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### **ENGINEERING HISTORY PAPER #91**

#### **“Remembered Engineers”**

**by Andrew H. Wilson**

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EIC HISTORY AND ARCHIVES

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THE CEDAGROVE SERIES OF  
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#51/2019

**REMEMBERED ENGINEERS**

by Andrew H. Wilson

April 2019

## **Abstract**

The research for this paper was done as part of a sesquicentennial project on *150 Years of Canadian Engineering*.

For those included, their 'remembrance' either has been generally recognised among the members of the profession or has been the subject of judgement on my part (and may or may not be shared).

It is important to remember that Canada's early engineers were mostly civils, that many were immigrants, and that the profession has been male-dominated, although this dominance has been slowly diminishing over the past several decades.

## **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 on his appointment in 1975 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 and edited historical material for both organizations and for the Canadian Society of Senior Engineers. He is also a past president of CSME and EIC.

## Preamble

Engineering is many things, but basically it is people...and what they accomplish as individuals - although, nowadays, *teams* of engineers have been replacing solo practitioners. Also, since World War II, relatively more engineers have been involved in research and development and relatively fewer in design, production/construction and other non-R&D activities. Some scientists have, from time to time, functioned more as engineers than as scientists, and vice-versa.

The engineering profession in Canada, as elsewhere, has been male-dominated from the beginning and, although the number of lady engineers has been increasing over the last several decades, there are still relatively few of them in this country. Since most are still alive, only a very few have become 'remembered.'

It may also seem invidious to single out some engineers, ladies as well as gentlemen, and to identify them in this way when there are undoubtedly others who may be equally worthy for inclusion. Nevertheless, the achievements of those remembered in this paper have been significant.

In identifying the remembered, the lists of those inducted into the Order of Canada and the Provincial Orders have been helpful, as have the inductees into the Science and Technology Museum's late and lamented Canadian Science & Engineering Hall of Fame, as well as those commemorated as 'persons of national historic significance' by the Historic Sites and Monuments Board of Canada. Unfortunately, all three sources have tended to overemphasise research contributions and underemphasise the roles played by practicing and management engineers in Canada's history.

The senior awards lists of the Engineering Institute of Canada, Engineers Canada and the Association of Consulting Engineers have been more helpful since, historically, they have drawn attention to the practitioners who did the actual designing, building, making and managing of engineered products as well as those who did the research. Interestingly, the Canadian Academy of Engineering was not established until 1987, so that many of the engineers included in what follows died before they might well have been inducted into it. Also, up until the passing of the Nickle Resolution by Parliament in the early 1920s, several Canadian engineers were recognized by the Crown and were dubbed 'knights of the realm' by the reigning monarchs in London, England.

It is also important to remember that, in the 19th century, many Canadian engineers were immigrants, mostly from the U.K. and that, until the turn of the 20<sup>th</sup>, electrical and chemical engineers were few in number, and there were no aeronauticals.

In a nutshell, the inclusion of specific engineers in this paper has been the result of my own judgement and may not be shared by other engineers. Also, none of them is still living, which explains why they are 'remembered' - and why Mike Lazaridis and Molly Shoichet, for example, have not been included, nor has Julie Payette, currently serving as the first engineer to be Canada's Governor General.

In some other papers resulting from my 'sesqui' research, four time periods have been identified: pre-1867; 1867-1918; 1919-1945; and 1946-2017. Since many of those included in this paper contributed in more than one period, I have ordered them according to their dates of birth.

In a number of cases, my sources - listed at the end of the paper - have included books as well as articles of varying lengths written about the engineers. In these cases, if my career descriptions are too short, the reader may go to them for further information. Also, I have already written biographical material on several of those included in this paper. And this time there are no photographs.

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The colourful story of **Casimir Stanislaus Gzowski** (1813-1898), one of the earliest engineers to be recognized in Canada and who latterly was also a friend of Queen Victoria, has been told many times in years past. Born to minor Polish nobility in St. Petersburg, Russia, at the age of 17 he began training as an army engineer officer in the Russian Imperial Corps of Engineers. In 1831, after being embroiled in a Polish-Russian military/political conflict, Gzowski was first held prisoner in Austria, then three years later admitted as an immigrant to the United States. By 1837, he had qualified as a lawyer, acquired American citizenship, and had established a practice in Pennsylvania, but found that he could contribute more to the development of the State through his military engineering experience, and did so. An 1841 trip to Ontario to scout business for his American employer resulted in an offer of engineering work in Canada, which Gzowski accepted. He became a railway and canal contractor and, by 1852, with some influential associates, had formed his own company. Over the next 20 years and more, Gzowski successfully developed his company, his engineering career, and his position in society. Among his projects were the construction of the International Bridge across the Niagara River at Fort Erie and the Toronto Rolling Mills. But, unlike many of his associates, he remained on the sidelines of politics although he could not avoid them completely. He was commissioned in the Militia, was instrumental in establishing the Dominion Rifle Association, chaired the Niagara Falls Parks Commission, and administered the Province of Ontario when it was without a Lieutenant Governor. By 1879 he was an honorary aide-de-camp to Queen Victoria. In 1882, Casimir Gzowski was promoted to the rank of Colonel. In 1887, he was a founding member of the Canadian Society of Civil Engineers (CSCE) and served as its third president, from 1889 to 1892. The Society's first 'best paper' medal bears his name and was originally funded by him. He was named a person of national significance by the Historic Sites and Monuments Board of Canada (HSMBC), and was knighted in 1890 within the Order of St. Michael and St. George (KCMG), and was 85 when he died.

**Thomas Coltrin Keefer** (1821-1915), the much younger half-brother of Samuel, was a notable *before and after* Confederation contributor to Canadian engineering. He learned his engineering as an apprentice on the Erie Canal and later as a professional on the Welland. He was also a writer and published essays on *The Philosophy of Railroads* in 1849 and on *The Canals of Canada* the following year. He did extensive survey work on railway location between Montréal, Kingston and Toronto but failed to win contracts to build them. Instead, he designed waterworks, including the ones at Hamilton, Ottawa and Montréal, and

consulted on bridge construction, such as the Victoria over the St. Lawrence at Montréal, in the late 1850s. He also served as chief of the Montréal Water Board. In 1851 and 1862 he assisted with Canadian exhibits for London, England, exhibitions. He was one of the first lecturers in engineering at McGill. His contributions to the Paris Exhibition of 1878 on behalf of Canada earned him a British honour, the CMG. In 1887 he was elected the founding president of the CSCE, and re-elected ten years later. He was the first Canadian to be president of the American Civil Engineering Society, in 1888. He was elected to the Royal Society of Canada in 1890 and became its president in 1898. He was honoured by the HSMBC and, in 1942, the Engineering Institute of Canada (EIC) established a civil engineering 'best paper' medal in his name.

A notable contemporary of the Keefers and Gzowski was **Sandford Fleming** (1827-1915), who is another early Canadian engineer whose story is well known. Born in Scotland, the majority of his engineering in Canada was done in connection with the railways, including the building of the Intercolonial Railway from Central Canada to the port of Halifax in the 1870s, when he insisted on building its bridges of iron rather than the usual timber. He also famously surveyed potential routes for the proposed westbound CPR. Earlier, in 1849 he had established what became the Royal Canadian Institute, the first 'learned' society for engineers and other professionals. He designed the first postage stamp in 1851. In 1876 he was among those who proposed what became 'standard time,' which was adopted world-wide. He also advocated the construction of a submarine telegraph cable connecting all of the British Empire, and completed in 1902. He was Chancellor of Queen's College (University) for 35 years, was honoured by the HSMBC, and was inducted into the Canadian Science & Engineering Hall of Fame. He was also involved in a number of private companies, and was knighted in 1897.

**John Kennedy** (1838-1921), the son of a Scottish-born millwright, was educated at McGill College. In 1853 he began his engineering career as a pupil under Thomas Keefer on waterworks in Montréal, Ottawa and Hamilton. In the 1860s he was a city surveyor in Montréal. In 1867 he became manager of a smelting works at Ironside, Québec, and later of a family-owned one in Ontario. In 1871, Kennedy was appointed a divisional engineer with the Great Western Railway. In 1875 he became the first chief engineer of the Montréal Harbour Commission, and held this office for the next 32 years, during which time he developed the modern port of Montréal, reduced the ice jams each spring in the harbour, erected grain elevators, and deepened the St. Lawrence ship channel to Québec. He also served on a number of federal commissions. Blindness struck him in 1899, and he was totally blind by 1907. But he continued to engineer, becoming a consultant and an arbitrator. He was a founding vice-president of the CSCE in 1867, and later president of it, and a member of the American and British civil engineering societies, He was also a co-founder of the original Canadian Engineering Standards Association, now simply the CSA. He was knighted in 1916, and was honoured by the HSMBC. In commemoration, the Sir John Kennedy Medal was established by the EIC in 1927 to recognize service to Canadian engineering and its profession and is today the Institute's highest honour.

**Henry Norlande Ruttan** (1848-1925) was both a military man and a civil engineer, and chief engineer of one of Canada's largest cities, Winnipeg. Born and raised at Cobourg and Cornwall, Upper Canada, he

was one of nine children, and the grandson of a Militia officer who was also a politician and inventor. He himself joined the Militia at 18 and fought during the Fenian Raids. In 1868 he began a career in engineering with the Grand Trunk Railway and worked under Sandford Fleming on the Intercolonial Railway in the early 1870s. In 1874 he rejoined Fleming at the CPR and went to work in Western Canada. He left the CPR in 1880 and settled in Winnipeg where, at first, he was involved in consulting work for the railways. He also became involved in gold mining and in 1883 rejoined the Militia. In 1885, he fought under Middleton in the Northwest Rebellion. Also in 1885, he was appointed the first city engineer of Winnipeg and held this position, sometimes controversially, until his retirement in 1915. In 1889, however, he was appointed to command Military District No. 10. He was promoted to Brigadier General in 1912. His attempts to serve in France in World War I were unsuccessful in view of his age. He served 12 years as a member of the Council of the Canadian Society of Civil Engineers and was its president in 1910. He was also honoured, as was Thomas Keefer, with the British CMG.

The Ottawa-born inventor and entrepreneur **Thomas Ahearn** (1855-1938) trained as a telegraphist in Canada and the United States and learned electrical engineering along the way. By 1880 he was manager of the Bell Telephone Company in Ottawa. In 1881, with Warren Soper, also a former telegraphist, he formed the company, Ahearn & Soper, electrical contractors who did contract work for the CPR and Bell Telephone among others. In 1893, with William Wylie, he founded the Ottawa Car Manufacturing Company, which built streetcars. He formed the Chaudière Electric Light & Power Company in 1887 and merged it with others to form the Ottawa Electric Company in 1894. He also founded the Ottawa Electric Railway Company to provide streetcar service to the city. In 1906 Ahearn was appointed president of the Ottawa Gas Company. By 1912 he was also vice-president of Wallace Realty Company and a director of Canadian Westinghouse. In 1927 he became the founding chairman of the Federal District Commission (now the National Capital Commission), and part of his work in this capacity was to develop the present Ottawa River Parkway and to build the Champlain Bridge across the River. Along the way, he filed for 11 Canadian patents - for example, for an electric oven, using which he cooked the very first 'all electric' meal, and for a system for heating streetcars by means of electricity. He was named to the Queen's Privy Council in 1928. Ahearn died at the age of 83.

**Richard Birdsall Rogers** (1857-1927) was the designer of the two quite different lift locks on the Trent-Severn Waterway, at Peterborough and at Kirkfield. He was also a pioneer in the use of concrete in construction in Canada. But his conservative politics generated a considerable amount of controversy. Rogers graduated in the 1870s from McGill University in civil and mechanical engineering. He was also qualified as a provincial and dominion land surveyor. In 1884 he was appointed superintending engineer of the Trent Canal. About this time, he acquired an interest in hydraulic lift locks as alternatives to conventional canal locks. In 1896, he was sent to Europe to study the three existing systems. When he returned, Rogers set up a laboratory to test specifications for the concrete he wished to use in place of limestone in canal construction, and for a possible lift lock. For one thing, concrete would be cheaper to install than limestone. He also wished to study the strengths of various concrete mixes. Simultaneously, his work on the Peterborough lift lock went ahead. Construction had begun by 1899 and the lock was

opened in 1904, the hydraulic system having been supplied by Dominion Bridge Ltd.. Meanwhile work was progressing on the design and construction of the Kirkfield lift lock, made of structural steel this time, and again with Dominion Bridge participation. It was opened in 1907, but Rogers had been replaced two years earlier as superintendent by A.J. Grant. Rogers' work on the Trent-Severn was dogged from the beginning by political interference, professional jealousies and accidents, the effects of which dragged on for years, until a report in 1914 exonerated him. Meanwhile, Rogers had turned to contracting to earn his living, although not very successfully. He died in 1927. Not long after his death, the Peterborough Branch of the Engineering Institute of Canada placed a plaque in his memory on the superstructure of the Peterborough lift lock. Both lift locks are still in operation, more than a century after their construction.

**George Herrick Duggan** (1862-1946) was Toronto-born and trained as an engineer at the University of Toronto. Although he spent most of his life managing engineering companies, he worked first as an engineer for the CPR and then for the Dominion Bridge Company. Between 1901 and 1910 he was an executive with the Dominion Coal Company, returning to Dominion Bridge where, by 1919, he was chief engineer and general manager. He had also been chief engineer of the St. Lawrence Bridge Company when the Québec Bridge was completed in 1917. In 1920 he established Dominion Engineering Works Ltd. to take over the manufacture of papermaking machinery and hydraulic turbines from St. Lawrence Bridge. He also pioneered the use of electric welding to replace riveting and forging. Duggan was president of Dominion Bridge from 1919 to 1936 and chairman of the board from 1936 to 1946. He was elected president of the EIC's predecessor Canadian Society of Civil Engineers in 1916. The Institute later established the Duggan Medal in his memory. He was a life-long, enthusiastic yachtsman who designed and sailed his own boats. He was awarded honorary doctorates by three Canadian universities.

**Rupert Wallace Turnbull** (1870-1954) was a contemporary in the aviation business of the Wright Brothers, Alexander Graham Bell and even Frank Whittle and made his contributions during the first and second periods. New Brunswick born, he graduated in mechanical and electrical engineering from Cornell in 1893, spent a year on graduate work there, and a year in Berlin. He spent the last years of the century as a research engineer with the General Electric Company in New Jersey, during which time he corresponded on aeronautical matters with Langley, Lilienthal and Eiffel, who had built the first wind tunnel. In 1902 he returned to Rothesay, New Brunswick, to open his own laboratories (in farm barns), to join the ranks of the 'heavier-than-air' investigators, to build the first wind tunnel in Canada (in one of the barns), and to find solutions to the practical problems of manned flight. For example, he made significant contributions to the theory of flight and to the design of wing surfaces. This work won him a Fellowship of the Royal Aeronautical Society. In 1914 he closed his lab for the duration and went to work in Britain on devices such as propellers, bomb sights and torpedoes. Returning to Canada and his lab in 1918, he continued the work that led to his most significant device, the variable pitch propeller. It was successfully tested in 1927, and patented, but was first exploited commercially in the United States. Throughout all of this, Turnbull found time to study the Bay of Fundy tides. He was honoured by the HSMBC and inducted into the Canadian Science & Engineering Hall of Fame.

**Julian Cleveland Smith (Senior) (1878-1939)** was born, a twin, in Elmira, New York and they received their early education in Buffalo. Julian earned a mechanical/electrical engineering degree in 1900 from Cornell University. Twin Joslyn, however, had died early in 1897, in his freshman year. Julian began his career as a draftsman, first in Buffalo. By 1901 he was assistant engineer to Wallace Johnson, a consultant at Niagara Falls. In 1902, Johnson moved to Shawinigan, Québec, and Julian went with him, to join the Shawinigan Water & Power Company (SWP) and help build its hydro dam and generating station on the St. Maurice River. Power generated from it went over 80 miles to Montréal, beginning in 1903. Julian became the SWP superintendent in Montréal, where he lived for the rest of his life. In 1906 he was made general superintendent of the company and, three years later, at the age of 30, general superintendent and chief engineer. A second plant was designed and constructed at Shawinigan in 1910 and 1911, as well as a new transmission line. SWP also participated with the Montréal Light, Heat & Power Company (MLHP) in a new power plant at Cedar Rapids, Québec, which MLHP bought outright in 1916. As a result of his contributions to this project, Julian was promoted to vice-president and chief engineer of SWP in 1915. The following year he was made general manager. The Shawinigan Engineering Company was established in 1919. SWP also participated in the establishing of the Dominion Engineering Works Ltd. (with G.H. Duggan) and Julian was appointed a vice-president. In 1924, he was elected president of the Montréal Tramways Company, a joint venture between SWP and MLHP. In 1924, also, he became a Canadian citizen. Overall, the 1920s were growth years for SWP. By 1928 it had 36 subsidiaries. However, by 1930 the Depression had made itself felt and the demand for electricity had ceased to grow. In 1933 Smith was appointed president of SWP, for which the slow business recovery had begun in an ever-more-complex political situation. By 1939, when Smith died, the Depression had eased. In his lifetime, he received several honorary degrees, served as president of the EIC in 1928. After his death, the Julian C. Smith Medal was established by the Institute to recognize “contributions to the development of Canada.”

**Jacques (James) deGaspé Beaubien (1881-1969)** was born in Outremont, Montréal, the son and grandson of Québec politicians, and into a family that had been in Québec since 1650. Before graduating in electrical engineering from McGill in 1906, he gained experience with the Montréal Light, Heat and Power Company and, after graduation, stayed at the university to teach for the next two years. He then worked briefly for the Westinghouse Electric Company in Pittsburg before opening a consulting practice in which, in 1922, he was joined by J.L. Busfield. He became president of Beaubien Limited when it was established in 1927, its specialty being hydro-electric power development, principally for cities, utilities and companies in Québec. Before, during and after the interwar period, deGaspé Beaubien was active in a number of organizations associated with the engineering profession. For example, he served from 1912 until 1957 as a member of the Electrical Commission of the city of Montréal. He was also a member of the main committee of the original Canadian Engineering Standards Association. In 1920 he was a founding member of what was then the Corporation of Professional Engineers of Québec and, in 1925, a founding member and the first president of the Association of Consulting Engineers of Canada (ACEC), and remained in this office until 1949. ACEC later named him Honorary President in 1954. His work during World War II included the preparation of a French version

of the National Building Code, service on numerous Dominion Government committees, including war savings, defence communications and postwar reconstruction, and for which he achieved the rank of Commander in the Order of the British Empire (CBE). In 1944, he was elected president of the Engineering Institute of Canada. Post World War II, he was a member of the National Research Council. Both before and after the War, he served on the boards of numerous companies and belonged to several engineering and business organizations. The University of Manitoba granted him an honorary doctorate in science. In March 1984 the ACEC created the Beaubien Award in his honour, to be the highest mark of distinction for consulting engineers in Canada.

**Philip Louis Pratley** (1884-1958) was born in Liverpool, England, and educated at the university there, receiving both BSc and BEng degrees. He was then apprenticed to a company at nearby Garston. At the age of 22, he came to Canada, working first for the Locomotive & Machine Company and then for Dominion Bridge Ltd. in Montréal. In 1908 he was awarded an M.Eng. degree by Liverpool. In 1909 he was involved in the re-design and construction of the Québec Bridge for the St. Lawrence Bridge Company. He was subsequently involved in the construction of two smaller bridges in New Brunswick for this company and, in 1920, examined Grand Trunk Railway bridges for the Government of Canada. In 1921 he began a consulting practice with Charles Monsarrat (who had designed the Lethbridge Viaduct) which was responsible for the design and construction of the Jacques Cartier Bridge at Montréal, the Île d'Orléans Bridge downstream from Québec, the Lions Gate Bridge at Vancouver, the Angus L. Macdonald Bridge at Halifax and the original Burlington Bay Skyway Bridge at Hamilton. He was working on the Champlain Bridge at Montréal and the Cornwall North Channel Bridge at the time of his death. Pratley has been recognized as a 'person of national historic importance' by the Historic Sites and Monuments Board of Canada.

**Chalmers Jack Mackenzie** (1888-1984) was born at St. Stephen, New Brunswick. Before attending Dalhousie University, he worked briefly for his mason/builder father. He earned his civil engineering degree in 1909. A very young C.D. Howe (see below) was one of his professors. His career spanned three of the four periods covered in this paper. Early in 1910, Mackenzie and a Dalhousie classmate opened a consulting practice in Saskatoon. In 1912 he was asked to join the staff of the University of Saskatchewan to start the engineering degree course. In 1913 he decided to make his career in teaching and designed the full four-year curriculum. However, he also decided he needed a post-graduate qualification and took a year off to obtain a master's degree at Harvard. The first of his Saskatchewan classes graduated in 1916, and went off to war. So did Mackenzie, who received a commission and was awarded the Military Cross. Returning to the University in 1919, he was appointed the first dean of the College of Engineering two years later. He also took an active part in university research projects, in national as well as local EIC activities, and in a number of other local organizations. During the Depression, he organized and carried out the design and construction of Saskatoon's Broadway Bridge, which was opened in 1932. In 1935 he was appointed a member of the NRC's advisory council in Ottawa and in 1939, when NRC President A.G.L. McNaughton returned to the Army, was appointed to replace him as head of the laboratories. In this role, he took part in Canadian diplomatic and scientific collaboration with the United States and other Allied countries...and worked with his old professor, C.D.

Howe, now a member of the federal Cabinet. In 1941 he served as president of the EIC. In 1944 he was named president of NRC in his own right and remained in this office until 1952. Involved from the beginning in Canada's nuclear program, he was appointed AECL president in 1953-54 and also served as president of the Atomic Energy Control Board from 1948 until 1961. He was involved in the post-war expansion of federal R&D programs and institutions, such as DRB and MRC, and provided advice on policies for science and technology up until his 90<sup>th</sup> year. He was inducted posthumously into the Canadian Science and Engineering Hall of Fame.

Very few Canadian engineers have been members of the House of Commons, let alone members of the federal Cabinet. **Clarence Decatur Howe** (1889-1960) was one of these very few. Howe was born at Waltham in Massachusetts, obtained his civil engineering degree at MIT in 1907 and, as a new graduate with limited job prospects due to a recession, moved to Nova Scotia to teach at Dalhousie University. However, in 1913 Howe was offered the post of chief engineer for the Board of Grain Commissioners, headquartered at Fort William, supervising the building of grain elevators from the Lakehead westwards. By 1916 he had left government service and started on his own to design and build elevators. Thanks to a massive storm, but saved by his customer's generosity, his first job broke even rather than being a disaster! The Howe Company soon dominated the elevator business among Prairie Co-operative clients and grew to include engineering consulting. He also designed the vastly more efficient Dominion-Howe unloader that could empty a grain car in eight minutes with only two operators. He was elected to local political office in the 1920s but agreed to run federally for the Liberals if guaranteed a Cabinet post. He ran and won in October 1935 and was appointed Minister of Railways and Canals and Minister of Marine. Not surprisingly, he was the only engineer in Cabinet, and the very first in a Liberal one. In the long run, however, Howe the engineer became known for his impatience with criticism and with the parliamentary system. In 1936 he brought in legislation to establish Canadian National Railways as a crown corporation. From 1936 to 1940 he was minister of Transport. In May 1937 he founded Trans-Canada Airlines and took part in its dangerous inaugural flight from Montréal to Vancouver. Howe was re-elected in January 1940 and became the first minister of Munitions and Supply and the employer of the famous 'dollar-a-year' men. In December 1940 he made an official visit to Britain and almost perished on the voyage there. Later, he set up Victory Aircraft, very successfully, as a crown corporation to make Avro aircraft for the war effort. Howe's efforts led to Canada becoming the fourth highest industrial producer among the Allies. In 1944 Howe became the first minister for Reconstruction and Supply, which he enjoyed much less. In 1948 he was made minister of Trade and Commerce. In November 1948 Louis St. Laurent replaced Mackenzie King as prime minister. In 1951 Howe added Defence Production to his responsibilities. Howe was 'undone' politically and finally with the so-called pipeline debate of 1956. The Liberals, and Howe, lost the 1957 General Election. Howe moved to Montréal and effectively into retirement. He was honoured by the HSMBC. He died in 1960. His work had laid the foundation for Canada to become an industrialized country, rather than an agricultural one, during the fourth period covered in this paper.

**Frank Arthur Forward** (1902-1972) was awarded the American Institute of Metallurgical Engineering's

James Douglas Gold Medal in 1965 for “inspired scientific, professional and academic leadership and for the development of new and successful processes utilizing pressure leaching and hydrogen reduction in hydrometallurgy.” Ottawa born, Frank graduated in chemical engineering from the University of Toronto in 1924. During the years that followed, he worked for the Consolidated Mining & Smelting Company of Canada, the Mount Isa Mines Company in Queensland, Australia, and the B.C. Nickel Mines back in Canada. He taught, did research in hydrometallurgy, and was the long-time head of the University of British Columbia’s Department of Metallurgy from 1935 until 1964, when he was named the founding director of the Science Secretariat of the Privy Council Office in Ottawa, with special responsibilities for science policy studies. Along the way, he served as director of the Canadian Uranium Research Foundation, and as president of the Association of Professional Engineers of British Columbia, the Canadian Council of Professional Engineers (now Engineers Canada), and the Canadian Institute of Mining and Metallurgy. For an academic engineer, his industrial connections were particularly strong and especially with the Sherritt-Gordon Company, for the development of the nickel ore on whose Lynn Lake property his research was especially important. Frank Forward received numerous awards and other honours for his academic and industrial work, including the McCharles Prize in 1955, the Inco Medal in 1960, and the University of Toronto’s Engineering Alumni Medal in 1963.

**George Johann Klein** (1904-1992) could be called ‘the inventor’s inventor.’ Born in Hamilton, Ontario, and George IV by the family’s count, he was the son of George III, the jeweller. As a youngster, he showed considerable mechanical talent, tinkering in his father’s workshop. A 1928 mechanical graduate of the University of Toronto, George accepted a job offer at the University with access to the wind tunnel, but soon received another, at the National Research Council in Ottawa, from his former professor, the legendary John H. Parkin. He began his long career there by helping to build the Council’s first wind tunnels. The rest, as they say, is history. He became an NRC’s expert mechanical designer and the ‘go-to guy’ who helped solve his colleague’s problems as well as original ones of his own. He did research on aircraft ski design and with time acquired an international reputation for his expertise in the mechanics of ice and snow and the design of vehicles for the Arctic environment. He contributed in many ways to the Council’s wartime military and defence projects, to the design of the ZEEP nuclear reactor at Chalk River, to the development of the first motorized wheelchair, and to the first microsurgical staple gun. He also designed the famous retractable STEM antennas that flew in space with the Canadian *Alouette* satellites and with later spacecraft, including the Hubble Space Telescope. And he was the gear consultant for the development of the first *Canadarm*. George Klein died in 1998 at the age of 88. The following year, he was inducted posthumously into the Canadian Science & Engineering Hall of Fame.

**Robert Ferguson Legget** (1904-1994) was another engineering graduate of the University of Liverpool who was very successful in Canada. He was also a long-time leader and builder of the geotechnical discipline and was recognized for this around the world. Born of Scottish parents, Legget graduated in 1925 with first class honours in civil engineering and geology, followed by a master’s degree in 1927. From 1925 until 1929, he worked for a firm of consulting engineers on the design of hydro power plants

for Scotland and several countries in Europe. He then moved to Canada and joined the Power Corporation of Canada for more hydro work. From 1932 until 1936 he was employed by the Canadian Sheet Piling Company, responsible for the design and construction of piling for a variety of projects. In order to further his latent interest in the mechanics of soils and the engineering of foundations, he changed careers in 1936, beginning with a lectureship at Queen's University followed by a professorial appointment at the University of Toronto. Exempt from military service during World War II, Legget - in addition to his teaching - participated in the engineering of the Shipshaw Power Plant in Québec, the Sarnia Polymer Plant and Toronto Subway System in Ontario. Before the War ended, he was also involved in NRC technical committees working on snow, ice and soil mechanics. In 1947 he was appointed the founding director of NRC's Division of Building Research, where he was charged with the development of national expertise in all aspects of this field, including permafrost and northern construction, and with the writing of the Canadian Building and Fire Codes. He was also active within the Engineering Institute of Canada, in international organizations in building and construction research, and in the writing of texts related to geology and civil engineering. He served as president of the International Council for Building Research (CIB), the Geological Society of America, and the American Society for Testing and Materials. By the time Robert Legget retired from NRC in 1969, his laboratory had become a major research facility with a world-wide reputation. In retirement, he turned his attention to yet another aspect of civil engineering that interested him: its history. Over the remainder of his long life he produced a great deal of historical material, including several books. He also made sure that his and other historical materials were properly preserved. He received much recognition for his work, including a dozen honorary doctorates and the senior medals of, for example, the Engineering Institute of Canada. He was elected a Fellow of the Royal Societies of Canada and Edinburgh, was the founding president of the Canadian Academy of Engineering in 1987, and was inducted into the Order of Canada as a Companion.

**Elsie Gregory MacGill** (1905-1980) was recently chosen one of the five final candidates for the first woman to grace a Canadian banknote. She was born in Vancouver. Both her parents were lawyers and her mother was a pioneer in her own right. In 1927 Elsie was the first woman to receive a degree in electrical engineering in Canada, at the University of Toronto. Two years later she was the first to graduate in aeronautical engineering, from the University of Michigan. But she wrote her final exams in a hospital bed, having contracted polio, which left her crippled and with difficult mobility for the rest of her life...and which stopped her from becoming the pilot she wanted to be. Pre-1939, she worked as an aeronautical engineer for Fairchild Aircraft at Montréal. During World War II she was with Canadian Car and Foundry Limited at Fort William, where she supervised the production of fighter aircraft. She also designed and built a training aircraft, which neither the RAF nor the RCAF would buy! She left Fort William in 1943 after some difficulties with the company and became a consultant in Toronto. She was also active in women's causes and served on the Royal Commission on the Status of Women. Elsie received several honorary doctorates, was awarded the Order of Canada, the Gold Medal of Engineers Canada, the Smith and the Gzowski Medals of the Engineering Institute. She died in 1980 at the age of 75. There is now an Elsie Gregory MacGill Foundation that makes an annual award to a person of

exceptional achievement. She has also been recognized by the Historic Sites and Monuments Board and was inducted into the Canadian Science & Technology Hall of Fame.

**Robert Macdonald Hardy** (1905-1985) was recognized internationally as a leading expert in soil mechanics and foundation engineering. He pioneered engineering techniques related to permafrost and to the construction of major highways, dams and pipelines. Born in Winnipeg and a 1929 graduate in civil engineering of the University of Manitoba, he received a master's degree from McGill a year later and joined the staff of the Faculty of Engineering at the University of Alberta, rising through its ranks to full professor. He was appointed Dean of the Faculty in 1947. Active during the academic summers in universities and in public and private organizations, by 1959 he had also opened a consulting practice. Resigning that year as Dean, he continued to serve the University in a part-time research capacity until 1963, when he was reappointed Dean. He retired from the University again in 1971 but remained in consulting until his death in 1985. He was a member of the Association of Professional Engineers of Alberta (now APEGGA), serving on its Council, and as its president in 1949. He also served as president of the Canadian Council of Professional Engineers (now Engineers Canada), as a vice-president of the Engineering Institute, and was named to the Royal Society of Canada. He was an Officer of the Order of Canada. Among his other awards were the CCPE's Gold Medal, the Alberta Achievement Award, and three honorary doctorates. He was a well-published author of technical papers in his field.

**Joseph-Armand Bombardier** (1907- 1964) was born at Valcourt, Québec, the eldest of eight children whose parents farmed and ran a general store. From a very young age he demonstrated a talent for machinery. He built working models of locomotives, tractors and steam engines and was only 15 when he built his first snowmobile. He also developed as an entrepreneur. At 17 he was apprenticed at a local garage, but left to go to Montréal to learn mechanics and electrics. He returned to Valcourt and soon opened his own garage. Beginning at age 22, and to make better use of the long, snow-bound winters, he developed and built vehicles for the snow. By 1937 he had built a seven-passenger vehicle and obtained a patent for the track-and-sprocket drive mechanism that was incorporated into this and future snow vehicles. By 1940 his vehicles had attracted military attention since they could carry troops over sand and swamp as well as snow and ice. Several hundred were built in his own factory. In 1942 he designed and built a 12-passenger vehicle with independent suspension on each axle, which went into long term production. In 1942, also, he incorporated his business. By the end of World War II, Bombardier was serving as a consultant on vehicles for the Arctic and sub-Arctic. But when the Québec government decided to plough country roads in 1949, he lost much of his market. By the end of the 1950s, however, he had designed and put into production the snow vehicle that became famously known as the *Ski-Doo*. He died at the early age of 56. Years later, he was inducted into the Canadian Science & Technology Hall of Fame.

**Joseph-Alphonse Ouimet** (1908-1988) was known as "the father of television in Canada." Born in Montréal, he was educated at Université de Montréal and McGill, graduating from the latter in 1932 with a degree in electrical engineering and at the head of his class. In his first jobs, for Canadian Television Ltd. and the Canadian Electronics Company, he helped carry out the first experiments on the

new equipment. In 1935 he joined the CBC to do research but wound up in operations. From 1941 to 1951 he served as assistant and later chief engineer. When TV began to make its mark in the U.S. in 1947, Ouimet urged CBC's management to undertake this task in Canada. This meant establishing operating and engineering services using the two official languages, plus the problems of serving such a huge country...and overcoming the prejudices of those who thought TV was just an expensive toy! In 1952, Ouimet was appointed assistant general manager of the CBC, becoming its youngest general manager a year later and supervising the construction of its major TV facilities in Toronto and Montréal. In 1958 he was appointed president, a position he held until his resignation in 1967. But by this time he had been recognized internationally as a leading technical and operational authority in the provision and operation of TV services. In 1969 he was appointed chairman of Telesat Canada, which built and launched many of Canada's communications satellites, and served until 1980. During his career he received many honours, including the Smith and Kennedy Medals of the EIC, Companion of the Order of Canada and induction into the Canadian Science & Technology Hall of Fame.

**Robert Fletcher Shaw** (1910-2001) spent much of his life managing engineering organizations, projects and people. He was born in Montréal and raised in Revelstoke, British Columbia. He is one of the very few members of the engineering profession to hold senior positions in industry, academia and government. A McGill graduate in civil engineering in 1933, at the height of the Depression, Shaw found work as a labourer with the Foundation Company of Canada on the piers of the Mercier Bridge near Montréal, as an erector on the superstructure of the same bridge with the Dominion Bridge Company, and on its deck and approaches with A. Janin & Company. After working for two other companies as a resident engineer and project manager, he rejoined the Foundation Company in 1937, working in its construction, marine salvage, shipbuilding and engineering branches, managing its design department during World War II and rising through the ranks to become a vice-president in 1950, executive vice-president in 1958, and president in 1962. For a short period during the Korean War, Bob Shaw was loaned to the federal government's Defence Construction (1951) Ltd., when he did work on airfield construction for NATO. He was again loaned to the Government of Canada from 1963 until 1968, this time as deputy commissioner-general for EXPO 67 and, briefly, as commissioner-general. That same year, Shaw was appointed vice-president (administration) of McGill University, a post he held for three years. He was also, concurrently, chairman of the Board of the Foundation of Canada Engineering Corporation (FENCO). In 1971 he was appointed the first deputy minister of the federal Department of the Environment, a position he held until he reached retirement age in 1975. He then joined the Monenco organization as a consultant and as president of its pipeline division. He was fully retired by 1985. Shaw was elected a full member of the Engineering Institute of Canada in 1943. He was also a member of the Corporation of Engineers of Québec (as it then was) and its president in 1953. In 1967 he received a Centennial Medal, was inducted as a Companion of the Order of Canada, was awarded the gold medal of the Association of Professional Engineers of Ontario (as it then was), and the EIC's Julian C. Smith Medal. In 1979 he received the Institute's Kennedy Medal. He was EIC president in 1975-76 and later served as chair of the Board of the 1987 Centennial of Engineering in Canada. He was awarded honorary doctorates by several Canadian universities. Bob Shaw died in March 2001 at the age of 91.

**William Howard Rapson** (1912-1997) was an academic engineer with a very strong connection to the pulp and paper industry he supported. Toronto-born, he received a BSc degree from its University in chemical engineering in 1934, followed by a master's in 1935 and a doctorate in 1941. From 1940 until 1948, he was a research chemist with the Canadian International Paper Company at Hawkesbury, Ontario, and was in charge of pioneering research for Industrial Cellulose Ltd., also at Hawkesbury, from 1948 until 1953, when he joined the Department of Chemical Engineering at his alma mater. Rapson was involved in all aspects of fundamental and applied research in cellulose chemistry and in the development of production processes. He was also responsible for the development of chlorine dioxide bleaching of kraft pulp, a major and environmentally friendly step for the pulp and paper industry which also broadened the use of kraft pulp. His contributions to university engineering education have also been substantial. He was board chairman of W.H. Rapson Ltd., president of Chemical Engineering Research Consultants Ltd. and, from 1953, a consulting chemical engineer. Howard Rapson was a member of, and contributed to, numerous technical societies, among them the Canadian Society for Chemical Engineering and the Technical Section of the Canadian Pulp & Paper Association, as well as a member of a number of foreign chemical societies. He was a Fellow of the Royal Society of Canada, the Chemical Institute of Canada and, in 1987, a founding member of the Canadian Academy of Engineering. His work has been honoured with doctorates from the Universities of Waterloo, McGill and Guelph. Among the medals he received were the Weldon Gold Medal of the Canadian Pulp & Paper Association, the John S. Bates Memorial Gold Medal, the Palladium Medal of the Chemical Institute of Canada (CIC), the Gold Medal of the Association of Professional Engineers of Ontario, the TAPPI Gold Medal of the Association of the Pulp & Paper Industry on the USA, the R.S. Jane Award of the Canadian Society for Chemical Engineering, the I.W. Killam Memorial Prize in Engineering of the Canada Council, and the Royal Society of Canada's James W. Eadie Medal, among others. Rapson retired from the University of Toronto in 1981 with emeritus status and died 16 years later.

**George Geoffrey Meyerhof** (1916-2003) was born in Kiel, Germany, the son of a professor of physiology and Nobel Laureate in medicine. However, he trained as an engineer in England, graduating from the University of London in 1938, and subsequently completed his master's and doctoral degrees. Meanwhile, between 1938 and 1943, he worked as a consultant with several firms on the design of bridges, airfields and other public works involving soil mechanics and other earthworks. He joined the staff of the British Building Research Establishment in 1943, where his work involved mainly soil mechanics and foundation engineering, and for which the University of London granted him a DSc degree in 1954. Arriving in Canada in 1953, Meyerhof joined the Foundation Company of Canada in Montréal in a supervisory capacity with responsibilities for buildings, bridges and other engineered structures. From 1955 until 1981 he was professor and head of the Department of Civil Engineering at Nova Scotia Technical College in Halifax, which became the Technical University of Nova Scotia (TUNS) in 1980. During this period, he also served as director of the school of graduate studies (1962-1964) and dean of engineering (1964-1970). In 1981, Meyerhof was appointed research professor of civil engineering at TUNS. He participated fully in the rapid growth phase of work in soil mechanics. His research, field operations and theoretical work have had a significant influence on construction

practices in Canada and abroad. He published over 200 papers in journals and books in various countries. The honours and awards that Geoff Meyerhof has received for his lifetime of work are, frankly, too many to list here. They include six honorary doctorates from Canadian and foreign universities, the Duggan and Julian C. Smith Medals of the Engineering Institute, of which he served as a vice-president, the 1974 R.F. Legget Award of the Canadian Geotechnical Society, of which he was the founding president in 1972-1974, the American Society of Civil Engineer's Karl Terzaghi Award for Soil Mechanics in 1991, and the Engineering Award of the Association of Professional Engineers of Nova Scotia in 1977. He was a Fellow of the Royal Society of Canada, a founding Fellow of the Canadian Academy of Engineering, and a member of the International Society of Soil Mechanics and Foundation Engineering. In 1999 he was admitted to the Order of Canada as a Member.

**John Alexander (Jack) Hopps** (1919-1998) was born in Winnipeg and received his degree in electrical engineering from the University of Manitoba in 1941 and joined the research staff of the National Research Council in 1942. He was consulted as an expert by governments at home and abroad. The work for which he is best remembered - the world's first external artificial pacemaker - was done between 1949 and 1951 at the Banting Institute in Toronto with Drs. Bigelow and Callaghan. In 1965, Hopps founded the Canadian Medical and Biological Engineering Society and was its first president. In 1973 he became head of the NRC's Medical Engineering Section. His career was devoted to the biomedical development of a variety of devices to help the blind, to assist people with muscular disabilities, and to advance the uses of ultrasound. He became a Fellow of the Society in 1976. Also in 1976, he was general chairman of the International Conference on Medical and Biological Engineering. Jack Hopps retired in 1978. From 1985 to 1988 he was secretary general of the International Union for Physical and Engineering Science in Medicine. In 2000, the Hopps pacemaker was identified in a public competition as the most significant Canadian engineering advance of the 1900s. Hopps was inducted into the Order of Canada in 1986 and later into the Canadian Science and Engineering Hall of Fame.

**James Milton Ham** (1920-1997) was one of the 44 founding members of the Canadian Academy of Engineering in 1987, served on its Board, and was the Academy's president in 1990. Born at Coboconk, Ontario, he was a 1943 electrical engineering graduate of the University of Toronto, served in the rank of lieutenant in the Royal Canadian Navy from 1944 to 1945, and was a lecturer in the UofT Ajax Division in 1945-46. He earned master's and doctoral degrees at MIT in 1947 and 1952 and was an assistant professor of electrical engineering at MIT in 1951-52. He then joined the Faculty of Engineering and Applied Science at UofT, becoming a full professor in 1959. Jim Ham took a sabbatical in 1960-61, visiting the University of Cambridge, England, and the USSR. He was head of the Department of Electrical Engineering from 1964 to 1966, dean of the Faculty from then until 1973, chairman of the University's Research Board until 1976, dean of Graduate Studies until 1978, and president of the University until 1983. This was followed by five years as professor of science, technical and public policy and, after 1988, as professor and president emeritus. He published some 20 papers on his research. Beginning in 1973, Jim Ham was awarded a succession of honorary doctorates by universities in Canada. He was an Officer of the Order of Canada and a Member of the Order of Ontario. He was the recipient of the UofT Engineering Alumni Medal in 1973, the APEO Engineering Medal in 1974 and Gold Medal in

1984, and the Centennial, Queen's Jubilee and Confederation Medals. He was awarded IEEE's McNaughton Medal in 1977 and the EIC's Sir John Kennedy Medal in 1983, and was a member of Sigma Xi. From 1959 to 1965 he chaired the National Research Council's Associate Committee on Automatic Control, and from 1969 to 1975 was a member of the Council. From 1970 to 1974, he chaired the Committee on Engineering Education of the World Federation of Engineering Organizations, from 1971 to 1986 was a member of the Board of Governors of the Ontario Research Foundation, and from 1974 to 1976 was chairman of the Ontario Royal Commission on the Health and Safety of Workers in Mines. He was a Fellow of the Brookings Institution in 1983-84, a director of Shell Canada Ltd. and, from 1988 to 1990, an adviser to the president of the Canadian Institute for Advanced Research. He was inducted posthumously into the Canadian Science & Engineering Hall of Fame.

The broadly-based engineering and consulting company in which **Camille Arthur Dagenais** (1920-2016) spent his working life was established in 1911 by Swiss-born Arthur Surveyer. In 1937 it became a partnership, Surveyer, Neninger, Chênevert - SNC. But in 1991, the year Dagenais retired from the company, it merged with rival Lavalin. Having taken his civil engineering degree from L'École Polytechnique in 1946, and after working for several other companies, Dagenais joined SNC in 1953, as a project engineer. He became a partner in 1959, general manager in 1965 and president a year later. He was chairman and CEO of SNC Enterprises from 1975 to 1986. In other words, he built the company. He remained a Board member until the merger in 1991. Dagenais' engineering expertise was in hydro-electric plants and their dams and it was appreciated by the appropriate international engineering organizations. He was associated, for example, with the design and construction of Québec Hydro's Manic 5 project, with the LG2A part of the James Bay Project, and with projects abroad in India, Greece, Saudi Arabia and China. He was also a Board member of a number of Canadian companies, such as SPAR Aerospace and Royal Trust and, through his SNC connection, was involved in the activities of the Canadian Nuclear Association. His contributions were recognized by awards from Canada, Québec and the city of Montreal, by several Canadian universities, and by the engineering profession. He served, for example, as president of the Canadian Society for Civil Engineering. This Society now has the Camille A. Dagenais Award for excellence in hydrotechnical engineering. He was a founding member of the Canadian Academy of Engineering in 1987 and its president in 1991.

**Ursula Martius Franklin**(1921-2016) was born a century after Thomas Coltrin Keefer, and in Munich, Germany, rather than Thorold Township, Upper Canada. Tom had many siblings. His father was deeply involved in the construction and operation of the Welland Canal. She was the only child of an archaeologist and an art historian. Her physics/mathematics studies at Berlin's Technical University were interrupted during World War II when she was interned in a forced labour camp, the physical results of which were with her for the rest of her life. By 1948, she had resumed her studies and received a doctorate in experimental physics, although her interests included history and literature. By 1949, she had won a post-doctorate fellowship to the University of Toronto and emigrated to Canada. In 1952 she married engineer Fred Franklin, another German immigrant, and they became members of the Society of Friends. That same year she joined the Ontario Research Foundation to study metals and alloys. Her work there on radioactive strontium-90 and its absorption by humans contributed to the

Partial Nuclear Test Ban Treaty. She was also involved in the design of a skeletal hip implant. In 1967 Dr. Franklin was appointed the first woman professor in the UofT Faculty of Applied Science and Engineering's Department of Metallurgy and Materials Science. Her specialty became 'archeometry' - the study of the development and use of materials, tools and practices throughout history, using modern materials science techniques, and how they contributed to human progress - in association with the UofT Institute for the History and Philosophy of Science and Technology. She published widely. In 1984 she named the first woman University Professor at the University of Toronto. She 'retired' from the Engineering Faculty in 1989, to become a senior fellow and interdisciplinary scholar of Massey College for the next 25 years. A feminist, like Elsie MacGill, Ursula Franklin was committed to social justice and to the peaceful uses of science. She served as a member of the Science Council of Canada and of NSERC. She received numerous honorary doctorates, became a Companion in the Order of Canada, a member of the Order of Ontario, and a Fellow of the Royal Society of Canada, and was inducted into the Canadian Science & Engineering Hall of Fame. In 2002, she was awarded the Pearson Peace Medal. She died in 2016 at the age of 94.

**John Herbert Chapman** (1921-1979) was a physicist/engineer, who led the team that designed and built one of Canada's signal engineering achievements - its first earth satellite - and is known as "the father of the Canadian space program." He also co-led the team that wrote the Science Council's background study in the late 1960s on Canada's potential space program that led to the establishment of Telesat Canada in 1969. Born in London, Ontario, John Chapman was a member of the first physics class to graduate in the radio option at the University of Western Ontario. He earned his master's and doctoral degrees at McGill. In 1951 he joined the Defence Research Board in Ottawa, only a little later becoming a section leader at the Defence Research Telecommunications Establishment (DRTE) at Shirley's Bay. Chapman's team worked on the first *Alouette* satellite, launched in 1962. *Alouette II* was launched in 1965, both of them providing more years of upper atmosphere data than they were designed to do. He took pains to have the technology generated in his laboratory transferred to industry to enable it to compete in the marketplace. He was also involved with the Canadian-U.S. ISIS and Hermes satellites and with the Anik communications satellites launched by Telesat Canada. When he died, John Chapman had been assistant deputy minister (space program) of the Department of Communications for five years. Earlier, he had been recognized by the Royal Society of Canada, of which he was a Fellow, and had been awarded the Engineering Medal of APEO, a gold medal by the International Union of Radio Scientists, and the McCurdy Award of the Canadian Aeronautics and Space Institute. The Canadian Space Agency was formed after his death. He was registered as a professional engineer in Ontario.

**John Douglas Ashton (Jack) Mollard** (1924-2017) pioneered the multidisciplinary art and science of aerial photographic and satellite image interpretation and analysis for earth engineering, resource development and environmental protection - a new sub-discipline of geotechnical engineering. He was also an entrepreneur, forming his own company and directing it for 60 years. Born in Regina, he took his engineering degree at the University of Saskatchewan in 1945, his master's at Purdue University in 1947, where he began his exploration of aerial photography, and his doctorate at Cornell in 1952. In 1945 he worked in the Department of Highways of Saskatchewan, as an air survey engineer with the Prairie Farm

Rehabilitation Administration (PFRA) from 1947 to 1950. From 1953 to 1956 he was chief of air surveys and engineering geology at PFRA, doubling as a technical adviser to a number of countries abroad. He was also a short course lecturer at a number of universities in the United States and Canada. Between its founding in 1956 and Mollard's death in 2017, his company undertook several thousand projects on all seven continents. It also helped NASA identify landforms on the planet Mars - a true example of *remote* sensing. He authored three textbooks and numerous papers. Among Jack Mollard's many honours were a Governor General's Medal (1941), the Keefer Medal of the Engineering Institute (1948), the Massey Medal of the Canadian Geographical Society (1989), the Legget Award of the Canadian Geotechnical Society (1992) and the Engineering Institute's Sir John Kennedy Medal (2008). He received an honorary doctorate from the University of Regina, was inducted into the Order of Canada as an officer, into the Saskatchewan Order of Merit, and into the Canadian Academy of Engineering.

Calgary born, **Benjamin Bernard Torchinsky** (1926-2013) began his career in civil engineering in 1947 when he graduated in civil engineering from the University of Alberta, which he followed with a master's from the same school. In 1949 he joined the staff of the College of Engineering at the University of Saskatchewan and taught there for eight years during which time he was attracted to the emerging field of soil mechanics and foundation engineering. In 1952, he founded a consulting company to undertake work in it. In 1959, it was incorporated into Agra Vegetable Oil Products Ltd., which went public as AGRA Industries Ltd. in 1970. Torchinsky led the company as chairman, president and CEO from 1957 until 1993, when he became chairman emeritus. The company merged with AMEC plc of England in 2000. He also founded Western Foundation Borings Ltd. in 1957, which subsequently became Western Caissons Ltd., to build deep pile foundation systems for buildings, bridges and other heavy structures across Canada, the United States and overseas. He was involved in cable television in the 1950s and, in 1960, built the first canola oil crushing plant in Canada. He was also involved in the recycling business in Alberta and participated in the construction of Highway 407 round Toronto. Ben Torchinsky received the senior awards of the Engineering Institute (the Sir John Kennedy Medal, 1997) and the Association of Consulting Engineers (the Beaubien Award, 2001). He also received an honorary doctorate from his alma mater in 2003 and was inducted into the Canadian Academy of Engineering.

**Earle Jardine Klohn** (1927-2013) was born in Winnipeg and moved with his family to Edmonton in 1937. He graduated in civil engineering in 1950 from the University of Alberta, which was followed by a short time working in California before returning to Edmonton to join R.M. Hardy's geotechnical consulting company for work in the Yukon, during which time he enrolled in a master's program, also under Hardy, completed it in 1952, and developed his interest in research into mine tailings problems. He then moved to Vancouver and, along with Cyril Leonoff, joined the consulting firm established by Charles F. Ripley, which changed its name to include the three engineers. By 1970, Ripley had dropped out of the firm to become an independent consultant, and Klohn and Leonoff carried it on, with the former as president, and it was he who saw to it that over the years the firm grew and became recognized nationally and internationally. (By 2015, it was known as Klohn Crippen Berger Ltd.) His personal interest was in water and tailings dam design and he was involved in the seismic design or review of many of Western Canada's notable dam designs, such as the E.B. Campbell Dam in Saskatchewan and the Brenda Dam in

British Columbia. He also designed the foundations for many of the large pulp and paper mills in British Columbia. Klohn was a member of many technical societies. He received professional recognition for his work and achievements, including the Leonard Medal of the Engineering Institute in 1972, the Meritorious Achievement Award of the Association of Professional Engineers of British Columbia in 1982, the Legget Award of the Canadian Geotechnical Society in 1990, and the McPartland Memorial Medal of the Canadian Institute of Mining and Metallurgy in 1992. In 1993, he was inducted into the Canadian Academy of Engineering. A scholarship in tailings research was established at the University of Alberta in Klohn's memory.

**Philip Alexander Lapp** (1928-2013) earned his bachelor's degree in engineering physics at the University of Toronto in 1950. He followed this with a master's in 1951 and a doctorate in 1955 at MIT. He joined de Havilland Aircraft of Canada in 1954 to do systems engineering and to pioneer the use of infrared sensors on the *Velvet Glove* missile. He was promoted to chief engineer in 1960, at the age of 32, and director of technical operations in 1965. He joined spin-off SPAR Aerospace Products Ltd. when it was formed in 1967 and was senior vice-president until 1969, when he left to establish his own company, although remaining a SPAR director. Philip A. Lapp Ltd. provided specialized services and studies ranging from space instrumentation, engineering education, science and technology policy, public broadcasting to information technology. He was involved in both the *Alouette* satellite program and the design and testing of the first *Canadarm*. Along with John Chapman, he contributed significantly to the Science Council report that got Canada's space program going. He served on numerous advisory boards and committees, as president of the Association of Professional Engineers of Ontario (now PEO) in 1982 and winner of its Gold Medal in 1992, as a governor of York University, as a founding member of the Canadian Aeronautical Society and a founder and second president of the Canadian Academy of Engineering. He received numerous awards, medals and other honours. He was elected to the Royal Society and became an Officer of the Order of Canada.

**Wallace Stanley Read** (1930-2011) was born in Newfoundland and graduated in engineering from the Nova Scotia Technical College in 1951. He spent his professional life in the pulp and paper and hydro-electric power industries. Between 1964 and 1984 he held senior positions in Newfoundland and Labrador Hydro and its subsidiary companies. Between 1985 and 1995 he was the Canadian Electricity Association's first full-time president. He then formed the consulting group REMAS Ltd. to provide electric power consulting services to utilities and governments and to promote the interests of the members' utilities and customers. Wally Read served the Institute of Electrical and Electronic Engineers in Canada and world-wide in many and various capacities and, unusually for a Canadian, was its president in 1996. (IEEE world-wide is the largest professional engineering society.) Since then, he served it in a variety of capacities. He was a Life Fellow. In 2001, he was inducted into the Canadian Academy of Engineering. Among his many other honours are the Sir John Kennedy and Julian C. Smith Medals of the EIC, the CCPE (now Engineers Canada) Gold Medal, and IEEE Canada's McNaughton Gold Medal. On the other side of the coin, IEEE Canada has established the Wallace S. Read Outstanding Service Award to commemorate volunteer contributions to the development of the Society. Wally was a

life member of the Association of Professional Engineers and Geoscientists of Newfoundland and Labrador.

**Bernard Lamarre** (1931-2016) was both engineer and entrepreneur. Born in Chicoutimi, Québec, he graduated in civil engineering from L'École Polytechnique in 1952. An Athlone Scholar, he received a master's degree from Imperial College, London, in 1955 and began his career as a soil mechanics engineer with the consulting firm of Lalonde & Valois, whose co-founder - Jean-Paul Lalonde - was also his father-in-law. Lamarre became chief engineer in 1960 and senior partner two years later. From 1972 to 1991 the firm was known as Lavalin, with Lamarre as president and CEO. His years at Lavalin saw the company participate in major construction projects, such as the James Bay Hydro-electric development, and the Louis-Hyppolite Lafontaine Tunnel, Ville-Marie Expressway, Olympic Stadium, Champlain Bridge, and Complexe Desjardins, all in Montréal. The firm also had contracts abroad in 50 countries. At its peak, it had 6000 employees world-wide. In 1991, when it collapsed as a result of failed business decisions, Lavalin merged with rival consulting firm, SNC. Lamarre served it as a Board adviser until his retirement in 1999. He was also president of the l'Ordre des ingénieurs du Québec, from 1993 to 1997. His hobby was art and he served for two periods as chair of the Montréal Museum of Fine Arts (MMFA). He was also associated with the Boards of L'École Polytechnique, the Montréal World Film Festival Foundation and the Old Port Corporation and chaired the Board of Directors of the Centennial of Engineering in 1987, during which he arranged special exhibits at the MMFA. He received numerous honours, awards and honorary doctorates. He was an Officer of the Order of Canada and a Grand Officer of the National Order of Québec. He was a founding member of the Canadian Academy of Engineering.

**Alan Garnett Davenport** (1932-2009) is known as “the father of modern wind engineering,” who investigated how wind reacts with tall buildings, bridges and other structures. He was born in India, grew up in South Africa, attended Cambridge University in England and received a BA and MA from that university in mechanical science. He came to Canada to take an MASc degree in civil engineering at the University of Toronto, at the same time serving as a pilot in the Royal Canadian Navy. He finished his formal education back in England, with a doctorate from the University of Bristol in 1961 and a thesis that was his first major excursion into wind engineering. However, he returned to Canada, to the University of Western Ontario (as it then was) and to a career that saw him establish in 1965 and lead its Boundary Layer Wind Tunnel Laboratory. He was an emeritus professor when he died in London, Ontario, at the age of 76. During his career he wrote hundreds of articles, papers and reports. He and his colleagues were consulted on such projects as the World Trade Center in New York, the Willis Tower in Chicago, the CN Tower in Toronto, the John Hancock Tower in Boston, the HKS Bank of Hong Kong and many bridges throughout the world. His work influenced building codes as well as their designs. Davenport's list of medals, prizes and other awards is far too long to mention. He also received a number of honorary degrees and was inducted into the Order of Canada. He served as president of the Canadian Academy of Engineering.

**Angus Andrew Bruneau** (1935-2017) was born in Toronto and earned a bachelor's degree in engineering physics from the University of Toronto, which he followed with a post-graduate diploma from Imperial

College, London, and a doctorate in physical metallurgy from the University of London. He then taught for short periods at universities in England and the United States, and in Canada at the University of Waterloo. He was appointed dean of the Faculty of Engineering and Applied Science at Memorial University in St. John's in 1968 and, a year later, introduced a co-op undergraduate engineering program, followed two years later by a graduate program. In 1975 he helped found the organization, C-CORE, at Memorial, which has undertaken research work in oceanography, ice and iceberg engineering, remote sensing and geotechnique, and was closely associated with the NRC's Marine Dynamics Division at Memorial. In 1980 Bruneau left academia and started a consulting/entrepreneurship business. In 1987 he was a founder of Fortis Inc., which has become a leading public utility in North America. In the 1970s, Bruneau was a member of the Science Council of Canada. He was later involved with the Canadian Coast Guard, the Atlantic Provinces Economic Council and the Social Sciences and Humanities Research Council, was the long-time Netherlands Consul in St. John's, received several honorary degrees and held several company directorships. In 1987 he was elected a founding member of the Canadian Academy of Engineering and served as its president in 1995 and 1996. He was inducted into the Order of Canada and the Order of Newfoundland and Labrador. He and his wife have made generous donations to Memorial. He was also a choral music enthusiast.

**Claudette MacKay-Lassonde** (1948-2000) was a 1971 graduate of l'École Polytechnique in chemical engineering in 1971 and followed it with a master's degree in nuclear engineering from the University of Utah in 1973 and an MBA from Toronto in 1983. From 1973 to 1975 she was a nuclear engineer with the Bechtel Power Corporation in San Francisco, after which she joined AECL. She went on to work for Ontario Hydro, Northern Telecom, the Government of Ontario, Xerox and, finally, Enghouse Systems, which developed IT and geographic systems. She was also a director of a number of other companies. Claudette joined APEO in 1976 and, from the start, was involved in promoting engineering as a profession, becoming the first woman elected to the Association's Board in 1982. Four years later she became its first woman president. In 1977 she was a founder of Women in Science and Engineering (WISE). In 1981 she helped organize the first Canadian Convention of Women Engineers. In 1990, she was a founder of the Canadian Engineering Memorial Foundation, created to commemorate the tragic deaths of 14 women engineering students at L'École Polytechnique in Montréal in December 1989. By 1986, Claudette had received seven honorary degrees. In 1988 she received a Vanier Award in recognition of her work, and was inducted into the Academy of Engineering in 1994. She died in July 2000 at the age of 51.

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