....and returned safely home.

In 1969, in Canada, the Official Languages Act became law and the federal government established Telesat Canada to provide satellite services. Also in 1969, the USS *Manhattan* was the first large vessel to traverse the Northwest Passage. This encouraged thoughts about the development of Canadian icebreakers and more attention to sovereignty in the Arctic. By 1970 the sovereigntist movement in Québec, which sought the eventual separation of the province from Canada, was making its presence felt. The resulting FLQ Crisis in October of that year shocked and disturbed Canadians. In response, Trudeau invoked the War Measures Act. In 1970, the consulting firm of Rousseau, Sauvé & Warren was founded in Montréal. It was deeply involved in the James Bay Project of Hydro-Québec. In Vancouver, the bridge-building and consulting firm of Buckland & Taylor Ltd. was founded. The Bombardier Company acquired a European train-building facility. The tanker *Arrow* ran aground at Chedabucto Bay, Nova Scotia, spilling a great deal of oil.

The expansion of coal production continued during the 1970s as world oil prices rose, requiring new mines and port facilities (such as Roberts Bank, outside Vancouver). However, because of their distance from Alberta, B.C. and Nova Scotia, steel mills in Ontario imported most of their coal from Pennsylvania.

By 1971 the country's population had reached 21.6 million, after the heaviest decade of immigration in the country's history. Eastern Ontario experienced 'the snowstorm of the century.' The federal government adopted a policy of multiculturalism, and the country was introduced to the metric system. Health warnings were added to cigarette packages and cigarette advertising dropped from radio and TV broadcasts. Trudeau also opened up formal discussions with China and Cuba. The Official Languages Act was promulgated. Canada began, in Victoria, B.C., a series of federal-provincial discussions on the repatriation and amendment of the Constitution. A landslide at Saint-Jean-de-Vianney, Québec, killed 31 people. The SEBJ was formed to manage the hydro-electric development of the James Bay region of Québec.

In 1972, Trudeau called a General Election, from which he emerged with a slim minority government. Rosemary Brown became the first black woman elected to the B.C. Legislature. Canada won the celebrated hockey series against the Soviet Union. In 1972 the federal Department of Indian Affairs and Northern development joined with the Engineering Institute of Canada to administer the Canadian Engineering Heritage Record. Some reports were produced, but the activity tapered off (and was terminated in 1979). The June 1972 break-in at the Watergate Complex in Washington, D.C., erupted later into a full-blown political scandal. In 1973, when the OPEC Countries administered their first 'oil shock,' they set in motion a period of worldwide financial inflation unmatched even during the two World Wars. In the Middle East, the brief Yom Kippur War was fought in October. In Canada, Lévesque's Parti Québécois became the official opposition in the Québec Legislature. The civil engineering arms of the three CAF elements were amalgamated as the Canadian Military Engineers.

In July 1974, Trudeau went to the polls again, but gained a majority this time. As a result of the

Watergate Crisis, U.S. President Nixon resigned in August 1974 and was replaced by Gerald Ford. Also that year, the Bombardier Company received an order for 432 cars for the Montreal Métro, to be built in Québec. The Hydro-Electric Power Commission of Ontario was renamed Ontario Hydro. In 1975, in spite of having promised not to, Trudeau instituted a regime of wage-and-price controls to counter the, by then, recession and rampant inflation. TV cameras were allowed in the House of Commons for the first time. The Foreign Investment Review Agency (FIRA) was established to monitor foreign investments in Canada. In January 1976, Petro Canada, the publicly-owned oil company established through a Liberal-NDP-sponsored bill began operations in Calgary. A *Péquist*e Government was elected for the first time in Québec, and the Summer Olympics were held in Montréal, whose mayor played a prominent part in their planning and the building of special stadia for the main events. Canada announced its 200-mile fishing zone, and the last Eaton's catalogue was published. William Davis succeeded John Robarts as Ontario's premier. Jimmy Carter won the 1976 U.S. Presidential Election in November. In 1977, the Québec Legislature passed Bill 101, restricting the use of English in the province.

In 1979, there was a second 'oil shock. Domestic recycling began in earnest with the 'blue box' program. In May, the Progressive Conservatives under Joe Clark won minority government in a General Election but, by year's end, lost a confidence vote on its first budget. Another Election was held the following Spring, and was won by Trudeau (who was persuaded not to retire from politics) with a majority. Russia invaded Afghanistan.

The year 1980 was notable for a number of events: Canadian Ambassador Ken Taylor played the key role in 'spiriting' six American diplomats out of Iran after militants had stormed the U.S. Embassy; the Parti Québécois sponsored (and lost) a provincial referendum on sovereignty-association; the federal Liberals' National Energy Program was introduced; Terry Fox ran more than halfway across Canada on his 'marathon of hope' to raise funds for cancer research; thousands of Canadians were infected with the AIDS or hepatitis viruses; the establishment of foreign-owned banks in Canada was permitted; and Canada boycotted the Olympics in Moscow to protest the Soviet invasion of Afghanistan. The Iran-Iraq war began, and lasted for eight years. Ronald Reagan won the U.S. Presidential Election in November. By the 1980s, Canadians had become predominantly city dwellers. Federal legislation was passed to allow 100%-owned foreign banks to be established in Canada. Gold mining became important again around 1981 with the discovery of the Hemlo deposit in Northern Ontario and others across Canada.

The first serious postwar recession began in Canada in 1982 and unemployment reached a historic peak of 13.1%. The Collingwood Shipyard closed. However, the Canadian Constitution was repatriated, along with a Charter of Rights and Freedoms, but without the support of Québec. The Canadian Institute for Advanced Research (CIFAR) was established to support Canadian research with potential global impact. The consulting engineering company Lavalin acquired Shawinigan Engineering. Britain and Argentina fought the Falklands War. The first woman Supreme Court Justice, Bertha Wilson, took her seat in 1982.

In 1984, the first woman Governor General, Jeanne Sauvé, was appointed. (She had also been the first

woman Speaker of the House of Commons.) In June, Pierre Trudeau retired as Liberal prime minister and was replaced by John Turner. However, in September he was beaten in a General Election by the Conservatives under Brian Mulroney. That year, also, Lazaridis and Fregin founded the IT company, Research in Motion, which later became BlackBerry.

In 1985, the U.S. ice-breaker *Polar Sea* travelled through the Northwest Passage. Prime Minister Mulroney and U.S. President Reagan met at Québec and discussed defence and trade among other matters. Conservative Frank Miller was premier of Ontario briefly, before losing the election to Liberal David Peterson, thus ending 40 years of Conservative Party rule. Lincoln Alexander became Ontario's first black Lieutenant-Governor. The rocket range at Churchill, Manitoba, was closed. The Canadian Association of Science Centres was established. The Macdonald Royal Commission reported on economic union and development prospects for Canada. Wheelchair athlete Rick Hansen began his *Man in Motion* tour round the world to raise money for spinal cord research.

By 1986, Mulroney had expressed opposition to apartheid policies in South Africa. He had also initiated a series of federal-provincial discussions on the amending of the new Canadian Constitution to accommodate Québec. EXPO 86, whose theme was transportation and communication, opened in Vancouver and ran for six months. The Canadian dollar hit an all-time low on the international money market. The federal agency, Emergency Preparedness Canada, was set up. The Bombardier Company went into the aerospace business with the purchase of Canadair. An estimated 3900 locomotives were in service in Canada, 3000 of them hauling freight. Air Canada banned smoking on its flights. In 1987, a Free Trade Agreement (FTA) with the United States was agreed upon. Stock prices tumbled in October. Video games became available in Canada. Ben Johnson broke the world 100-metre sprint record.

By 1988, there were 16.3 million motor vehicles in Canada, of which 12 million were passenger cars. Canadian ports loaded/unloaded 390 million tons of cargo, led by Vancouver with 70 million. Sept Îles had 23 million, Thunder Bay had 17 million tons and Halifax and Saint John 15 million each. The 1988 Winter Olympics were held at Calgary. At the Summer Olympics, at Seoul, South Korea, Ben Johnson won the 100-metre sprint, only to lose the gold medal after a subsequent drug test. David Lam, born in Hong Kong, became Lieutenant-Governor of British Columbia. George H.W. Bush won the U.S. Presidential Election in November. In 1989, the Canada-U.S FTA went into effect. Mulroney won a second majority mandate in a General Election. The one-dollar 'loonie' coin replaced the paper dollar. Audrey McLaughlan became the first woman to lead a national political party, the NDP. The Canadian Space Agency was created. In late May/early June protests took place at Tiananmen Square in Beijing, China. In November, the Berlin Wall was breached, and communist regimes began to fall in Eastern Europe. The headquarters of the Bata Shoe Company returned to the Czech Republic after the end of Communist rule. In December, 14 women engineering students were killed in a shooting at École Polytechnique in Montréal (that has been commemorated every year since then).

While in office in the late 1980s and early 1990s, the Mulroney Government unsuccessfully sponsored the Meech Lake and Charlottetown Accords on amending the Canadian Constitution.

In 1990, Canada experienced a short economic recession. A land dispute brought about a lengthy armed confrontation between Mohawks and the Army at Oka, Québec. One result of the Mulroney constitutional discussions was the formation of a new federal political party, the Bloc Québécois. The federal government settled a land claim with the Inuit involving 350,000 square kilometers of the Northwest Territories. Bob Rae was elected the first (and so far only) NDP premier of Ontario, replacing Liberal David Peterson. By 1990, the Canadian population exceeded 26 millions, with Toronto the largest city. \$6.8 billion was spent on road, street and bridge construction. In the Middle East, late in the year, Iraq invaded Kuwait. Early in 1991, Operation Desert Storm - led by the United Nations and the United States, and in which Canada participated - ousted Iraq from Kuwait. That same year, Communist Party control in Russia ended. The Croatian War of Independence also began (and ended four years later). The first of two Strategic Arms Limitation Agreements between the U.S. and Russia was signed (the second two years later). In Canada, Petro-Canada was privatized. A federal Goods & Services Tax (GST) went into effect. Ovide Mercredi replaced George Erasmus as the leader of the Assembly of First Nations. In 1991, two very large Montréal-based engineering consulting and management companies, SNC and Lavalin, merged. Canadair acquired the American Lear Jet Corporation.

By the early 1990s, reserves of uranium ore at the Elliot Lake Mines were seriously depleted and uncompetitive, and the last of them closed.

For many years from the late 1950s, Japan was a leading world competitor in markets for manufactured goods, and enjoyed strong economic growth. This had ended by late 1991/early 1992 when with the collapse of a massive asset price bubble, caused by excessive loan growth. (Japan's lesser international position continued for an estimated 20 years.)

In 1992, the Bombardier Company acquired the de Havilland aircraft company, lately owned by Boeing. The Newfoundland cod fishery was stopped due to disappearing cod stocks. A mining disaster at the Westray coal mine in Nova Scotia led to the closing of the mine. Balsillie joined Lazaridis in heading the RIM/BlackBerry company. The Toronto Blue Jays won the first of two successive World Series of Baseball. William J. Clinton won the U.S. Presidential Election in November. The wars in Bosnia and Somalia had begun (and ended three years later). Canada contributed to the UN Forces involved. In 1993, Canada contributed to the U.N. Observer Mission in Rwanda. In March, Catherine Calbeck became Canada's first female premier, of Prince Edward Island. In June, Brian Mulroney stepped down as prime minister and was replaced by Kim Campbell, the first female PM, and the first to lead the federal PC Party. However, the Conservatives under her leadership lost heavily to Jean Chrétien's Liberals in the October General Election, which also saw the Bloc Québécois under Lucien Bouchard become the Official Opposition, with Preston Manning's Reform Party close behind. In 1993, also, the Canadian economy slipped into recession (but, by 1994, it had recovered). After many adjustments to its terms over the years, the Crowsnest Pass Agreement was terminated. Also terminated were the federal advisory Economic (1963) and Science (1966) Councils. The separatist Parti Québécois was elected to

govern Québec and Jacques Parizeau became premier. The NAFTA Free Trade Agreement between Canada, Mexico and the United States went into force.

In 1995, Canadian troops were involved with NATO in the war in the former Yugoslavia. A second Québec Sovereignty Referendum was held and was very narrowly defeated. The so-called 'turbot war' over fish stocks erupted between Canada and Spanish fishermen on Newfoundland's Grand Banks. The World Trade Organization replaced GATT. Conservative Mike Harris replaced Bob Rae as Ontario premier and served for seven years. Donovan Bailey broke the world record for the 100-metre sprint. Early in 1996, Lucien Bouchard replaced Jacques Parizeau as premier of Québec. In July, there was serious flooding in the Saguenay-Lac-Saint-Jean area of Québec. On July 1, 1997, Hong Kong reverted to being part of China. That year, there was also a financial crisis among countries in Asia. An international protocol to reduce greenhouse gasses was signed at Kyoto, Japan. (Canada ratified it three years later.) In Canada, there was massive spring flooding of the Red River in Manitoba, but the Floodway saved the city of Winnipeg. That year, and the next, Canada had high GDP growth rates. By then, also, the Bombardier Company had about a 50% share of the world's regional jet market. At the same time, it was experiencing stiffening competition from the Brazilian company, Embraer.

The most destructive ice storm in Canadian history hit central and eastern Canada in January 1998. Later that year, the federal government issued a formal apology to First Nations people for past injustices. The government also rejected two proposed mergers of 'big banks.' The Ekati diamond mine opened in the NWT. In 1999, Nunavut became Canada's third Territory and the Inuit homeland, and the Northwest Territories became somewhat smaller. D-Wave Systems Ltd., which later sold the world's first quantum computer, was established at Burnaby, B.C.. The so-called 'BlackBerry' phone addiction began. The Kosovo War, which involved Canadian Armed Forces, took place between 1998 and 1999.

A recession was brought on in 2000 in the United States by the so-called Internet-related 'dot-com bubble,' which saw the collapse of the stock prices for some companies in the high-tech field. (It lasted for about three years.) Federal responsibility for Canadian vehicle emission standards was transferred from the Department of Transport to the Department of the Environment. Beverley McLachlin became Canada's first female Chief Justice in 2000. The federal Clarity Act on Québec separation passed into law. The Reform Party became the Canadian Alliance, and Stockwell Day its leader. Matthew Coon Come was elected leader of the Assembly of First Nations. The federal Liberal's sponsorship scandal erupted, but the party was re-elected with a majority in a General Election. George W. Bush won the U.S. Presidential Election in November. Pierre Trudeau and Maurice Richard both died during the year. In 2000, a non-for-profit organization, MaRS, was established to help commercialize Canadian innovations resulting from medical and other publicly-funded research.

In 2001, Canada began a 13-year military participation in Afghanistan alongside American and other nations' troops. Canada's population reached 30 million. A federal gun control measure affecting the registration and control of 'long guns' went into effect. Lucien Bouchard resigned as Québec premier. The West Nile Virus made its first appearance in Canada. The decline of Nortel Networks as a 'power'

company began. The original Teck mining company merged with Cominco to form Teck Resources Ltd, to mine coal and refine copper and zinc. The Nanotech Institute opened at Edmonton.

On September 11 (9/11), 2001, the World Trade Center in New York and the Pentagon in Washington were attacked from the air by Islamic terrorists and almost 3,000 people lost their lives. Meanwhile, Newfoundlanders helped care for American air travellers stranded by this event.

During 2002, the Canadian dollar reached its lowest value against the American one for the post-war period. The *Euro* was adopted as the pan-European currency. In 2002, Canada signed the Kyoto Accord, concerned with lowering the levels of greenhouse gas emissions. At a G-7 Nations' Summit held at Kananaskis, Alberta, it was announced that Russia would join the group. Pope John Paul II visited Canada. Canada's CPI inflation rate for the year was 3.80 per cent, the highest since 1990. Also, General Motors closed its plant at Ste. Thérèse, Québec, eliminating over 1000 jobs. But an Agreement between Québec and the Cree Nation allowed for the exploitation of the Eastmain River by Hydro-Québec. INCO Ltd. announced it had reached a deal to develop the Voisey Bay nickel deposit in Northern Labrador. The federal government announced it would spend \$105 million to bring the high speed internet to rural areas. Canada's RIM/Blackberry lost a patent suit to an American Company. The SARS virus epidemic in Canada spread further and more deaths were reported.

Early in 2003, U.S., British and other forces invaded Iraq in the 'weapons of mass destruction' war (and remained there until 2011). Canada did not participate. In February, the space shuttle *Columbia* disintegrated during take-off, killing all on board. In October, the *Concorde* flew for the last time in service. Because of SARS, in April and again in May-June, Toronto became a place to avoid, according to the WHO. In August, there was a massive power outage that began in Cleveland, Ohio, and affected Southern Canada and eight northeastern U.S. States. In August, also, Canada's unemployment rate reached 8 per cent. In December, Paul Martin replaced Jean Chrétien as prime minister. One of his first acts was to cancel the scandal-plagued federal advertising sponsorship program, designed by his predecessor to promote federalism in Québec (which later became the focus of the Gomery Inquiry). Jean Charest, leading the provincial Liberals, won election to power in Québec. Liberal Dalton McGuinty replaced Ernie Eves as premier of Ontario (and the party, under Kathleen Wynne, was still in power in 2017). The Consolidated Gold Mine (opened 1938) closed at Yellowknife, NWT, but the Diavik diamond mine opened. Forest fires were particularly bad in the Kamloops area of B.C.. An epidemic of pine beetles also struck that province's forests and those of northern Alberta. In 2004, bird-flu was detected on a chicken farm in British Columbia and millions of birds were culled as the disease spread. In the June General Election, Prime Minister Martin's government became a minority. However, in October the government's tax intake had produced a budget surplus of \$9.1 bn. The Canadian population reached 32 millions.

In 2005, Canadian military activity in Afghanistan concentrated in the Kandahar region. Prime Minister Martin announced Canada would not join the American ballistic missile defence program. In February, the federal government introduced legislation that would permit same-sex marriages in Canada. By

April, and over the preceding two years, the Canadian dollar had risen 25 per cent in terms of its U.S. counterpart. There was serious spring flooding in Southern Alberta. In May, the Martin minority government survived a confidence motion by a single vote. In 2005, Alberta and Saskatchewan celebrated the 100th anniversary of becoming provinces. A massive railcar oil spill occurred at Wabanum, Alberta. The Giant Gold Mine closed at Yellowknife, NWT (opened 1948). In November, the Martin government was defeated in the House of Commons. A UN Climate Change Conference was held in Montréal late in the year. By year's end, there had been a record 78 murders in Toronto, 52 gun-related. Statistics Canada announced that Canada's 'worth' was \$4.5 trillion, or \$137,000 per head, at the end of the year. The new Canadian War Museum opened on LeBreton Flats, Ottawa.

Stephen Harper, at the head of the new Conservative Party in Canada, won the 2006 General Election over the Liberals under Paul Martin, but with minority status. In May 2006, Canada's central bank overnight interest rate rose to 4.25 per cent. The Canadian dollar reached 90 cents U.S., its highest since 1978. Negotiators reached an agreement to compensate 80,000 Canadian Indians who has been abused while attending residential schools. In June 2006, 17 people were arrested in Toronto on terrorism-related charges. In November, Parliament formally recognized the French-speaking people of Québec as a nation within Canada. Also, the UN Human Rights Council passed a declaration to protect the rights of indigenous people. The Dofasco Steel Company in Hamilton was acquired by Belgium-based Arcelor (which shortly afterwards merged with Mittal Steel). In September, Canada and the U.S. signed an agreement to end a protracted dispute over softwood lumber. By late 2006, the Iraqi dictator, Saddam Hussein, had been captured, tried and hanged.

In 2006, INCO agreed to be acquired by Vale do Rio Doce of Brazil, Falconbridge/Noranda by Xstrata (and later Glencore), and Alcan by Rio Tinto. Ed Stelmach was elected premier of Alberta, replacing Ralph Klein. In 2007, Canada claimed it had the highest population growth among G-8 nations between 2001 and 2006, with the arrival of 1.2 million migrants, and the federal finance minister announced that Canada had had 10 successive annual fiscal surpluses. The Canadian dollar rose above parity with the U.S. dollar for the first time in 31 years. Trade Minister David Emerson signed a technology deal with China. In Newfoundland and Labrador, Premier Danny Williams and the Conservatives won a 'province-first' election. New census data published in 2007 showed that one-in-five Canadian residents had been born in another country. Stelco was acquired by U.S. Steel. The serious decline of electronics giant, Nortel Networks, began. Both CPR and CNR experienced strikes during the year. Rio Tinto made a successful bid to take over Alcan. The Criminal Intelligence Service announced there were around 950 organized crime groups operating in Canada.

The riskiness of sub-prime mortgages involved in U.S. real estate transactions, particularly, set off a world-wide financial crisis in 2007 that lasted for many months. It became known as the 'Great Recession.' The global financial system was threatened. Several U.S. banks were in trouble, Bear Stearns and Lehman Brothers in particular, as were U.S. agencies Fannie Mae and Freddy Mac. There was also a debt crisis in Europe. The U.S. economy was affected much more than the Canadian one, where the downturn lasted for about 18 months. Remedial measures were instituted in the United States and

elsewhere. For example, the Bank of Canada kept interest rates low. In 2008, some 55,000 jobs were lost in Canada in July, the largest number since February 1991. The dollar fell below 80 cents U.S.. In October, six central banks cut their interest rates in an attempt to restore confidence in the financial system. Harper won another minority in the October General Election. The Bank of Canada's key interest rate fell to a 50-year low of 1.50 per cent in December. Also that month, Prime Minister Harper won a rare suspension of Parliament to avoid defeat and replacement by a coalition of the Opposition parties. The federal and Ontario governments provided financial support for the domestic car industry in its current (U.S. subprime) difficulties. The Canadian Forces experienced their 100th death in the fighting in Afghanistan. The city of Québec celebrated its 400th birthday. Barack Obama won the U.S. Presidential Election in November. A three-week Gaza War was fought between Israel and Hamas in December and January.

In January 2009, the Nortel Networks Corporation filed, spectacularly, for bankruptcy, its recent decline having been accelerated by the world-wide economic crisis. In July, Swedish L.M. Ericsson took over the Network's \$1.13 bn North American wireless business. Canada put the CANDU Nuclear Division up for sale. In Ottawa, the Harper government announced measures to stimulate the recovery of the economy, including a budget deficit after 11 years of surpluses. In March, the Bank of Canada's key rate fell to 0.5 per cent (and a month later to 0.25 per cent), and Suncor Energy Inc. agreed to buy Petro-Canada. The H1N1 flu virus struck Canada. And U.S. entry points required Canadians to show their passports when entering the country. In 2009, the services sector accounted for 70 per cent of the Canadian economy, industry for 27 per cent, and agriculture for 1.6 per cent. The energy, forestry, mining and agriculture industries accounted for 58 per cent of Canadian exports and the manufacturing, equipment and automotive sectors for 38 per cent. 73 per cent of Canadian exports went to the United States, and 63 per cent of Canadian imports came from there. Total exports accounted for 30 per cent of the GDP.

In 2010 the Winter Olympics were held at Vancouver/Whistler. Canada's medal standing was its best to date. The G-8 and G-20 summits were held in Toronto, and \$1 bn. was spent on security. Even so, there were some lengthy and 'un-peaceful' demonstrations. The Canadian dollar rose to one-for-one footing with the U.S. dollar, the best since 2008. David Johnston, president of the University of Waterloo and former principal of McGill, was named the next Governor General, replacing Haitian-born Michaele Jean. In July, the Bank of Canada raised its key interest rate to 0.75 per cent. Canada's population was estimated to be 34.1 million. Anglo-Australian company, BHP Billiton, failed in its attempt to take over Saskatchewan's Potash Corporation, the world's largest producer. The city of Montréal awarded the Bombardier Company a contract to build 500 subway cars. Meanwhile, Bombardier let a contract in Mexico for the manufacture of aircraft parts.

In 2011, serious spring flooding occurred in Manitoba, leading to the deliberate flooding of some farm land. Later, wildfires ravaged the Slave Lake district of Alberta. Surprisingly, perhaps, Canada in 2011 was the location of the tenth largest of the world's coal reserves, mainly in Alberta, B.C., and Saskatchewan. In particular, Canada has been the producer/exporter of anthracite/metallurgical coal used for steel-making. The industry, however, was having ecological problems associated with the

mining and burning of coal. British Columbia agreed to share tax revenues from the mining industry with aboriginal groups. Also, Canada's coal exports to Asia and elsewhere continued from western mines. In the east, as usual, industries preferred to import coal from the nearer U.S. mines. In February 2011, Stephen Harper and Barack Obama agreed on how to reduce logjams at the border and boost both trade and security. In May, on his third try, and after having been defeated earlier in the Commons, Stephen Harper and the Conservatives achieved a majority in a federal General Election. The NDP became the Official Opposition. Christy Clark became premier of British Columbia. Also in 2011, Kim Jong-Un - the third generation of his family to do so - came to power in North Korea and began a visible program of 'nuclearization' in that country. And Japan apologised for its mistreatment of Canadian POW's during World War II. The so-called 'Arab Spring' uprisings took place in 2011 in Egypt and Tunisia and resulted in regime changes. The civil war in Syria also began in March (and has entered its ninth year as this paper is being written). A tsunami hit Fukushima, Japan, causing extensive damage to a nuclear power plant. As scheduled, Canada's combat mission in Afghanistan ended, although troops remained in a training role for another three years. During this year, the three elemental commands of the Canadian Armed Forces reverted to being the Canadian Army, Navy and Air Force. By 2011 the best days for Blackberry/RIM were over and layoffs began. Its revenues peaked and began to fall significantly in the face of U.S. competition and the company experienced problems with customer countries in the Far East. The company also had a break in service for several days. Life expectancy at birth in Canada was calculated to be 81.7 years. The increase from 80 years was due largely to reduced infant mortality and circulatory diseases. In late December, Canada announced it was exiting the Kyoto Protocol.

In 2012, the Canadian embassy in Damascus was closed as a result of the Syrian civil war, and sanctions were also applied. Some new plans were made for the construction of the proposed Keystone XL pipeline that would carry Canadian crude to Texas refineries. Student strikes and demonstrations took place in Montréal against proposed hefty increases in university fees. In June, the roof of a shopping mall at Elliot Lake, Ontario, collapsed killing two people. An inquiry into it was later convened. In May, Canada minted its last one-cent coin. Shaun Alteo was re-elected national chief of the First Nations. In September, in the provincial General Election held in Québec, the Parti Québécois under leader Pauline Marois won minority government, defeating the Liberals under Charest. The Canadian Wheat Board's marketing power ended. San Francisco's BART ordered 410 railcars from Bombardier. Blackberry/RIM lost its business with the U.S. Customs Agency to Apple Inc.. Mike Lazaridis and Jim Balsillie relinquished management control of the company to Thorsen Heins (with J.S. Chen taking over in 2013). The Bank of Canada's outgoing Governor, Mark Carney, was appointed Governor of the Bank of England. Xi Jinping became president of the People's Republic of China and moved the country into a world economic leadership position as the United States' rival, continuing the work begun in 1978 by Deng Xiaoping.

The NHL lost the first half of its 2012-2013 season, due to the absence of an appropriate collective bargaining agreement. In 2013, serious spring flooding took place in Southern Alberta. The Ontario Liberals chose Kathleen Wynne to succeed Dalton McGuinty as premier. A federal court ruled that Metis and First Nations people living outside the reserves should be considered Indians under the Constitution. PM Harper met with First Nations leaders to discuss the grievances behind their increasing

number of protests. Justin Trudeau, as leader of the federal Liberal Party, excluded Liberal Senators from his Parliamentary caucus. Sub. Lt. Jeffrey Delisle was jailed for 20 years for spying for Russia. The 'Mike Duffy' Senate expenses scandal began (and expanded) in Ottawa (and lasted for three years). In July 2013, five tanker cars of a freight train travelling east at Lac Mégantic, Québec, exploded, destroying the downtown area and killing 47 people. In September, a passenger train collided with a city bus in Ottawa, killing six. Canada Post announced it would begin to phase out door-to-door city mail delivery. Canadian writer Alice Munro won the Nobel Prize for Literature. By 2013 the country's population had risen to 33.5 million. The largest provinces were Ontario (13.4 million), Québec (8.2), British Columbia (4.6) and Alberta (4 million). The largest city was Toronto (5.9 million), followed by Montréal (4.1), Vancouver (2.5), Calgary (1.4), Ottawa/Gatineau (1.3) and Edmonton (1.3). Toronto's GDP estimate for 2013 was the same as Quebec's and exceeded those of every other province and territory except Ontario.

By 2014, Canada was the world's 8th-largest producer of iron ore, most of it from Labrador. In January, parts of Canada suffered outbreaks of H1N1 and H5N1 flu, and bone-chilling cold weather. An early morning fire at a home for the elderly in Québec killed 32. Terrorists carried out attacks at St. Jean, Québec, and Ottawa, killing two soldiers. The Liberal Party regained majority government in Québec, and Philippe Couillard became premier. In October, Parliament voted to authorize airstrikes against the Islamic State in Iraq. Trouble erupted in the Ukraine and involved the Russian seizure of Crimea. An outbreak of the ebola virus occurred in West Africa (and lasted for two years). The world oil market collapsed. In February 2015 Canada imposed sanctions on Russia over its conduct in the Ukraine. The Canadian economy went into recession in the second quarter of the year, for the first time since the 2007-09 financial crisis. The Bank of Canada lowered its key lending rate to 0.75 per cent. The Liberal Party under Justin Trudeau won a majority in the federal General Election in October. Shortly thereafter, the government announced it would resettle 25,000 Syrian refugees. It later announced an enquiry into 'Murdered and Missing Indigenous Women and Girls.' In 2015 the *Protecting Canadians from Online Crime Act* came into force. In October, 12 Pacific Rim countries concluded a free trade deal (the TPP). The first freighters carrying Mary River Mine iron ore left Baffinland, Nunavut.

In 2016, Canada's was the world's 10th largest economy. By then, the population numbered over 36 million, its labour force was around 20 million, the distribution of the GNP was 1.6 per cent to agriculture, 27.7 per cent to primary and secondary industry and construction, and 70.7 per cent to services. In January, Canada posted its first trade surplus in more than two years. Steel production in Canada was at its lowest in years, due in part to competition from the Far East. It was also becoming clear that innovative high-tech companies 'born' in Canada and successful/profitable here in their initial years were being sold in relatively large numbers to larger American companies and moved to the U.S.. The B.C. Government agreed to protect the Great Bear Rain Forest from logging. The port of Churchill, Manitoba, was closed. In May, an enormous wildfire broke out at Fort McMurray, Alberta, and devastated the area. 80,000 were forced to leave their homes. In July, the B.C. government introduced a tax on foreign purchases of real residential estate, to help 'cool' the Vancouver market. Teck Resources Ltd. operated six coal mines in Alberta and British Columbia. Anti-ISIS Canadian Forces air strikes ended

in Syria in February 2016. Canadian Armed Forces were deployed to Latvia in support of NATO. The British voted in June to leave the European Union (in 2019). Donald Trump won the U.S. Presidential Election in November.

In 2017, Canada celebrated its 150th Anniversary on July 1st. Not the stylish show of the Centennial, this one still had a number of highs as well as lows, one of the latter being the continuing lack of free trade among the provinces. In January, Canada posted its first trade surplus in more than two years, but generally the country's recent economic recovery from the 2007-08 recession had been unsteady. Concern was being expressed about privacy questions in regard to the social media. In 2017, a shooting at a Quebec City mosque killed six people. Floods in the spring of the year washed out parts of the railway tracks into Churchill, Manitoba, limiting access to the town until repairs could be made. Summer brought one of the worst wildfire seasons to British Columbia. The Liberals, long in office, lost the B.C. provincial general election narrowly to the NDP, with Green Party support. Canada completed a Comprehensive Trade Agreement (CETA) with the European Union, while Canada, Mexico and the United States began the renegotiation of the NAFTA Agreement amid President Trump's threat to cancel the Treaty. A handful of tech stocks (Apple, Google, Amazon, for example) were leading the U.S. recovery, which had been gaining strength since 2009, although public debt burdens continued to increase. Services continued to dominate the Canadian economy, although their measurement was introducing uncertainty into overall economic activity figures. Peter Munk's Barrick Company became the largest gold mining company in the world. However, every surviving steel mill was foreign-owned and Canada was a net importer of steel.

By 2017, Canada's population exceeded 36 million. The House of Commons had 365 members, and the size of the 'traditional' federal public service was around 260,000, plus another 106,000 serving in the Canadian Armed Forces and the RCMP, and 80,000 working for the Crown Corporations. The largest city was Toronto. In May, engineer/astronaut Julie Payette was appointed to succeed David Johnston as Canada's Governor General.

Engineering timeline: 1946-2017

Canada exited from the World War II years in a position of relative strength from the engineering point of view. It had, for example, participated in the production of warlike products and in matters nuclear and electronic and was preparing to pursue peaceful uses for them. Through ministers such as C.D. Howe, its federal government and manufacturing industries had developed closer ties with the ones in the United States and looked forward to beneficial collaborations with them. In some areas, such as aeronautics, collaboration with the British also remained strong. There were also increases in hydro- and thermal-power capacities and developments in the primary extraction and manufacturing industries in progress, and the housing and consumer markets had demands that were unsatisfied during the War. More engineers than ever before were being educated and trained for both the public and private sectors, and were immigrating into Canada. Through the National Research Council, the Defence

Research Board and other federal technical agencies, if not through its companies - either indigenous or branch plant - Canada had contacts with R&D and design activities in the U.S that held potential benefits for it. On the other hand, the wartime advantages gained in shipbuilding, were allowed to slip away. So while the first 25 postwar years may have been mostly boom years for the economy, they still provided challenges to Canadian engineering.

1946: de Havilland Canada introduced its DHC-1 *Chipmunk* trainer aircraft. Avro Canada acquired Turbo Research and, with it, the gas turbine division that went on to establish Canadian competence in this new field of engineering, beginning with the TR.4 *Chinook*. Then Avro was asked to develop what became the CF-100 interceptor aircraft, along with an engine for it, and the resulting TR.5, a scaled-up *Chinook*, became the *Orenda*. The Temaskaming Pulp Mill was opened, in part to take advantage of new techniques for bleaching pulp. Engineering associated with defence and the armed forces was transferred from the National Research Council to the new the Defence Research Board, and Dr. Omond Solandt was named to direct it. The Nova Scotia Research Foundation was established (without laboratories until 1969).

1947: Imperial Oil's Leduc No. 1 oil well was discovered. The Saskatchewan Research Council was established (without laboratories until 1958). Among the very first robotic machine tool systems was the AMCRO, patented by Eric W. Leaver, the co-founder of Electronic Associates Ltd., one of Canada's earliest innovation-driven technology companies. The first de Havilland DHC-2 *Beaver* 'bush' aircraft flew. The NRX reactor went into service at Chalk River. The National Research Council established a new division - Building Research - to meet two specific needs: for the continuing revision of the National Building Code, and to support the newly established Central Mortgage and Housing Corporation.

1948: Bitumount, the last in a series of experimental oil sands extraction plants was built in Alberta. It was also the most successful and represented engineering developments that began in the 1920s. Canadair Ltd. began selling CL-4 *North Stars*. The Tea Hill Microwave Station, the first of its kind, was established on Prince Edward Island to replace the underwater cable connection between PEI and Nova Scotia. The majority of the electric power generated in Newfoundland and Labrador was consumed by the pulp and paper industry. The companies involved also supplied power to their neighbouring communities.

1949: Construction of the Trans-Canada Highway began (was opened in 1962, and completed in 1970). The first *Orenda* engines were built, tested and went into production. The Avro C-102 *Jetliner*, the world's first commercial jet, flew in August. Premier Duplessis of Québec began a rural winter road-clearing program that robbed the Bombardier company of its major market, so that it switched to the production of all-terrain vehicles while still developing snowmobiles. The Montréal Locomotive

Company began building diesel locomotives under licence from ALCO.

In the early postwar period, the tractor-drawn combine harvester was introduced into farming. In the period from 1949 to 1959, Ontario Hydro standardized it's a.c. frequency at 60Hz.

1950: Highways in the B.C. mountains began to be protected by snow sheds. The *Scott Misener*, the first turbine-powered laker in Canada, was launched, its engines made by the John Inglis Company of Toronto. Production of the Avro *Jetliner* was cancelled to allow for production of the all-weather fighter, the CF-100, for the Korean War.

Television services began in the 1950s, in black-and-white (colour arrived a decade later). Engineer Alphonse Ouimet of the CBC played a key role in the development of TV services.

1951: The first blast furnace plant in Canada was operated by Dofasco at Hamilton. Hopps, Bigelow and Callaghan developed the world's first external artificial heart pacemaker. de Havilland Canada designed and built the *DHC-3 Otter*, the first of several STOL aircraft for which the company became famous. The Chenux generating station began operating, for Ontario Hydro, on the Ottawa River, as did the station farther upstream at Rapides-des-Joachims. Atomic Energy of Canada marketed its first 'cobalt bomb' medical radiation equipment. The Aluminum Bridge was built at Shiphaw, across the Saguenay River in Québec.

1952: Ontario began designation of its 400-series highways and opened 400 (Toronto to Barrie) and 401 (the Trans-provincial). Atomic Energy of Canada, formerly a division of the NRC, became a Crown Corporation. George Klein (NRC) designed and built the first STEM antenna (which would later fly on many earth satellites). The first 'walk behind' (driveway) snow blowers appeared. Ontario Hydro's Otto Holden generating station was completed, north of Mattawa.

Between 1952 and 1960 the Eldorado Uranium Mill was in operation at Port Radium, on the shore of Great Bear Lake, NWT.

1953: British Columbia opened four major highways: the Coquihalla, the Okanagan, the Yellowhead and the Island. Hydraulic fracturing (fracking) was first used by the oil industry in Alberta. By 1953, the rural electrification program in Manitoba had 'hooked-up' 39,000 of the province's 50,000 farms. The one in Alberta was privately run but had 'hooked-up' 20,000 farms. The one in Saskatchewan was also introduced during the 1950s. Avro Canada was asked to develop a new engine for the CF-105, the *Arrow*, and the *Iroquois* engine was the result. During its testing period, this engine was the most powerful jet engine in the world. George Klein designed the first electric wheelchair.

1954: A notable and massive aluminum refining operation was established by Alcan at Kitimat, Northwestern British Columbia, in partnership with the Kenny Dam and the Kemano Powerhouse on the Nechako River. The Research Council of Alberta laboratories were established. The Sherritt Gordon

Nickel Refinery was established at Fort Saskatchewan, Alberta, to use a Canadian-developed nickel refining process. The Sir Adam Beck II generating station was completed at Niagara Falls. Dofasco, in its Hamilton steel mill, introduced the basic oxygen steel making process to North America. The first Canadian subway system opened in Toronto. Hugh Le Caine began work at the NRC in Ottawa on electronic music, including the further development of his 'electronic sackbut.' Iron ore extraction began in the Labrador Trough. Beginning with the Pinetree Line in 1954, it and the Mid-Canada and DEW Lines were built across Canada to provide early warning of the approach of hostile aircraft.

1955: Bruce Nodwell developed the double-sprocket, wide-tracked vehicle for use in the Alberta oilfields, in Northern Canada and Alaska, (which became the Nodwell 110) and which could deal with muskeg soils and greatly assisted the development of the Canadian North. The Angus L. Macdonald Bridge opened at Halifax harbour. The Canso Causeway and Canal were completed, linking Cape Breton with the Nova Scotia mainland.

In the 1950s, the RCN's *St. Laurent* Class destroyers were conceived, designed and built in Canada.

1956: The Churchill, Manitoba, rocket range built by the U.S. for the Defence Research Board was opened (closed 1985). The *Black Brant* rocket was designed and built in Canada for use at that Range. The Bersimis I generating station of Hydro-Québec went on stream (Bersimis II in 1959). Fairey Aviation, in Dartmouth, Nova Scotia, developed the *Beartrap* method for landing helicopters on pitching and rolling warship decks. First Trans-Atlantic submarine telephone cable laid between Nova Scotia, Newfoundland and Scotland.

1957: The abandoning of the Kettle Valley Railway in Southern B.C. began (and was completed seven years later).

1958: The top of the Ripple Rock, an underwater hazard for shipping in the Seymour Narrows in B.C.'s Discovery Passage, was blown up. The construction of the first container port began at Vancouver. The Saskatchewan Research Council laboratories were established. AECL began design work specifically directed to the construction of CANDU-type nuclear reactors. The final *Orenda* jet aero-engine was delivered to the RCAF, the last of 4,000 that had been installed in several aircraft types. Pratt & Whitney Canada began manufacturing its very successful PT-6 turboprop aero-engine, the first in a series of small aero-engines. The Trans-Canada microwave system, an east-west link and then the largest in the world, was completed for the CBC. The Trans-Canada natural gas pipeline (which was earlier debated acrimoniously in the House of Commons) was completed to Toronto.

1959: The George Massey Tunnel under the Fraser River at Delta/Lardner, B.C., was completed. The first oil pipelines were built to transport oil from Edmonton to Vancouver. The first *Black Brant* rocket, designed by Albert Fia, was launched at Churchill, Manitoba. The Avro *Arrow* interceptor project was cancelled, as was the *Iroquois* jet engine project. The St. Lawrence Seaway was completed and opened by HM Queen Elizabeth and President Eisenhower. Harry Stevenson designed a crash position indicator that subsequently became mandatory equipment in aircraft. The Bombardier Company launched its new

personal snowmobile, the ski-doo. Hydro-Québec began its Manic-Outardes project, which led to the building of seven generating stations on these rivers, including the famous Manic-5 (later renamed for Premier Daniel Johnson). Because of their remoteness, record-breaking 735 kv lines were built to deliver their power. The Princess Margaret Bridge opened at Fredericton, New Brunswick, as part of the Trans-Canada Highway.

In the early 1960s, Ferranti-Canada of Toronto produced the first computer, the FP6000, with time-sharing features. The company also installed the first computerized airline reservation system, for Trans-Canada Airlines, in Toronto. Also in the 1960s, the federal government brought a number of industrial R&D incentive programs into operation – the Defence Industrial Research (DIR), the first tax-based general incentive, the Industrial Research Assistance Program, the Program for the Advancement of Industrial Technology, Industrial R&D (IRDIA), and the Defence Industrial Productivity Program.

1960: The Montréal Central Station was rebuilt and extended as Place Bonaventure. The concrete arch Hugh John Fleming Bridge was completed over the Saint John River at Hartland, New Brunswick. The conversion from steam to diesel by the railways was completed.

1961: The four-arch Victoria Street Bridge was built over the Columbia River at Trail, B.C.. The *Diefenbunker* - an underground building - was designed and built at Carp, Ontario, to house the federal government in the event of a nuclear attack. The Beauharnois hydro-electric generating station completed by Hydro-Québec as part of the St. Lawrence Seaway Project. The year-round harbour complex to handle iron ore and other cargoes was completed at Port Cartier, Québec. Gerald Bull undertook the High Altitude Research Project (HARP) at Highwater, Québec, using a former (U.S.) battleship gun to test the re-entry of missile components from space.

1962: The first Canadian-designed and -built topside-sounder space satellite, the *Alouette 1*, was launched and went on to set records for reliability and longevity. It carried STEM antennae (see above), which also set world standards for performance. The latest Lewiston-Queenston Bridge was opened at Niagara Falls. The first electricity was generated by a nuclear reactor (NPD) at Rolphton, Ontario. The New Brunswick Research and Productivity Council established (without laboratories until 1965). The Trans-Canada Highway was officially opened (begun in 1949).

1963: the first Port Mann Bridge opened at Vancouver. The Manitoba Research Council was established (without a laboratory until 1978). Hydro-Québec nationalized the privately-owned electricity suppliers in the province.

1964: The laker *Saguenay* was the first bulker to employ diesel main engines and bow thrusters. Canada's National Aeronautical Collection (later Museum) was established at Rockcliffe Airport, Ottawa. Hydro-Québec rebuilt the Carillon generating station on the Ottawa River. The Government of Newfoundland and Labrador began construction of the Baie d'Espoir hydro-electric plant. Around this time, the first computer science/engineering departments were established in Canadian Universities.

1965: The *Alouette II* satellite was launched. The Boundary Layer Wind Tunnel was established at the University of Western Ontario. The NRC Telescope began operating in Algonquin Park. de Havilland put its DHC-6 *Twin Otter* into production. The new 'curved' city hall opened in Toronto. The first 735 kv transmission system was completed by Hydro-Québec.

1966: The TD Centre was built in Toronto. Building of the two-reactor Gentilly nuclear plant at Bécancour, Québec, on the South Shore of the St. Lawrence, began (it closed in 2012). The Montréal Subway was completed.

1967 was Canada's Centennial Year. Engineers took part in all phases of the construction and operation of EXPO 67 at Montréal. Part of the site was designated as the Engineers' Plaza, in which a statue made by Gerald Gladstone and commissioned by the members of the profession was erected. Engineer Robert F. Shaw served as deputy commissioner-general of EXPO 67. The various Canadian engineering societies organized an international conference, again at Montréal.

1967: The first plant to produce commercial oil from the oil sands in Alberta began production. The South Saskatchewan River Project was completed by PFRA. It involved the construction of two major dams and a reservoir (Lake Diefenbaker) and supplied drinking water to half the population of the province. The GO Transit system began operating at Toronto. The Louis-Hippolite Lafontaine Bridge-Tunnel over and under the St. Lawrence at Montréal was opened. L'Institut de recherche d'Hydro-Québec (IREQ) established. The Laviolette Bridge over the St. Lawrence at Trois-Rivières was completed. The first natural gas drilling took place at Sable Island, Nova Scotia. Canada's National Museum of Science and Technology opened in Ottawa. CNCP introduced a broadband service for the more efficient transmission of data, as well as voice and facsimile.

1968: Central Heat Distribution Limited's district heating plant began its service of 180 buildings in the downtown core of Vancouver. The W.A.C. Bennett Dam and generating station (and Lake Williston) completed on the Peace River in British Columbia. A hot water extraction process was developed for the Alberta tar sands. The Floodway, designed to divert Red River floodwaters round Winnipeg, was completed. Canada's first full-scale nuclear reactor came on line at Douglas Point, Ontario. Highway 401 was completed across Southern Ontario. The first container port opened at Montréal. An experimental turbo train entered service (and was withdrawn in 1981). The Mactaquac hydro generating station went into service in New Brunswick.

1969: The Canadian *ISIS I* satellite was launched. Canadian firm built landing gear for Apollo 11 LM moon landing. The specially-built National Arts Centre opened in Ottawa, and the Ontario Science Centre in Toronto. The Government of Québec established l'Institut national de la recherche scientifique (INRS) (and subsequently formed centres for special studies in, for example, energy, telecommunications and oceanology). Le Centre de recherches industrielle du Québec (CRIQ) was established (without laboratories until 1975). Canadair Ltd. marketed the first CL-215 *Water Bombers*. The first container port opened at Halifax.

1970: The *Isis II* satellite was launched. The building of artificial islands and drilling for oil in the Beaufort Sea began. One of Canada's most striking high rise buildings, the West Coast Transmission Building, was completed in Vancouver. A new crop, canola, was introduced in Saskatchewan. University of Toronto engineering professors participated in the rescue of the Apollo 13 spacecraft in April, on its way to the moon. The Manic-5 (later the Daniel-Johnson) Dam and generating station were completed in Québec. Phase I of Hydro-Québec's James Bay Project, to build a number of hydro-electric generating stations on the La Grande and other Rivers in the northern part of the province, began. The A. Murray MacKay Bridge opened at Halifax harbour. The *Laser* sailboat was designed by Bruce Kirby and Fogh (it could be carried on car roof racks). A *slicklicker* was developed to help clean up the oil spilled by a distressed tanker at Chedabucto Bay, Nova Scotia.

In the 1970s, the phase-out of analog technology and the phase-in of the digital variety began in earnest in Canada, as elsewhere. After 20 years of construction, the building of the paved 7800 km-long Trans-Canada Highway (TCH) was completed.

1971: The first nuclear power was generated at the Pickering Plant, east of Toronto. The Province of Ontario opened two major highways - the Queensway (417) across the city of Ottawa, and the Gardiner Expressway across the city of Toronto. The first public IMAX shows began in the geodesic dome at Ontario Place, Toronto. Physicist Gerhard Herzberg of the National Research Council awarded the Nobel Prize in Chemistry. The first Canadian vehicle emission regulations were introduced.

Beginning in 1972 with the launching of the *Anik A1* satellite, and over the next 30 years, Canada launched a series of more than a dozen domestic communications satellites in geostationary orbits. (*A1* was the first in the world.) They were owned and operated by Telesat Canada.

1972: The Nelson River HVDC transmission system was completed by Manitoba Hydro. A channel to bypass the city of Welland was added to the Welland Canal. Eel River HVDC converter station opened in New Brunswick. The Churchill Falls (Labrador) Corporation's hydro-electric plant began commercial operations. It was the largest such plant in the world at the time. By 1972, Roland Galarneau had developed the Converto-Braille machine that computerized Braille.

1973: The Kettle 'run-of-river' generating station was completed by Manitoba Hydro, at Gillam. Bell-Northern Research began development work on fibre optic telecommunications systems. The Bruce heavy water plant began production at Kincardine, Ontario (it closed in 1998.) All four units of the Pickering Nuclear Power Plant came on line. The energy crisis of 1973 persuaded many owners to upgrade the insulation of their homes and buildings.

1974: The first 500 mev proton beam was generated by the TRIUMF cyclotron at UBC. The Long Spruce Generation Plant on the Nelson River in Manitoba came on line. Stelco began construction of its Lake Erie Works. The Churchill Falls, Labrador, generating station officially opened.

1975: Canada adopted the metric system. Nortel developed the DMS-100 digital telephone switch that

could serve up to 100,000 lines. The Bombardier Company bought a majority interest in MLW-Worthington. Separately incorporated within Memorial University of Newfoundland, C-CORE began addressing problems relating to applied R&D in remote sensing, ice and geotechnical engineering related to the province's oil and gas developments offshore.

The engineering of expert and artificial intelligence systems began with machine translation. In the mid-1970s, a group at the Université de Montréal developed a fully automatic translation system for weather forecasts.

1976: Toronto's CN Tower was completed, and its Harbour Castle Hotel complex opened. Canada's millionth patent awarded to Guillet and Toth for an invention related to photodegradable plastics.

1977: Nuclear power was generated by the Bruce Plant at Kincardine, Ontario.

1978: The *Anik B* communications satellite was launched. The first civilian synthetic aperture radar was used by *Seasat A* (built by MacDonald Detweiler and Associates (MDA)). SAGD recovery technology was first developed for the Alberta oil sands. A 24 km light rail system opened in Edmonton. The de Havilland Company placed its Dash-7 STOL aircraft in service. The first permanent IMAX film format installation, developed by four Canadians, opened at Ontario Place, Toronto. The federal government established the National Science and Engineering Research Council to take over the administration of university science and engineering research grants from the NRC.

In the 1970s, 'word processing' using computers began to replace the typing practiced by stenographers on conventional typewriters. In the late 1970s, early 1980s, the Canadian Communications Research Centre developed the Telidon videotext/teletext system, which was overtaken by the Internet several years later.

1979: The Dempster Highway, the first all-weather highway to cross the Arctic Circle opened, from near Dawson City in the Yukon to Inuvik in the Northwest Territories. The CCGS *Amundsen*, a research icebreaker built by the Burrard DryDock, North Vancouver, entered the service of the Canadian Coast Guard (as the CCGS *Franklin*). Roy Thomson Hall in Toronto opened. La Grande 2, the first of the James Bay hydro-electric generating stations, began operating. The Hibernia oilfield on Newfoundland's Grand Banks was discovered.

Since the late 1970s, fracking has been widely used by the oil and gas industry in Western Canada. Since then, also, the introduction of the personal computer influenced people everywhere, at work and at home. From the 1980s, CD's and DVD's have been popular with Canadian consumers.

1980: Distance education by satellite began in B.C., Manitoba and Québec. Canadair Ltd. built and marketed the *Challenger* executive jet.

1981: A 60 km light rail system opened in Calgary. The first *Canadarm* was built by SPAR Aerospace Ltd. of Toronto. Later versions flew on U.S. space shuttles and the International Space Station. Canada's

Wonderland, its first major amusement park, opened at Maple, Ontario, as a result of a collaborative design and construction effort. The University of Waterloo developed the first local area network (LAN) for microcomputers. The Robert- Bourassa hydro-electric generating station officially opened as part of Hydro-Québec's James Bay project.

1982: The first of the *Anik C* series of satellites was launched. The *Saddledome* was built in Calgary. The Canadian Institute for Advanced Research (CIFAR) was established to sponsor and support Canadian R&D and chose artificial intelligence and robotics as the first two areas for this. Nuclear power was generated at The Gentilly plant in Québec. One of the Hibernia oil rigs, the *Ocean Ranger*, was lost in a storm, the mechanism of its loss being the subject of a later investigation by the NRC.

1983: The multi-purpose B.C. Place Stadium, with an air-supported roof, opened at Vancouver. The Point Lepreau nuclear reactor was commissioned in New Brunswick. The first commercially successful video games were developed in Canada.

1984: Canadian engineer Marc Garneau made his first space flight aboard the shuttle *Challenger*. The Revelstoke Dam completed on the Columbia River in B.C..

The 1980s also brought the launching of the launching of the *Anik D* satellites, which were built by SPAR Aerospace Ltd.. Also, Hydro-Québec concluded an agreement with the U.S. to send James Bay power to Boston.

1985: The first of three lines of the Metro Vancouver's light rail system (the Sky Train) began operations, in time for EXPO 86.

1986: The cable-stayed Annacis Island (later Alex Fraser) Bridge over the Fraser River at Delta, B.C., opened. The La Grande-2A, -3 and -4 hydro-electric projects opened as parts of Hydro-Quebec's James Bay Project.

1987: The Port Stanley heritage railway opened between Port Stanley and St. Thomas, Ontario. The first of 12 Halifax Class guided missile frigates for the Royal Canadian Navy was commissioned. (They were commissioned between then and 1996 and were built by Saint John Shipbuilding Ltd. and MIL Davie Shipbuilding.) The world's largest and tallest vertical axis wind turbine, the *Éole*, began operating at Cap-Chat, Québec (and continued to do so until 1993).

In 1987 the engineering profession in Canada celebrated its Centennial. As part of these celebrations, a committee was asked to identify the ten most exceptional and representative engineering achievements of the past 100 years. These have been listed (again) at the end of this paper.

1988: The *Skydome* (later the Rogers Centre) opened in Toronto. Its structure included a retractable roof. The first Canadian 'web' address was granted. The National Aviation Museum moved into new space at Rockcliffe. The Bombardier Company sold its MLW business to General Electric (Canada), which closed the plant five years later.

1989: Ballard Power Systems developed the first PEM fuel cell technology. The Saskatchewan Science Centre was established in Regina. The Canadian Patent Act was changed to allow patents to be awarded on a 'first-to-file' basis rather than 'first to invent.'

1990: Underground construction, in an extension to INCO's Creighton Mine, of the Sudbury Neutrino Observatory began (and was completed nine years later). The first web search engine (Archie) was developed by Alan Emtage, a McGill student.

The 1990s saw the introduction in large Canadian cities of 'smart' electronic traffic management.

1991: The Canadian-built wind imaging interferometer launched into space on board a NASA satellite.

1992: Ottawa's *Freenet* went into operation. Astronaut Roberta Bondar flew in space.

1993: The second tunnel under the St. Clair River between Port Huron and Sarnia opened (and the first one closed). The third of four nuclear reactors was commissioned at the Darlington nuclear power plant east of Toronto.

1994: B.N. Brockhouse was awarded the Nobel Prize for Physics, for research done using a specially-designed triple-axis spectrometer at Chalk River.

1995: RADARSAT I, Canada's first earth observation satellite was launched; it used synthetic aperture radar and was built by MDA Associates (and flew until 2013). The first of several mobile telephony satellites (MSAT's), developed by NRC in Ottawa with the help of Canadian and U.S. companies, and built by Hughes in the U.S., was launched. Canadian James Gosling, working in the U.S., contributed to the development of the computer programming language, Java.

1996: Mike Lazaridis unveiled the first *Blackberry* wireless communication device.

1997: Shaw Communications Inc. and Bell Expressvu offered Canada-wide direct-to-home satellite TV service (and Rogers followed in 2001). The Confederation Bridge between PEI and New Brunswick was opened. Built at Bull Run, Newfoundland, the Hibernia Platform went into oil recovery service offshore.

1999: The *BlackBerry* 'addiction' began. Quantum computing was established by D-Wave, a Burnaby, B.C. hardware company.

The early 2000s coincided with the introduction of cloud computing, which required Internet connections. The content of websites was also affected. Later in this decade, the rising use of social media was affecting the appeal of print, television and radio media.

2000: The Defence Research Board changed its name to Defence Research and Development Canada. An estimated 140 small to medium firms in Canada were working in the new field of nanotechnology. The iPod came to Canada. The Montréal Science Centre opened in the Old Port district of the city.

2001: Astronaut Chris Hadfield spacewalked to install the *Canadarm 2* on the International Space

Station. Ottawa's 8 km O-Train (Trillium Line) light rail system opened. Rogers Cable offered digital TV service. After the 9/11 terrorist attack in the United States, security arrangements at airports underwent significant technical change. SAGD technology, developed over 20 years earlier, was put into operation for recovery of Alberta oil sands. The iPod portable music player was introduced in Canada.

2002: The Institute for Quantum Computing established at Waterloo by Mike Lazaridis, a founder of Research in Motion (RIM), linking it to the University's nanotechnology program.

2003: Rogers introduced personal video recorders (PVR's). The research icebreaker CCGS *Amundsen* was launched. The third Provencher Bridge (actually two bridges) was completed across the Red River in Winnipeg. The Public Health Agency of Canada developed and patented a vaccine against the ebola virus that was ravaging parts of Africa.

2004: The Mining Association of Canada began a program to help solve environmental problems caused by mining activities. The Welland Canal was deepened to increase the tonnages that could pass through it.

2005: The Giant Gold Mine closed at Yellowknife, NWT. Engineering work was stopped on the construction of a natural gas pipeline from the Arctic to Alberta. The CBC began broadcasting HDTV. Skype (talk-and-see) technology became available in Canada.

2006: The Millennium Line of Metro Vancouver's light rail system opened. In December, there were 22 million Internet users in Canada, and over 7.6 million broadband connections.

2007: Canada's RADARSAT II earth observation satellite was launched. The Rideau Canal was named a World Heritage Site. The CN Tower's high-efficiency LED lighting system was installed. The towers of the TD Centre in Toronto began using a hydrothermal cooling system that took its cold water from Lake Ontario. The Bell 429 twin-engined helicopter was tested at Montréal.

2008: AECL introduced the Advanced CANDU Reactor (ACR-1000). *Dextre* - an enhanced vision manipulator system designed and built by Macdonald Detweiler & Associates - was installed on the ISS to inspect its outside surfaces. Bombardier began to design, build and test its C-Series passenger aircraft. The first Canadian LNG port facility opened at Saint John, New Brunswick. The iPhone was introduced in Canada.

2009: The fully-automated Canada Line of Metro Vancouver's light rail system opened, bringing the length of the system to 80 km. Astronaut Bjarni Tryggvason flew a replica of the McCurdy *Silver Dart* to commemorate the centennial of the first Canadian flight. Kobo digital book service was introduced by Indigo Books and Music. Cloud computing technology and Internet television became available in Canada, as did electronic check-in facilities at airports. Canadian circus billionaire, Guy Laliberté became the world's seventh space tourist.

2010: The International Space Station celebrated 10 years of continuous occupation, and the use of the

Canadian-built *Canadarms*. It has been estimated that, by 2010, there were around 100 3D printers in use in Canada. (3D printing is also called additive manufacturing.) The Aviation Museum in Ottawa was renamed the Canadian Air and Space Museum. Telephone landlines began to disappear as iPhone use grew. The iPad web surfing device was introduced in Canada. In August, the NRU nuclear reactor was successfully restarted after a year had been spent fixing a heavy water leak. By 2010, 60 per cent of Canada's electrical generation was from hydro sources and 40 per cent from all the others.

2011: NASA's rover *Curiosity*, which included Canadian-built instrumentation, landed on Mars. The Blackberry *Playbook* was marketed.

By 2011, Canada had over 1 million km of (two-lane equivalent) highways, of which around 40% were paved and 60% unpaved, mainly in Saskatchewan and Alberta. 38,000 km were included in the National Highway System, mainly in Ontario and British Columbia. There were 19 toll bridges in this System, two toll highways and 1 tunnel.

2012: The nuclear-powered rover *Curiosity* landed on Mars, carrying Canadian-made equipment, and sent photos back to earth. The Deh Cho Bridge across the Mackenzie River opened in the Northwest Territories. A new cable-stayed Port Mann Bridge opened over the Fraser River, replacing the one built in 1964.

2013: A new water tunnel to service the Sir Adam Beck II Generating Station was completed at Niagara Falls.

By early 2013, eight Canadian astronauts had completed missions in NASA space shuttles and at the International Space Station, including engineers Marc Garneau, Chris Hadfield, Bjarni Tryggvason, Julie Payette and MD/engineer Bob Thirsk. In 2013, Hadfield served as commander of the ISS.

2015: Dr. Arthur McDonald of Queen's University shared the Nobel Prize for Physics for work done at the Sudbury Neutrino Observatory.

2016: The city of Trail, British Columbia, opened the 1000 ft-long pedestrian/bicycle *Skywalk* across the Columbia River. The Province of Ontario launched a ten-year pilot program to allow the testing of automated vehicles on Ontario roads. A ten-year refurbishment program began at the Darlington nuclear power plant east of Toronto.

2017: Canada was operating 2 per cent of the world's earth-orbiting satellites (36). The all-weather highway between Inuvik and Tuktoyaktuk in the Northwest Territories was opened. The building of a replacement for Montréal's Champlain Bridge was underway. In November, the first oil was recovered by the Hebron platform off the coast of Newfoundland. (The GBS platform itself was built at Bull Arm, Newfoundland.)

It has been estimated that, in late 2017, 84% of Canadian households had home computers and that 89% of them had access to the Internet. The remaining people were located mostly in rural and

northern areas of the country. Similarly, Canada's installed wind energy capacity was over 12,000 mw at the end of the year, around half of it in Ontario. A provincial list of the numbers of dams and reservoirs in Canada compiled in 2017 reads as follows: Alberta 16; British Columbia 39; Manitoba 14; New Brunswick 5; Newfoundland & Labrador 9; Ontario 56; Québec 49; Saskatchewan 46; Yukon 2. Canada also had over 800,000 km of oil and gas pipelines in operation.

Summary: 1945-2017

Whereas Canada had come alive engineering-wise as a country around the turn of the 20th century, and had experienced mixed progress from 1919 to the beginning of WW II, it took advantage of World War II to establish, postwar, an engineering profession of considerable size, maturity and competence, which participated in activities at the forefront of engineering activities internationally - although still operating in the shadow of the United States, especially in regard to space exploration and the production of electronic devices.

During the post-World War II period, which has been a very busy one, Canada had also sought much more international activity and exposure than before, including participation in the exploration of space, the development of earth-space-based information systems, and political exposure and responsibility. Canadian engineering has also improved its ability to supply the infrastructure needed for a growing economy and for advancing technology, as well as dealing with aggressive U.S. and Japanese competition and with the more recent development of China's economic activities.

Significantly, this third period included both the 1967 Centennial and the 2017 Sesquicentennial, which provided opportunities to celebrate Canadian engineering events and achievements.

Postscript

As part of the Centennial of Engineering in 1987, the Engineering Institute (EIC) tasked a committee with identifying the ten most important Canadian engineering achievements of the century just ended. This list has been published before, but it should be once again...

...the CPR to the West Coast; the St. Lawrence Seaway; the CANDU nuclear reactor; the de Havilland *Beaver* aircraft; the Polymer petrochemical plant at Sarnia; the Trans-Canada microwave network; the Hydro-Québec 735KV voltage system; the *Alouette I* satellite; the Bombardier *Skidoo*; and the Syncrude oil sands plant.

At the end of the 20th century, at the initiative of the Canadian Council of Professional Engineers (now Engineers Canada), a further survey was held, for 20th century achievements. These were...

...the CPR Rogers Pass project completed in 1985; the Confederation Bridge between PEI and New Brunswick; the *Canadarm*; the IMAX system of motion picture photography; and the Hopps (external) pacemaker. The latter was voted in an Angus Reid Poll as the most important.

The EIC, on the 125th anniversary of its founding in 2012, identified six achievements...

...the CN Tower; the *Canadarm*; the Confederation Bridge; the RIM *Blackberry*; the TRIUMF particle accelerator; and *Radarsat I and II*.

Industrial and technical concerns with implications for the future surfaced during the sesquicentennial year and included instantaneous worldwide communications, driverless vehicles, artificial intelligence and robotics, crypto-currencies and blockchain technology, demonstrating U.S. dominance in contemporary information technology and its associated engineering, internet of things, 3D printing, VR and AR, cloud computing thanks in part to the efforts of the federal government and industry that have helped improve Canadian participation in the research-innovation link. While these have added new research and engineering institutions and the capabilities of engineers and scientists in cities like Toronto, there are concerns about their ability to translate research into economic activity.

The reader will notice that the word *innovation* has not been used in this paper although, in 2019, it is frequently heard and, indeed, is part of the responsibilities given to at least one current federal minister. Innovation, along with S&T and R&D policies, have been discussed at length and in the context of engineering in a companion paper to this one in the Cedargrove Series, #54/2019.

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