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ENGINEERING HISTORY PAPER #75

"Engineering Stories"

By Andrew H. Wilson

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EIC HISTORY AND ARCHIVES

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Abstract

This paper formed the basis of an oral presentation by the author in May 2018. The various stories have no unifying theme (except that they are related to engineering) and are presented in pairs in order to demonstrate how similar or different their objectives can be.

Time-wise, the various pairs have been drawn from the mid-19th century until quite recently, from two railway workshops, through sister-steamboats, to space-related research applications. They are also representative of the regions of Canada. Their treatment has been brief and factually, rather than argumentatively, historical. Fewer illustrations appear in this paper than were used in the presentation.

About this 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 to chair the first history committee of the Canadian Society for Mechanical Engineering in 1975 and served both CSME and the Engineering Institute of Canada in this capacity for varying periods until 2003. He has since researched, written and edited historical material for both organizations and for the Canadian Society of Senior Engineers. He is a past president of both CSME and EIC.

Introduction:

Parts of this paper were presented orally by the author to the Ottawa Kiwanis SAGE Group on 9 May 2018. The intention was to demonstrate to the Group the variety of Canadian engineering, but in a different form from the author's earlier presentations to it. There was no unifying theme this time, and the stories were told in related pairs. They also jumped around chronologically. However, the original collection was too long for the allotted speaking time and had to be shortened. This paper, however, includes all of the original stories, but only a few of the illustrations used in the presentation.

Two Railway Workshops:

The earliest railway locomotives, cars and rails were imported into Canada from Britain and the United States. James Good built the first locomotive in Canada in 1853 in Toronto.

The Grand Trunk Railway began construction of the first major railway workshop in Canada 1854, at Point St. Charles, Montréal, alongside the Lachine Canal and not far from the soon-to-be-completed Victoria Bridge. The plant, which replaced a smaller one at Longueuil, opened in 1857 and became a series of buildings between then and 1890 when, as has been noted in an account of this railway's growth:

> The Grand Trunk shops at Point St. Charles, Montréal, were a virtual steam city, sprawling over thirty acres, with iron foundry, rolling mill, wheel mill, smithy and thousands of boilermakers, machinists, electricians, moulders, pattern makers, pipe fitters, metal workers and carpenters.

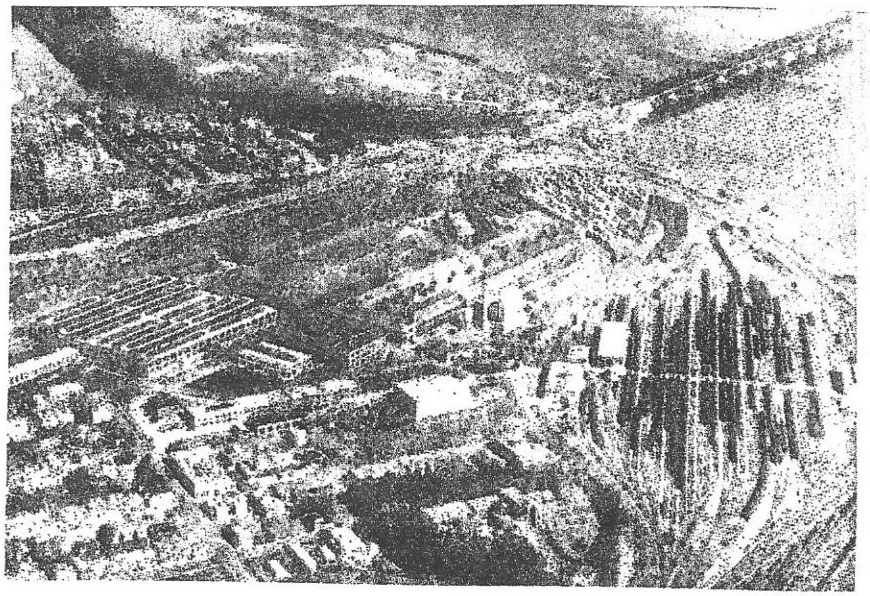
Its machine shop was huge. The railway's main line ran through the plant. Housing for its workers and their families was built nearby.

Its main jobs were the construction, overhaul, repair and re-manufacturing locomotives and rolling stock, including sleeping and passenger cars and a variety of types of box and freight cars. But for much of the steam era, the Grand Trunk could not supply all of its locomotive needs internally and had to buy quite a few from the Canadian Locomotive Company in Kingston and the Montréal Locomotive Company. Nevertheless, during the steam era, PSG built over 700 locomotives, beginning with the *Trevethicks*, one of which pulled the Prince of Wales' car when he came to open the GTR's Victoria Bridge in 1860, and the *Moguls*, which were designed by its long-time superintendent Herbert L. Wallis.

During both World Wars, Point St. Charles - like so many other Canadian manufactories - made ammunition and armaments.

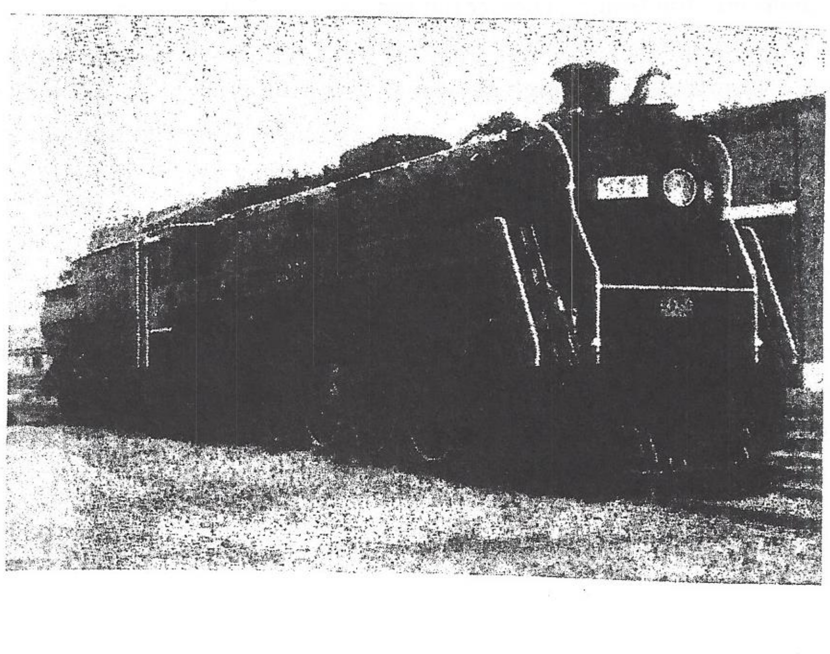
However, by the middle of World War I the Grand Trunk's financial picture was deteriorating and this continued until 1923 when the Dominion Government came to the rescue. The GTR and its subsidiaries became part of the Canadian National Railway Company which, later in the 1920s, modernized the PSG Shops.

Point St. Charles Shops, in 1943; Victoria Bridge upper right; employee housing lower left



By the 1950s, the steam era at CNR was over and conversion to diesels accelerated. Since the diesels were all purchased from outside suppliers, the Point St. Charles work on them was limited to repair and overhaul. The postwar decline in the activities at the PSC Shops was also affected by competition from the postwar trucking industry and from the development of automobiles and highways. However, in 1971 Canadian National and its Air Canada subsidiary formed CANAC Consultants to sell the services of its Point St. Charles and other shops. The last steam locomotive to be overhauled at PSC was the Mountain Class #6060, in 1972-73.

#6060, built for CNR in 1944; overhauled at PSG, 1972-73



In 1993, the Shops became AMF Technotransport. In 1995, CN was privatized and contracted with GEC-Alsthom to manage them. Customers included CNR, VIA Rail, Toronto's GO Transit and several U.S. rail lines. In 1998 the plant became Alstom (spelling change) Transport Limited and was bought by Alstom. But lacking adequate business success, it had closed by 2003.

*

The Canadian Pacific Railway opened its Angus Shops in the Rosemont district of Montréal in 1904, when the two existing shops could not meet its needs, and after spending 10 years accumulating the 50 hectares of real estate needed for them.

The new Shops were named after the first general manager of the CPR, Richard Bladworth Angus. In the 70-odd buildings, the CPR built and repaired locomotives, passenger and freight cars. They included foundries, machine shops, wood mills, dining rooms, a library and a hospital. The buildings were also heated. Some of them were very large, and employed thousands. Their mandate was to maintain CPR rolling stock and to build, when requested, new locomotives and cars. Some 80 kilometers of track were laid. The Angus Shops were among the largest contemporary industrial complexes in North America and became the focus of the 'health' of the CPR's rolling stock in Eastern Canada.

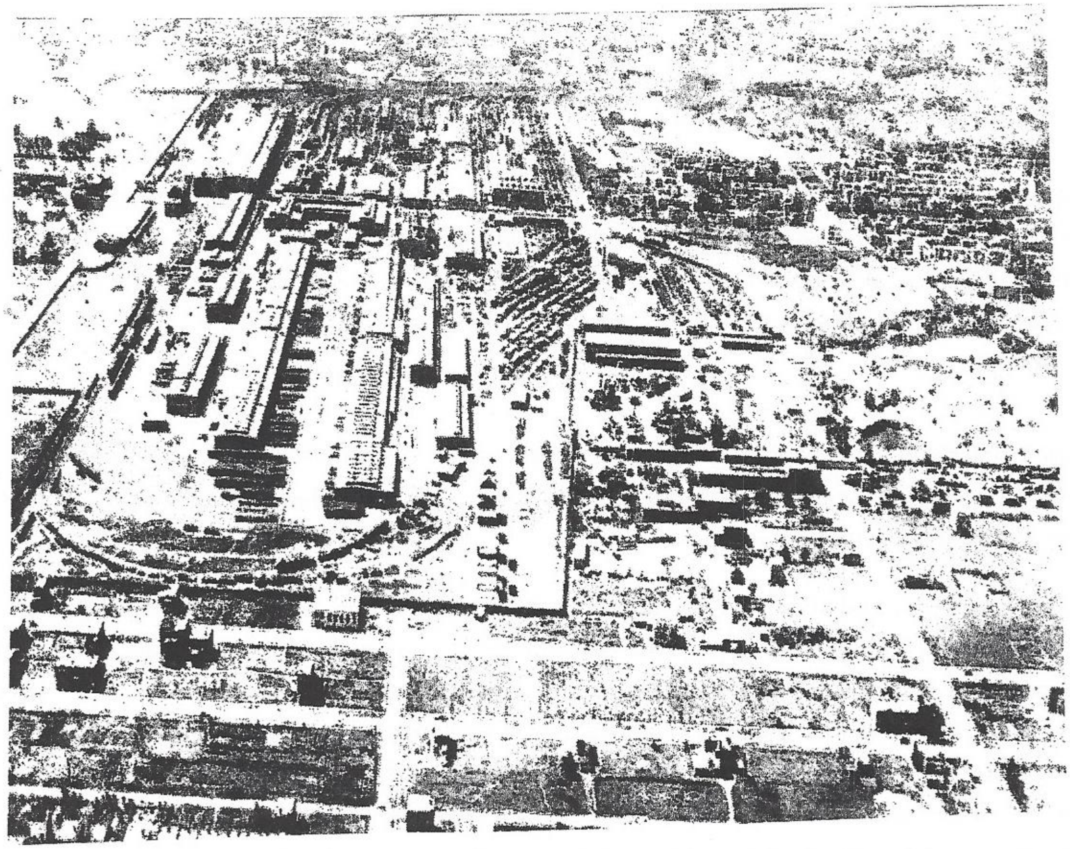
Electrical energy was supplied by the Montréal Light, Heat and Power Company. However, like the GTR and CNR, the CPR purchased many of its new locomotives from other suppliers. And, as happened at Point St. Charles, housing for workers was built nearby. During World War I, the Shops also produced war materiel, and employed some women to do so.

Locomotives belonging to the CPR (and the CNR) were involved in taking the King and Queen across Canada in the summer of 1939. However, they were not built at the Angus (or PSC) Shops.

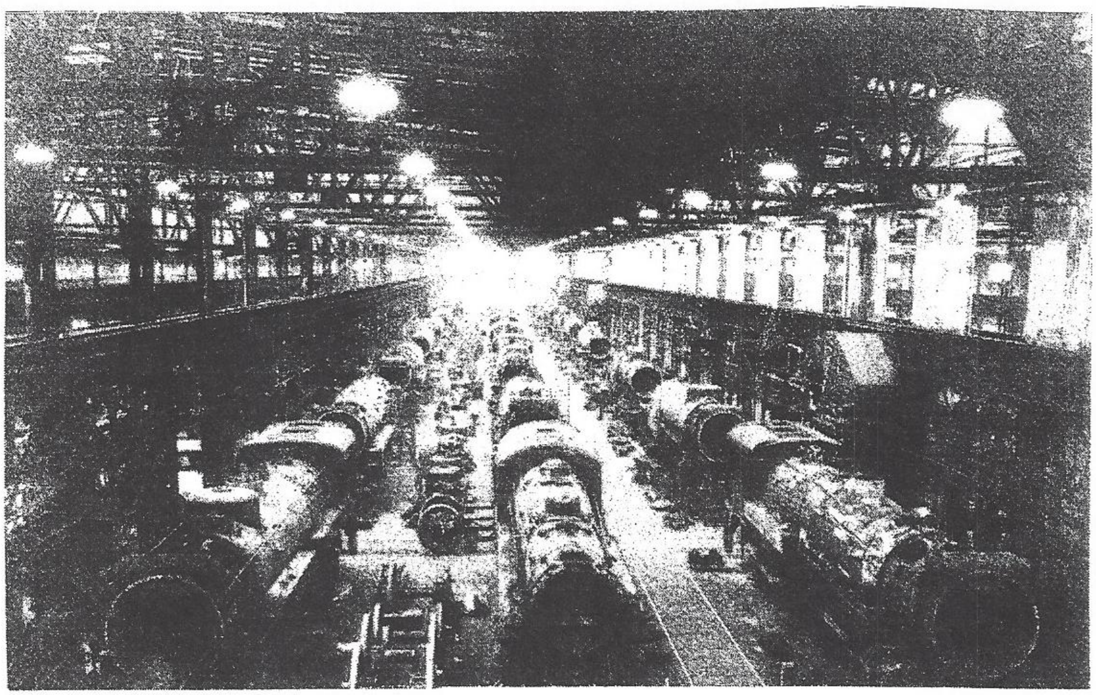
During World War II, the Angus Shops built tanks, corvette engines and other war equipment. Around 12,000 were employed at the Shops.

In the middle-1950s, the Angus Shops employed 8,000 people, covering more than 20 trades and professions. However, by 1980 the diesel 'revolution' was in full swing and they were limited to repair and overhaul work. The selling-off of unused land and buildings for re-development was well under way, led by the City of Montréal.

As had happened at CNR, the arrival of the diesel era killed the production, but not the repair, of steam locomotives at the Angus Shops. The last locomotive was repaired in early 1992, just before the Shops were decommissioned. Now, in 2017, only three of the original buildings are left on the redeveloped site.



The Angus Shops, 1948



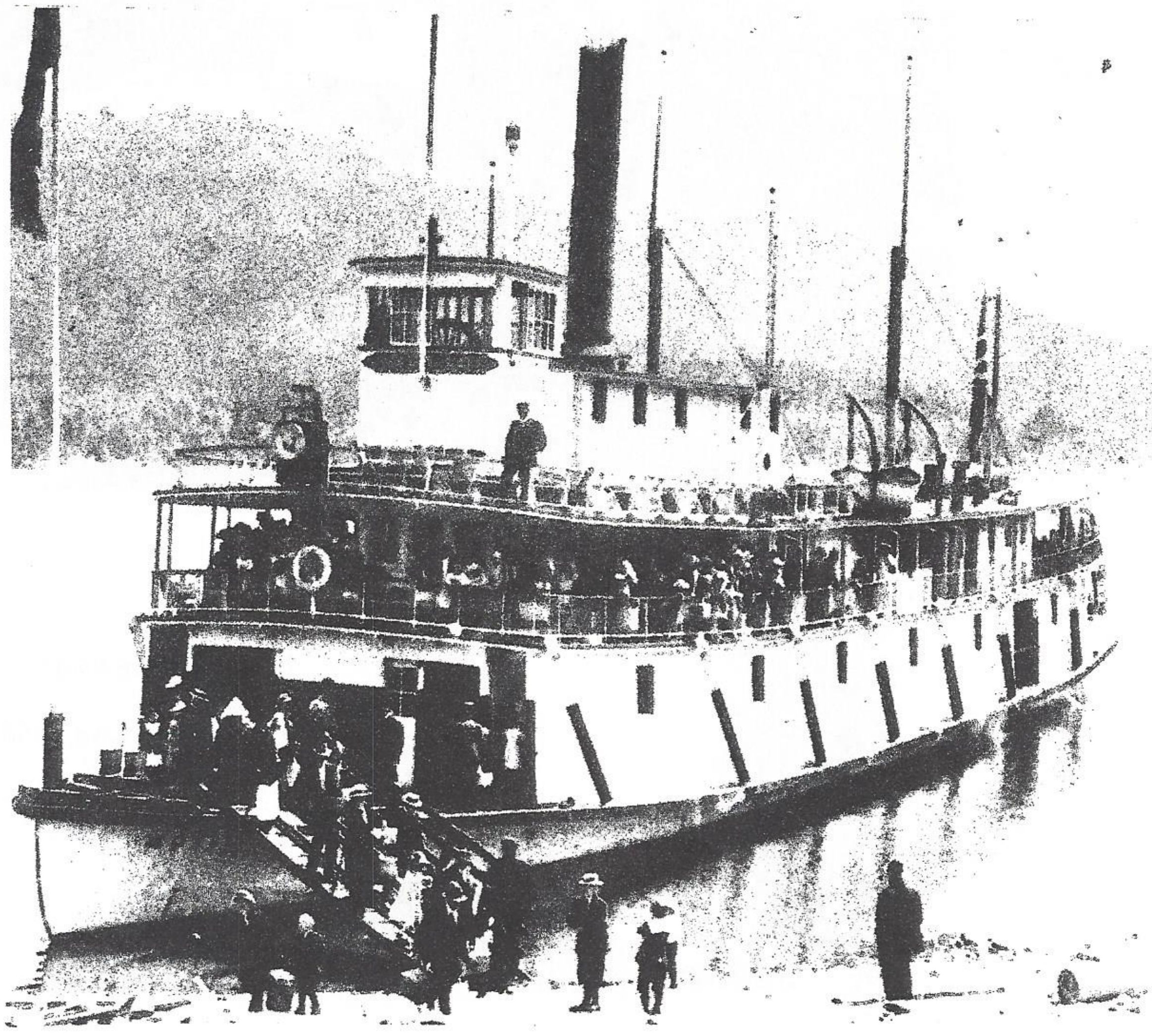
Steam locomotives under construction, 1930

Two steamboats:

Actually sister-steamboats...the hulls and machinery for the CPR sternwheelers *Minto* and the *Moyie* were prefabricated in Toronto and shipped 'in a thousand pieces' to British Columbia by rail. The boats were originally intended for service on the Stikine River, in support of the Klondike Gold Rush, but would have arrived there too late. Both were 160 feet long, with beams of 30 feet, had 835 tons capacity, and could carry hundreds of passengers. Their hulls had steel frames, wooden bottoms and steel side sheets, which were useful in lake ice. They had coal-fired boilers that raised 175 psi of steam, with twin, single-cylinder, horizontal steam engines that generated 17 horsepower. Their crews included two engineers and three firemen.

The *Moyie* was rebuilt and launched at Nelson, B.C., in October 1898 and operated on the all the routes on Kootenay Lake. It could make a speed of 16 knots. It also hauled barges. Around 1915, with increasing competition from the railways, the era of the steamers began to close. However, having a steel hull, the *Moyie* continued to survive with a regular schedule until the very end of the steamboat era in B.C., remaining in service until 1957. Indeed, the vessel has been preserved, donated by the CPR to the village of Kaslo, where it was beached on a concrete berth to become a museum run by the Kootenay Lake Historical Society, and has since been designated by the Historic Sites and Monuments Board of Canada as a 'national historic site.'

SS *Moyie*



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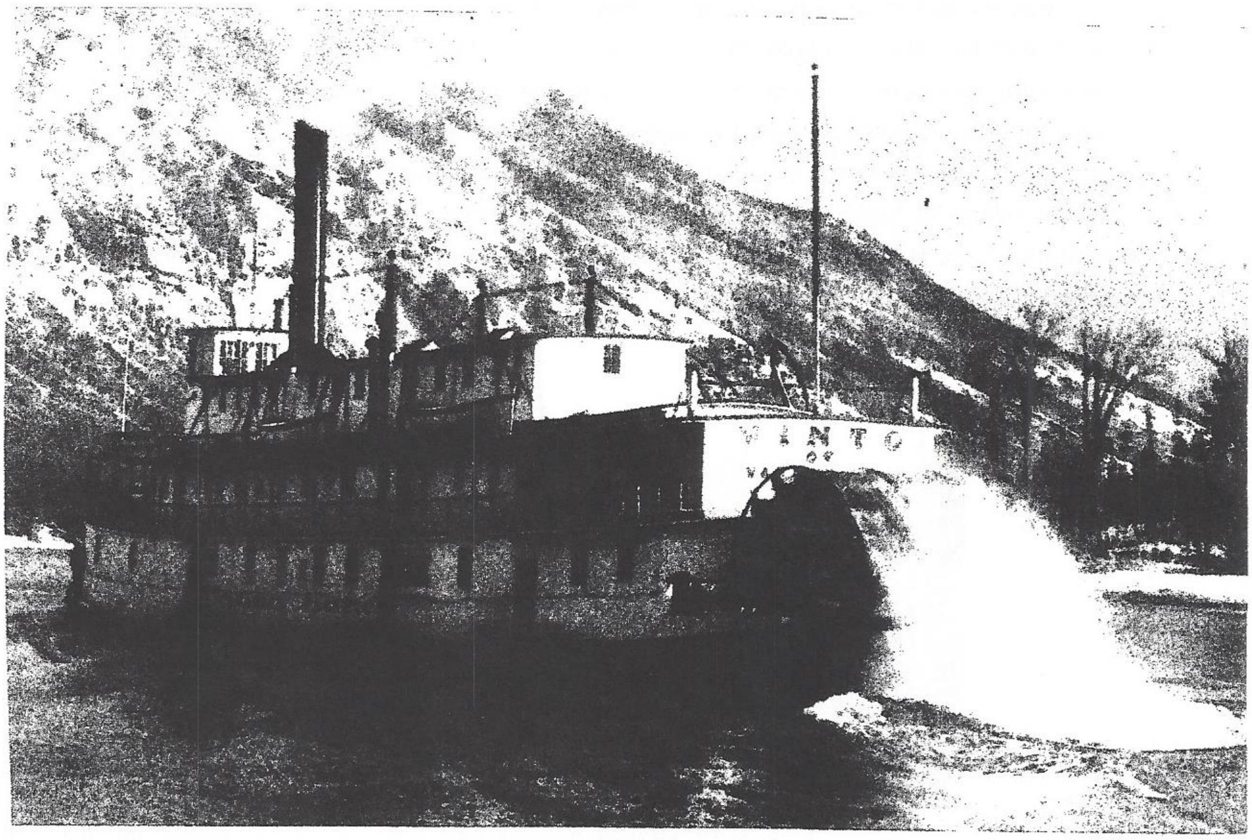
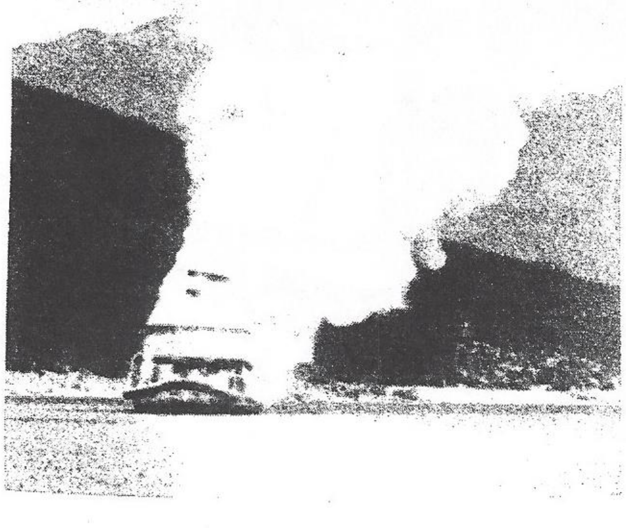
The *Minto* was rebuilt at Bulger's yard at Nakusp by the same crew that built the *Moyie,* was also launched in 1898, but was assigned to the Arrow Lakes, where it replaced the SS *Nakusp,* which had been destroyed by fire. Over the years, the *Minto* travelled over 2 million miles and was the last regular steamship to serve on the Arrow Lakes, being retired in 1954. It was then sold to the town of Nakusp and intended, like its sister, to be a museum. But the town lost interest and sold the boat to a junk yard, who stripped it of its machinery and furnishings. However, a farmer from farther up the lake decided he could save the vessel, bought it, and beached it on his farm. But the job was beyond his means. The farmer also died. His son, not knowing what else to do with the hulk, had it towed out into the lake and set on fire.

SS *Minto*



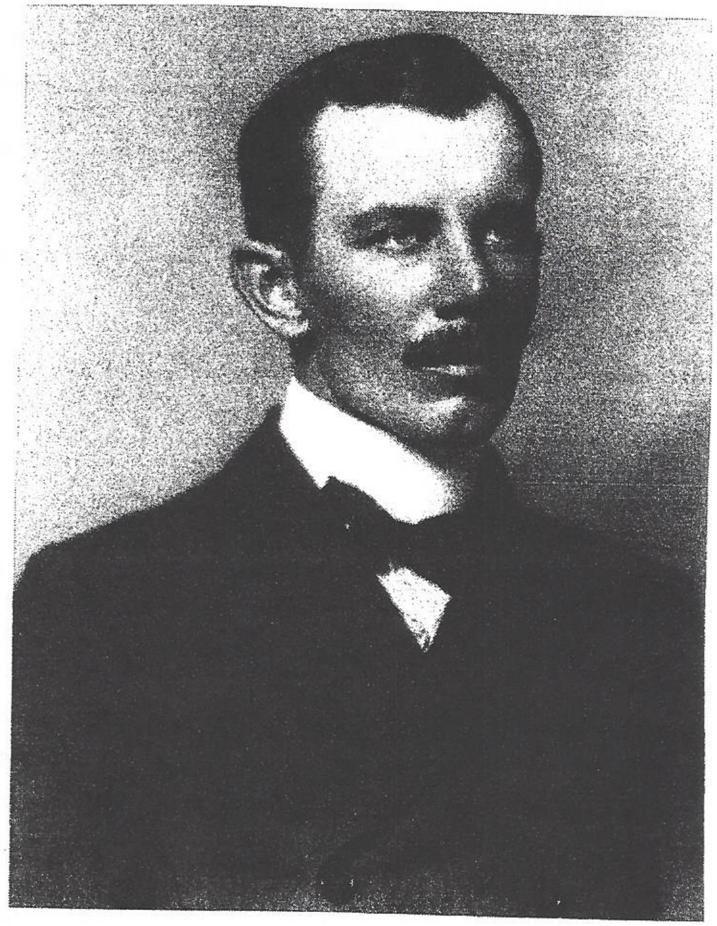


The end of the *Minto,*

Upper Arrow Lake, 1968

Two Canadian Engineers in two unusual situations:

The first concerns the Battle of Omdurman, in the Central Sudan, in 1898. That year, General Kitchener, seeking revenge for the murder of General Gordon, defeated the Mahdi's army in this battle.



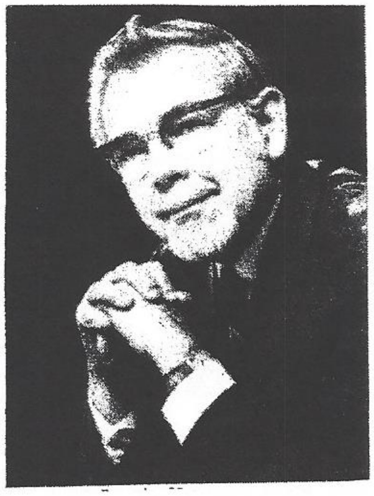
We step back to 1867, to the birth in Canada of Edward Percy Cranwell Girouard. In 1886, Girouard graduated in engineering from the Royal Military College, Kingston. But there was then no Canadian engineering regiment for him to join. So he went to England and joined the Corps of Royal Engineers. Between 1896 and 1898 he was in charge of railways in the Sudan. It has been said that the bypass line Girouard built, that brought Kitchener's troops to Omdurman, was the key factor in the victory. One might go on to say that the battle was really won by a Canadian *engineer*!

Girouard went on to build railways during the Boer War and to serve as Governor of Northern Nigeria (where he built more railways) and of Kenya, and received a knighthood for his services. He died in 1932. Much more recently, he was recognized by the Historic Sites and Monuments Board of Canada as a 'person of national historic significance.'

*

The second concerns Professor Ben Etkin and the aborted Apollo 13 moon landing in April 1970.

Apollo 13 was to have made NASA's third moon landing, but on the way there disaster struck. An explosion crippled the service module and effectively disabled the spacecraft. Most systems had to be shut down. The problem then was: how to get the crew safely back to earth. Grumman Aerospace, the lunar module contractor, asked a team at the University of Toronto's Institute for Aerospace Studies (UTIAS) for a solution, which involved separating the lunar and command modules. The team had only a few hours to develop its solution and had only their engineering experience...and slide rules...to help them with their calculations.



The team was led by Professor Bernard Etkin. Ben was born in Toronto in 1918, completed his degree in engineering physics at the University of Toronto in 1941, and later earned a doctorate. He became a specialist in aerodynamics and joined the UofT's Institute of Aerospace Studies when it was formed in 1949. He eventually served the University as dean of engineering.

For the record, the other team members were Rod Tennyson, Irvine Glass, Barry French, Philip Sullivan and Peter Hughes.

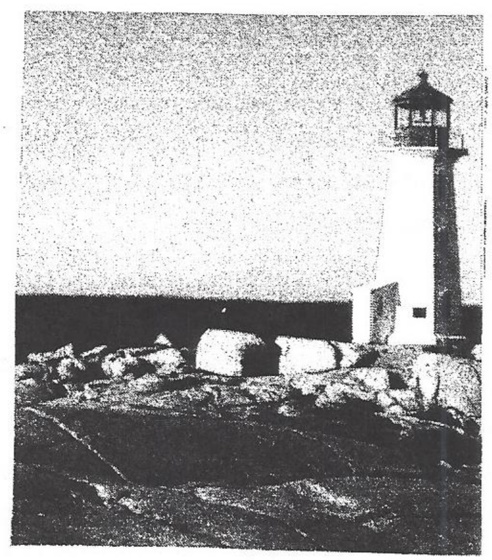
Canadian *engineers* really won the Battle of Apollo 13!

Ben Etkin died in 2014 at the age of 96.

Two Lighthouses:

Many Canadian lighthouses were built of wood, as was the first one to appear on barren rock at Peggy's Point, next to the fishing community at Peggy's Cove, on the eastern side of St. Margaret's Bay, some 30 miles from Halifax, on the south shore of Nova Scotia. The Cove was likely named after the wife of William Rogers, an Irish immigrant, in the late 18^{th} century.

This first lighthouse, one of many historic provincial ones, was essentially a tower with a light that sat on the top of the keeper's quarters. It was equipped with a kerosene lantern and a silver-plated reflector.



The second lighthouse, built 50 feet from the original lighthouse, was first lit in 1915. Octagonal in shape, it was built of reinforced concrete rather than wood, is 50 feet tall and 67 feet above the water. A fourth order dioptric Fresnel lens was installed. Its range is 10 nautical miles. Automated in 1958, with an electric light since 1999, the light has been red for most of its active life. It was declared surplus by the Canadian Coast Guard in 2010, but is still operating.

The first lighthouse building was destroyed by Hurricane Edna in 1954.

*

In 1860, the Prince of Wales (later Edward VII), opened the Victoria Bridge across the St. Lawrence at Montréal, substituting for his mother, Queen Victoria. On his way in to Montréal up the St. Lawrence River, opposite the mouth of the Saguenay River, his ship ran aground on a shoal in mid-stream, which was named after him: the Prince Shoal.

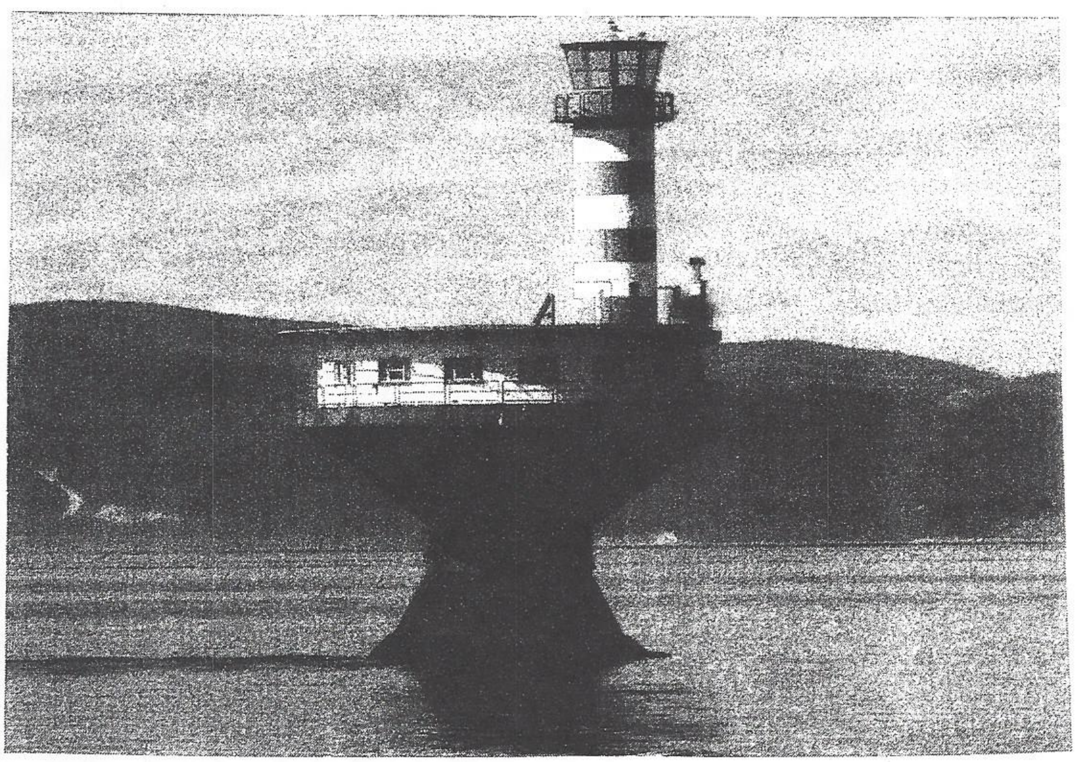
At first, a buoy marked this dangerous spot. But in 1905 it became a lightship station. Another lightship arrived on station in 1956 and, in 1963, this was replaced by the present caisson-based, hour-glass-shaped lighthouse.

Built at the Champlain Dock at Lévis, 105 miles upstream from the shoal, four tugboats pulled the structure down-river to its destination. When the tide was right, the caisson valves were opened and the structure was allowed to sink on to a specially-built foundation on the riverbed. Crushed rock was then fed into the caisson, replacing the water. Concrete was then poured in on top of the rock, and sheet piling added around the caisson for added protection.

The upper circular section was then added, housing the equipment rooms and living quarters. Finally, a 39-foot high, 12-foot diameter, tower and a helipad were added.

The slope of the lower cone helps break up spring ice. The slope of the upper one helps disperse the energy of the waves striking the structure, which was designed to withstand the 25-foot variety.

The lighthouse can be accessed from the helipad or through doors in the narrow part of the structure. It is also a tourist attraction.



Two 'Royal' Occasions:

In 1937, the King's representative in Canada was the Scottish-born Governor General, Lord Tweedsmuir, better known as the historian, biographer and author of 'shockers', John Buchan. Tweedsmuir served in Canada from 1935 until his death in 1940. Trained as a lawyer, he served as an administrator in South Africa after the Boer War, as a publisher and as a Member of Parliament, as well as being an author, which to him was a hobby rather than a job.

Back in the earlier days of the Canadian Society of Civil Engineers, and the Engineering Institute of Canada that it became, Governors General were often elected to honorary membership in the Society and the Institute. Tweedsmuir was elected in 1936. At the EIC's semicentennial banquet in Montréal the following year, he was the main speaker. Among his remarks were these:

> Some time ago you honoured me by making me an honorary member of the Institute, a distinction of which I am very proud, for having no knowledge of engineering to justify it. I have had a good many professions in my life, and at different times I have had inclinations to many more. But I cannot ever remember wishing to be an engineer. I always felt that your world was a world quite beyond me. I admired it profoundly, but I admired it from afar...
>
> Your profession, gentlemen, has always been the foundation of any civilized society...
>
> But, gentlemen, I think your work has only begun...

That was said over 80 years ago. It may still be true.

But thinking of Tweedsmuir's main message, why did he - as 'shocker' author Buchan - make Richard Hannay, a South African *mining* engineer, his hero in at least four of his early novels? The plots had nothing to do with engineering!

*

Buchan in his library

at *Elsfield,* England

In June 1953, the president of the Engineering Institute of Canada, Ross L. Dobbin, was invited to attend the Coronation of Queen Elizabeth II and to sit in Westminster Abbey during the ceremony. He also attended a Trooping of the Colour, a Royal Tournament and a Queen's Garden Party. All of this was combined with meetings with the officers of the British engineering institutions.

I rather doubt if the EIC's president will be invited to the next coronation!

During his year, Dobbin's travels took him an estimated 35,000 miles throughout Canada and abroad. His address on retiring as president included the following, which illustrates what an early post-war EIC president had to do during his year in office. He said, in part:

> I have spent my time travelling through Canada from coast to coast and even to the Arctic Circle, by air, rail, motor, steamship and even by dogsled. Of all the visits I made, the highlight was the trip to England to represent the Institute at the Coronation of Her Majesty, Queen Elizabeth. My reception by the engineers of England was indeed a wonderful experience...
>
> It would scarcely be fair, however, to give you the impression that (it) has been all work...
>
> The people I visited (in Canada) belonged to every branch of the Institute and to many unofficial groups as well...
>
> My travels have impressed me with the size of our country, and even more with the problems such size has created for us. Our Institute is a widespread society, and close cohesion is necessary to promote the strength it needs.

Ross Dobbin on his way to the Coronation, In 1953


DIEU ET MON DROIT

CORONATION OF HER MAJESTY
QUEEN ELIZABETH II

By Command of The Queen

the Earl Marshal is directed to invite

Mr. Ross L. Dobbin

to be present at the Abbey Church of
Westminster on the 2nd day of June 1953

Norfolk.

Earl Marshal

Reproduction of the president's invitation to the Coronation. The original has been framed and will be hung in the Headquarters Building.

The invitation to the Coronation

One of the matters to which Ross Dobbin gave his attention while on his visit to England was to press for acceptance by the Duke of Edinburgh of honorary membership in the Institute, which he received at Rideau Hall in July 1954.

Two men, neither of whom was an engineer, but who were influential in the development of engineering in Canada:

One of them, Omond Solandt, was trained as a medical doctor. He was born in Winnipeg in 1909, a son of the manse. When he was 11, his family moved to Toronto. He finished his high school education at Jarvis Collegiate, where he played football. He also qualified as a radio operator. His undergraduate studies were in biology, and again he played football. He graduated in 1931 with a gold medal and, before entering medical school, went on to an MA degree in physiology in the Banting and Best laboratory. There, he learned to do research. But before he got to medical school, he also contracted polio, from which, fortunately, he made a satisfactory recovery some months later. In 1935, before taking his medical degree, and another gold medal, he attended his first international conference...on physiology, in Russia. In 1936 he went to London, England, to do graduate work in cardiology, returning to Toronto to complete his internship. He then went back to England, to study for membership in the Royal College of Physicians and to earn an MA degree from Cambridge in pathology.

During his time at Cambridge, Solandt had become interested in blood transfusion. So in May 1940, around the time of Dunkirk, he was asked by the Medical Research Council to organize the blood supply for the London District, serving there through the Battle of Britain. In 1941 he was transferred to the Armoured Fighting Vehicle School in Dorset to study physiological problems suffered by tank gunners, and learned a great deal about the engineering of fighting vehicles. This led to his involvement in the new discipline of operations research in 1942, in a senior position. By 1944, Solandt was superintendent of the Army Operational Research Group. By War's end, he was also a senior officer in the Canadian Army, had served on Lord Louis Mountbatten's staff in the Far East, and had been chosen to join the Allied delegation sent to Japan to assess the effects of the atomic bombs.

He returned to Canada in the fall of 1945, but not to medical practice. He was appointed director-general of Defence Research in Ottawa and went on to establish the Defence Research Board, to be its first head, serving all three Services, with rank equal to the Service chiefs. He served from 1947 until 1956, at the end of which he received the PIPS gold medal for his contributions.

He then chose to leave government and was appointed vice-president R&D of Canadian National Railways, with the task of applying his varied experience to improving CN's operations. His approach was holistic and associated engineering problems with human ones. In 1963, he left CN and joined the de

Colonel

Solandt

Council Chairman Solandt

Havilland and Hawker Siddeley Companies in Toronto, again as vice-president R&D. Between 1966 and 1970 he was vice-chairman of ERCO Chemicals Limited. But by 1966, he had two additional jobs: as Chancellor of the University of Toronto and as the founding chairman of the Science Council of Canada, a position he held until 1972. For several years after 1971, he was a director of Mitchell Plummer, a venture capital company that invested in new engineering-related companies.

In the years between his Science Council days and his death in 1993, he served many public and private organizations in a variety of capacities and was awarded many honours. Let me just mention a few: chairman of the Ontario Government Inquiry into Transmission Line Routes; vice-chairman of the International Centre for Research into Dry Areas; and senior advisor to the Inquiry into the *Ocean Ranger* Disaster. He was elected an honorary member of the Engineering Institute of Canada and, unusually, served as treasurer of it for a year.

*

The other, Wilfrid Bennett Lewis, affectionately known as 'Ben' or 'Benny,' was born in Cumberland, England, in 1908, into a family of engineers. He was an undergraduate and graduate student in physics at the University of Cambridge, at the Cavendish Laboratories, receiving his doctorate in 1934. He remained at the Cavendish until 1939, working under Lord Rutherford, in part in electronics and in part on experimental nuclear research.

During World War II, Lewis was loaned to the Air Ministry to work on the development of radar, ending as chief superintendent of the Telecommunications Research Establishment at Malvern. In 1946, on the recommendation of his predecessor and Cavendish colleague, Sir John Cockroft, he was appointed director of what was then the NRC's Division of Atomic Energy Research at the new laboratories at Chalk River. He became vice-president, Research and Development when AECL was formed in 1953 and, ten years later, was named senior vice-president, Science. He was the *de facto* leader of the engineering side of the Canadian nuclear reactor program, and of the CANDU reactor in collaboration with Ontario Hydro. But he also promoted the economic application of nuclear energy and had responsibility for basic research in physics, chemistry and biology. Lewis retired to Queen's University as a distinguished professor in 1973.

W. Bennett Lewis

Lewis also received many awards during his lifetime and, like Solandt, was elected an honorary member of the Engineering Institute of Canada in recognition of his contributions to Canadian engineering. He died in 1987.

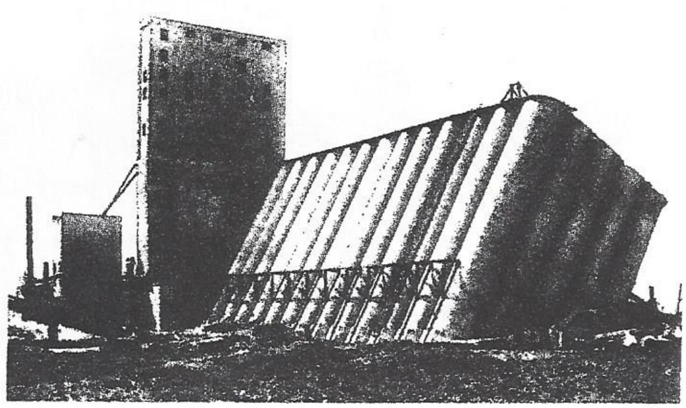
Two engineering failures:

Discussion of major *Canadian* engineering failures usually hinges around the two that occurred during the construction of the Québec Bridge early in the 20th century. They have been well remembered. So let us move on to two others.

The first concerns Transcona, Manitoba, east of Winnipeg and nowadays part of that city. Established as a town in 1912, a year later the Grand Trunk Pacific Railway opened a workshop there, and the Canadian Pacific Railway built a very large concrete grain elevator. Prior calculations and tests appeared to show that the elevator's bin house, on its reinforced concrete raft foundation, was safe when fully loaded. However, the disaster occurred during loading in October 1913, a month after it opened, when the bin house slowly began to settle and came to rest 24 hours later at a 27 degree angle to the vertical. The main sinkage was on the western side. A line of boulders under the structure limited the tilt on the east side. Basic errors in soil strength calculations and tests were to blame.

Fortunately, there was no damage to the bin structure and the attempt was made immediately to right it. Over a three-week period, the grain was removed from the bin house and the structure was slowly righted in three stages using systems of jacks. It was levelled out at 14 feet below grade on a newly excavated foundation. The Foundation Company of Montréal was responsible for the remedial work.

This failure and its remedials, over 100 years ago, helped advance the theory of soil mechanics and foundation engineering, world-wide. The elevator is still in operation.



Transcona grain elevator failure

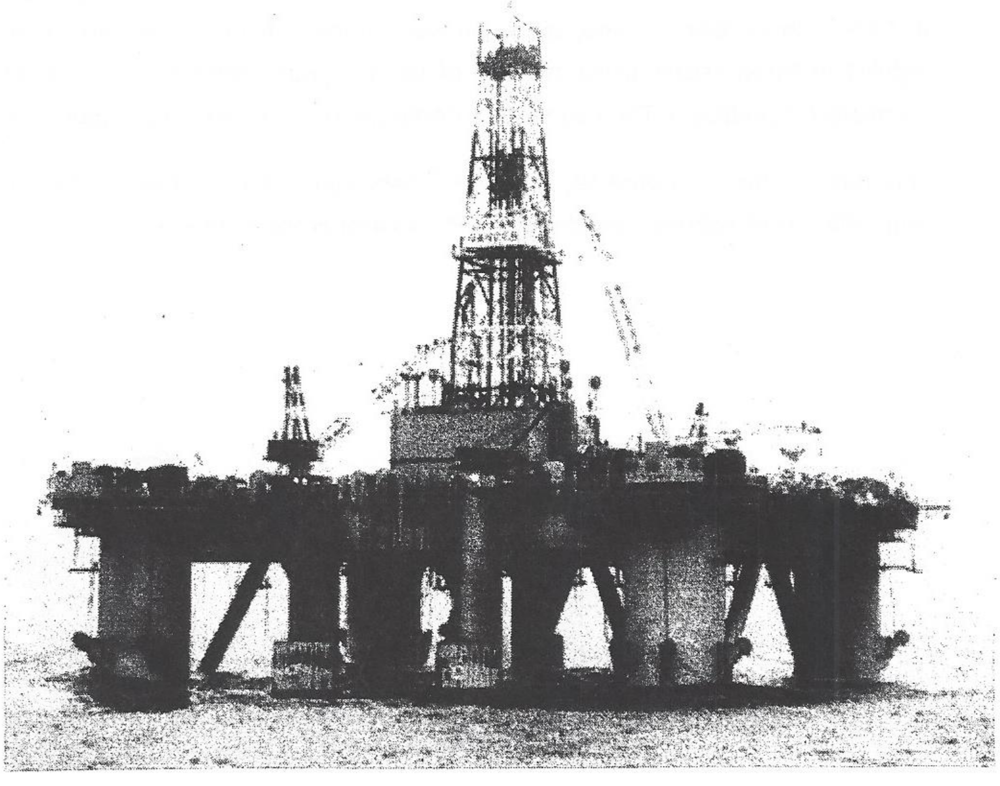
The second failure, of the oil rig *Ocean Ranger,* occurred in 1982, this time with considerable loss of life.

The vessel was a very large, self-propelled, semi-submersible offshore drilling rig designed, built and owned by ODECO, of New Orleans, and launched in 1976. In February 1982 it was under contract to Mobil Oil Canada Ltd. and was working in the Hibernia Field, less than 200 miles east of Newfoundland. On Sunday, 14 February, the *Ocean Ranger* became involved in a strong winter storm with 90 mph winds and 40-foot waves. At 7 pm it had stopped drilling. Around 9 pm damage was done by the storm to a window of the ballast control room. But by 1 am on 15 February the rig was reported as listing and shortly after that sent out 'Mayday' calls. At 1.30 am, nearby rigs began searching for survivors, but were hampered by the storm. Reported still afloat, but crewless, at 2.45 am, the vessel finally capsized and sank. All 84 on board were lost.

In March 1982 a federal-provincial Royal Commission was set up to investigate the sinking of the *Ocean Ranger.* It undertook studies and experiments and reported two years later. Several design flaws were identified, including some associated with the damaged window. Nor did the crew fully understand what to do when the ballast control system failed. Lifesaving equipment was inadequate, and training lacking. Essentially, the design was more suited to the Gulf of Mexico than to the North Atlantic.

On the positive side, these shortcomings were corrected in later platforms.

The *Ocean Ranger*



Two pieces of canal equipment:

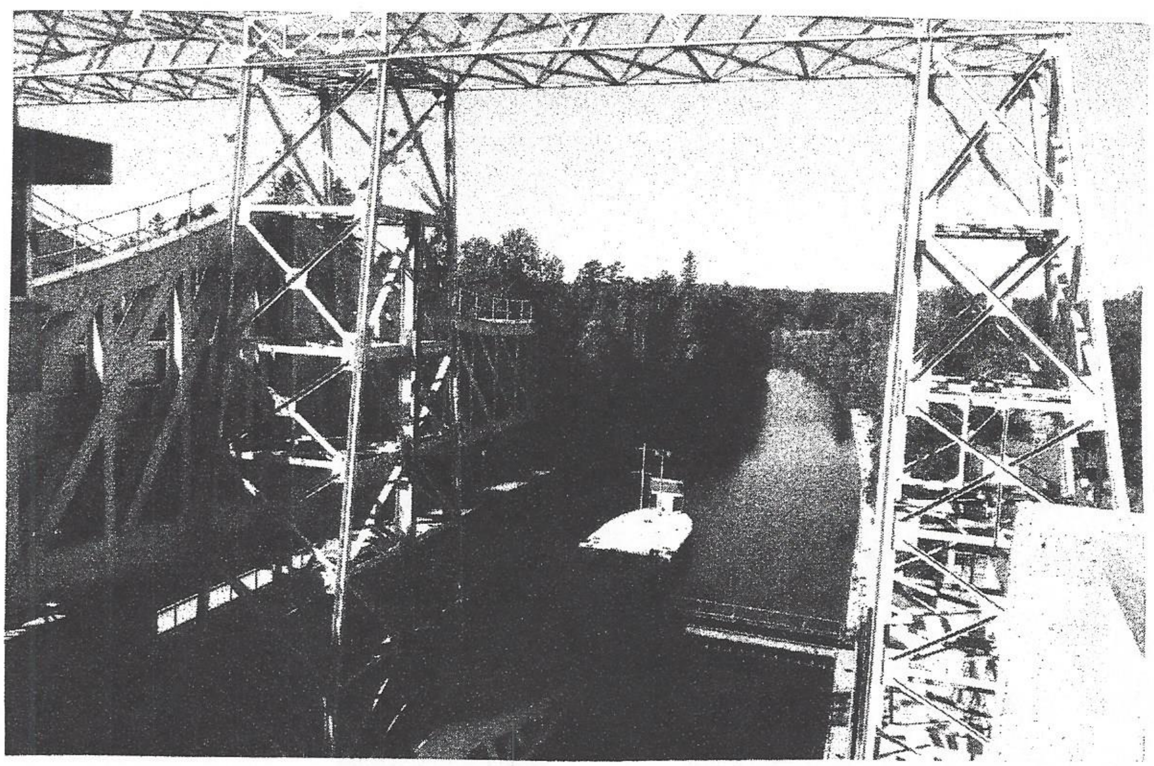
The first is a lift lock...

There are very few lift locks in the world, and two of them are in Canada. One, the better known and visited, is at Peterborough, Ontario, on the Trent-Severn Waterway. The other, less well known or visited, is farther north, in the Kawarthas at Kirkfield, on the same Waterway. Both were designed by Richard B. Rogers.

Kirkfield is Lock 36 in the Trent-Severn system. It is situated at the highest point of the Waterway and is an important link between Lakes Balsam and Simcoe. Built between 1900 and 1907, the lifting part of the structure was made of steel (in contrast with Peterborough's reinforced concrete) and installed by the Dominion Bridge Company. The two movable caissons are 140 feet long, 33 feet wide and eight feet deep, and are moved up and down by a hydraulic ram, the lift being 49 feet.

Since 1932 and the opening of the competing Welland Ship Canal, the Trent-Severn Waterway has been limited to pleasure craft.

Kirkfield was extensively renovated in the 1960s and its controls were electrified and automated.



The Kirkfield Lift Lock

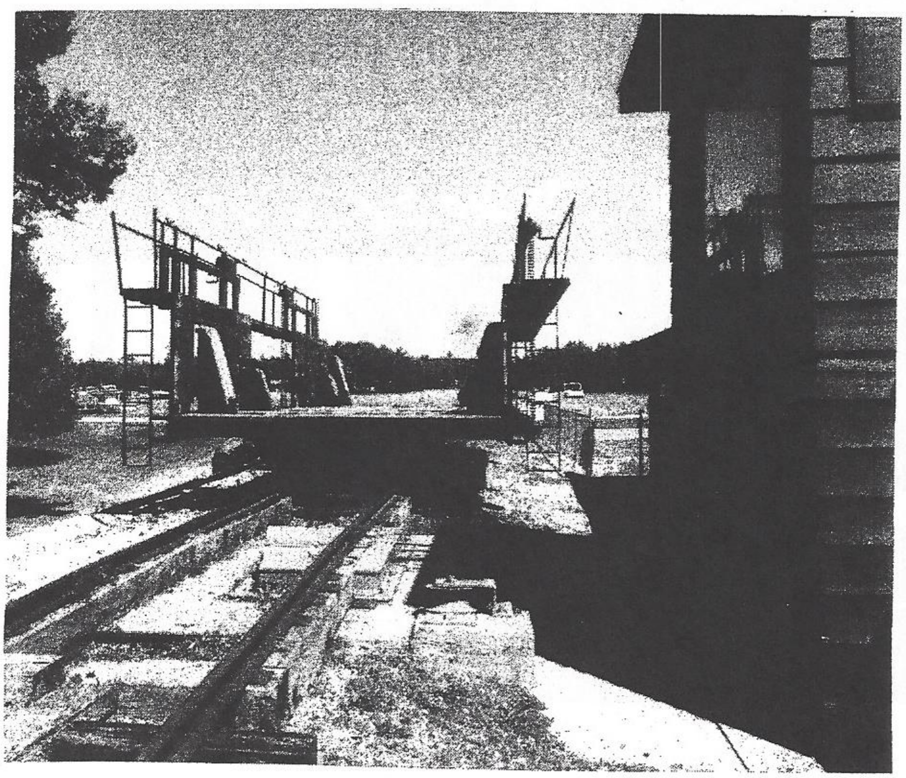
The second is a marine railway...

Again, there are only a few in operation around the world. The only current Canadian one was installed originally at Big Chute as a stopgap for a series of locks between two levels of the River Severn, not many miles from the western entrance to the Waterway at Port Severn. It is known now as Lock 44.

In spite of plans to the contrary, no locks were built at Big Chute. Plans made during World War I were shelved due to a shortage of materials and the first railway was built instead, in 1917. The car was 24 feet long and six feet wide and could take a 35-foot boat that weighed less than 5 tons

In 1921, plans were made to replace the railway with locks but, in 1923, a second railway and car were installed. A portage up or down could take a half-hour. By the end of the 1960s, *this* car could no longer keep up with the summer traffic, and the substitution of locks was again suggested. However, by this time the migration of sea lamphreys from Lake Huron to Lake Couchiching had to be prevented, and the locks were abandoned in favour of an even larger railway car and tracks. These had been installed by 1978. The 1923 railway remained in use as a back-up until 2003, and has since been preserved near the present one.

The platform of the 1978 railway remains horizontal during traverse, and is maintained this way by varying the profile of the track. The boats are kept in position by a series of slings. In 2017, on any Saturday during the height of summer, the Big Chute railway carried as many as 180 boats a day.

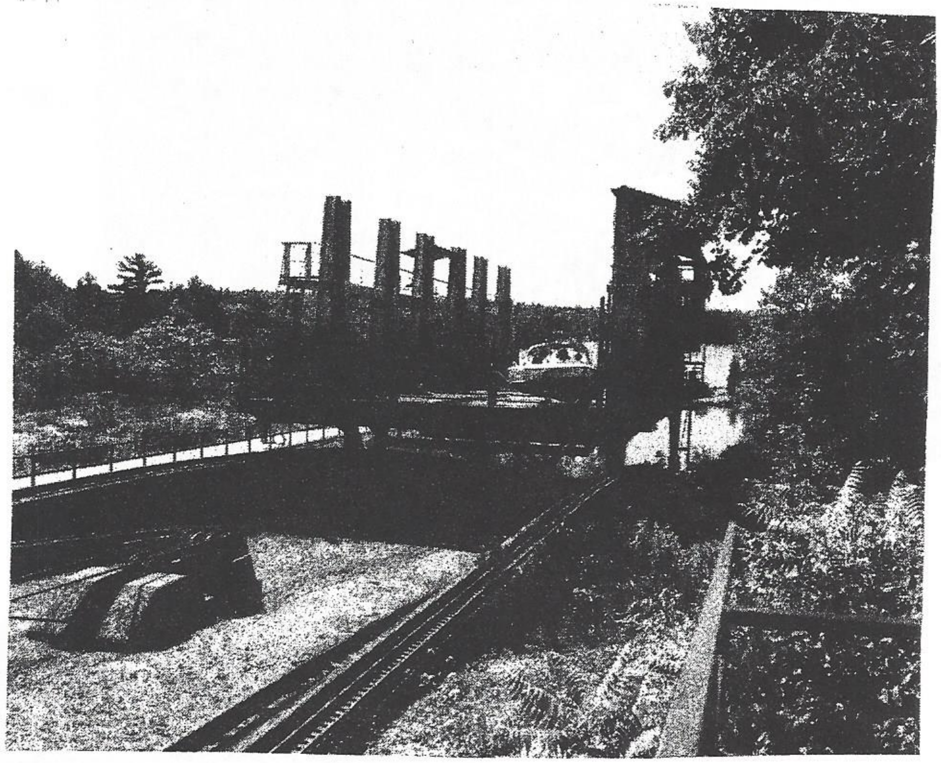


The 1923

railway and car

The present

railway and car



Two Centennials:

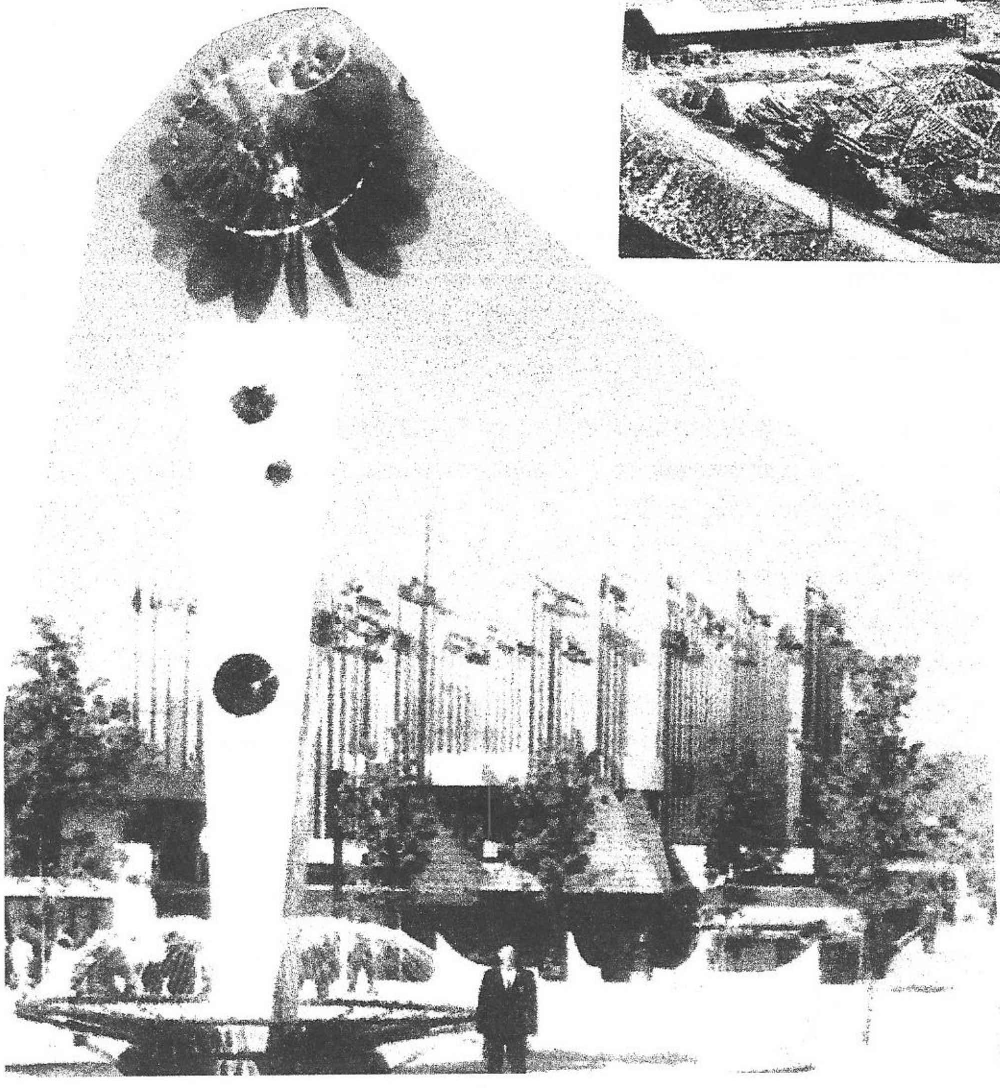
The first was Canada's, in 1967. The principal memory people have of that year was EXPO 67 at Montréal. But it was also the year that the Laviolette Bridge over the St. Lawrence at Trois-Rivières was opened, as was the Lafontaine Tunnel under the St. Lawrence at Montréal; that the National Arts Centre opened in Ottawa; and that GCOS began commercial production at the Alberta oil sands. It was the year the Confederation (Museum) Train toured the country. The Montréal Métro was opened in time for EXPO. And it was the year the Order of Canada was instituted.

EXPO 67 was, of course, a spectacular engineered marvel, built on islands in the St. Lawrence, the theme of which was *Man and His World.* The engineering team of Robert F. Shaw and Edward Churchill, who had earlier built the *Diefenbunker* at Carp, near Ottawa, built EXPO 67.

There were 90 pavillions, such as the American's Buckminster Fuller geodesic dome, the Russian pavilion, Canada's *Kitimavik* structures and, on the north shore, Moshe Safdie's *Habitat 67* housing complex. It also had an *Engineers' Plaza,* on which stood a metal sculpture by Gerald Gladstone that represented the different kinds of engineering, and had been subscribed by the engineering profession across Canada. This Plaza was opened by an engineer then serving in the federal Cabinet, Robert Winters.

EXPO 67

...under construction



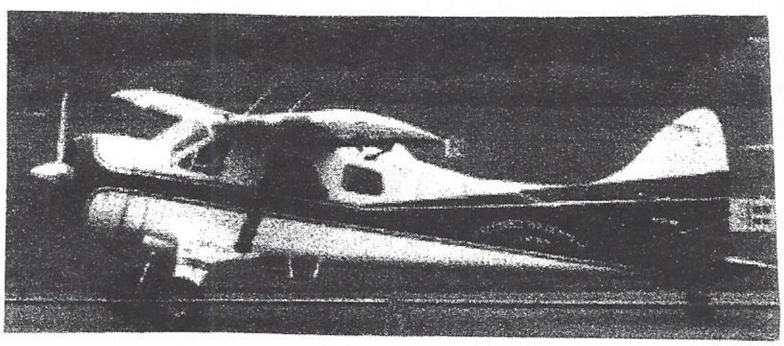
The Engineers' Plaza

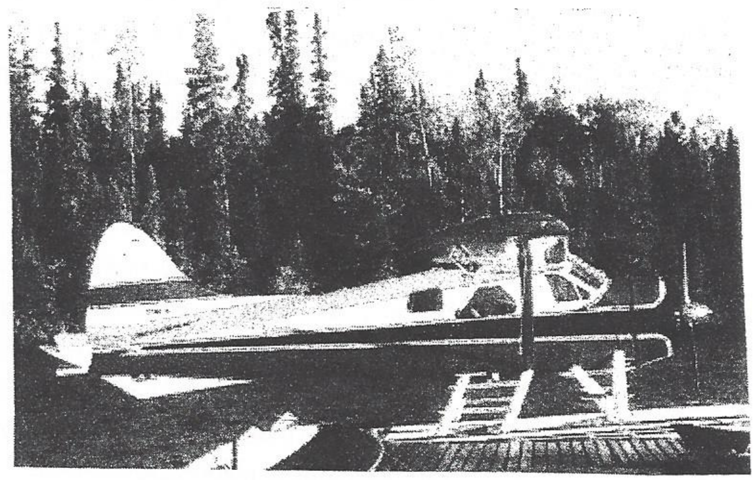
*

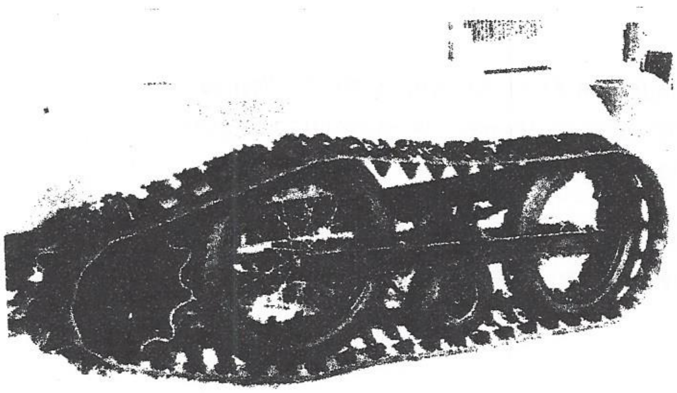
The second was the celebration of the Centennial of Engineering as a Profession in Canada, linked to the establishment in 1887 of the Canadian Society of Civil Engineers which, in 1918, became the Engineering Institute of Canada. The principal celebrants were the three Canadian federations: the Institute, the Canadian Council of Professional Engineers and the Association of Consulting Engineers of Canada. It was also the year that the Canadian Academy of Engineering was founded.

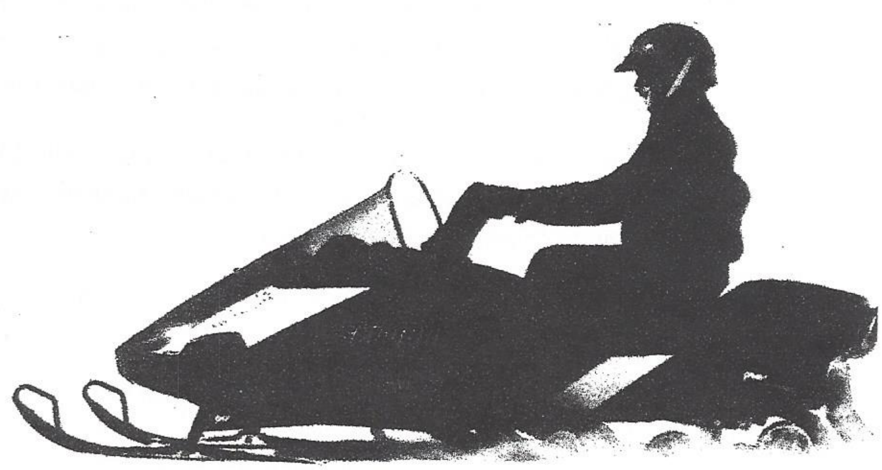
Individual celebrations were held by the federations and their branches and sections and by other elements of the profession across the country. An international conference that attracted thousands of engineers from around the world was held in Montréal. The profession also caused a commemorative postage stamp to be issued. An account of engineering in Canada from 1887 to 1987, *Mind, Heart and Vision,* was written by Norman Ball. And a committee chose ten best examples of Canadian engineering over the past century. The list included: the CPR line to the West Coast; the St. Lawrence Seaway; the *Alouette I* satellite; the Trans-Canada microwave network; the Québec 735 KV transmission line; the Polymer petrochemical plant at Sarnia; the *CANDU* nuclear reactor; the Syncrude oil sands plant; the de Havilland *Beaver* aircraft; and the Bombardier *Skidoo.*

These are photographs of the float and land versions of the de Havilland DHC-2 *Beaver* airplane, and the Bombardier *Skidoo* and its sprocket wheel and track drive system (invented in 1935)...









Two projects in support of basic research:

First, above the earth...

George Klein, the talented son of an expert watchmaker, spent his professional career at the National Research Council in Ottawa, researching and developing many things, from skis for aircraft, to electric wheelchairs, surgical sutures, nuclear reactors, and gearing systems...to the antennae that were parts of Canada's first spacecraft, the *Alouette I* satellite.

In the early 1960s, the *Alouette* was being designed as a 'topside sounder' - an instrument that would yield information on the properties of the top of the ionosphere, which could be used to improve radio communications across Canada, and especially in the North.

The problem was that *Alouette* needed antennae that were long enough to send signals and data from space to earth, yet were robust enough to withstand the pressures of blast-off. The solution was found in a remembered George Klein invention of ten years earlier. It was quickly patented and licenced to de Havilland Aircraft of Canada, where a team of engineers took the basic invention into a production model for the *Alouette* and laid the foundations for the expansion of its application.

This was the STEM antenna, which stands for 'storable, tubular, extendible member.'

Essentially, this antenna is a long piece of thin metal strip several inches wide that can be rolled up into a small cylindrical space (for take-off) and rolled out many feet in tubular form, by centrifugal forces generated by the rotating satellite (for use in space). The trick was to design the mechanism that made the transition and the roll-out. As it happened, George smoked roll-your-own cigarettes and was doing so when returning by boat from a business trip to Europe. As biographer Richard Bourgeois-Doyle notes in his book on George:

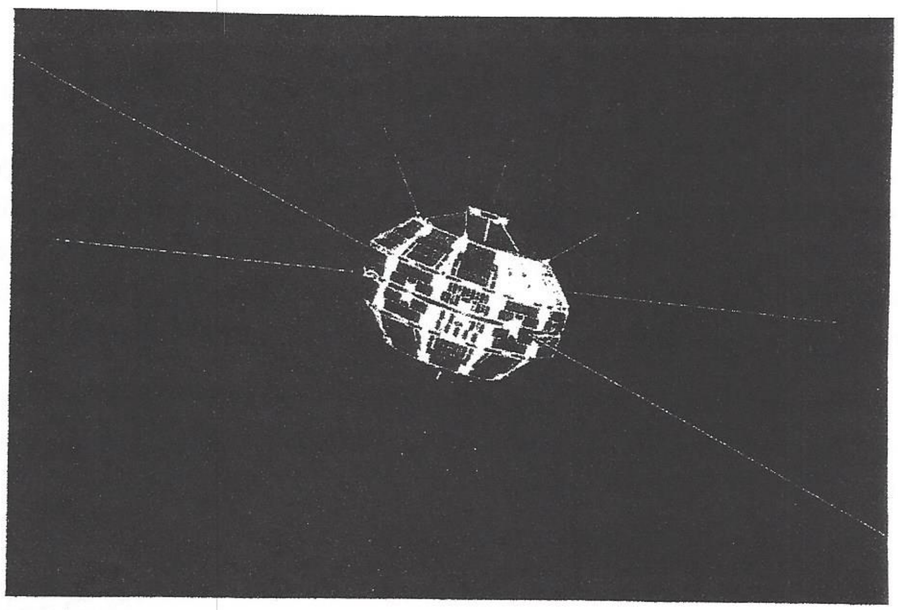
> Klein saw the solution to one set of problems in his cigarette. After he put it to his lips, lit it and smoked, he took out another paper and rolled it back and forth (in the machine), this time with no tobacco. As he did, he noticed two phenomena. First, the rolled-up paper had more tensile strength than a piece of unrolled paper. Second, once rolled into a tube, the paper could be extended out considerably.

The potential device, however, also needed a system of springs and gears to control the furling (and unfurling) of a rolled-up strip of metal into a stiff, straight tube. George applied his knowledge of gears to the problem. The result was a prototype of what became the STEM antenna.

The *Alouette I* satellite was launched in 1962. It generated information from space for 10 years and was succeeded by other research satellites which, together, helped lay the foundations for today's world-wide satellite communications systems.

George Klein with a prototype STEM antenna

The *Alouette I* satellite carried two 22.5 metre and two 11 metre STEMs, plus four more much shorter telemetry antennae



Now going underground...

The recipient of the most recent Nobel Prize in Physics awarded to a Canadian (in 2015) was Dr. Arthur McDonald of Queen's University, for his work in connection with the Sudbury Neutrino Observatory (SNO). The ground-breaking observatory's design and the subsequent research done at it was, in practice, the work of an international team, internationally funded, led by Dr. McDonald. The idea for the SNO was first promoted in the early 1980s as a rare, very large Canadian, collaborative pure science project to detect and study the behaviour of fusion-reaction neutrinos arriving at the earth from the sun into an environment with extremely low background radiation. The initial 'product champions' were Dr. George Ewan of Queen's University and Dr. Herb Chen of the United States. The host, INCO, and people living in the Sudbury area were also involved, as were government agencies in Canada, such as AECL and NSERC.

Although physics and physicists massively dominated SNO's public spotlight, engineers, miners and Sudbury people have all been involved in its construction and operation. While the design of the equipment for the observatory was the responsibility of the scientists, engineers were also involved. The consulting firm, Monenco, was appointed to manage the construction of the SNO and to provide engineering services. INCO's engineers were also involved.

The basis of the SNO was a 34m x 22m lined, barrel-shaped chamber or cavern around 7000 feet underground, in a cavity excavated from norite rock, in an extension to the INCO's Creighton Mine at Lively, Ontario. The chamber was shielded from cosmic rays and, at the same time, isolated from the mine's operations. It was reached through a drift from a mine shaft over a mile away. The chamber and its associated facilities were among the very cleanest places on earth, and everyone who worked there had to be scrubbed clean too.

Technically, the main instrument in the chamber was a 'second generation water Cherenkov detector.' In its centre was a 12m diameter acrylic vessel, attached to anchors above by cables and filled with 1000 tonnes of heavy water borrowed from AECL. Around the vessel was a geodesic structure in which were set 9600 photomultiplier tubes, and the space between the detector and the barrel walls was filled with very clean ordinary water. All of this equipment had to be brought down from the surface in pieces and reassembled in the chamber. Essentially, neutrinos arriving from the sun strike the heavy water molecules and produce a flash that is seen and recorded by the detectors.

Construction began in 1990 and was completed in 1999. Initially, the research involved 70 scientists from 12 institutions in Canada, the U.S. and Britain. The last measurements were made in 2006 and, in 2007, AECL got its heavy water back!

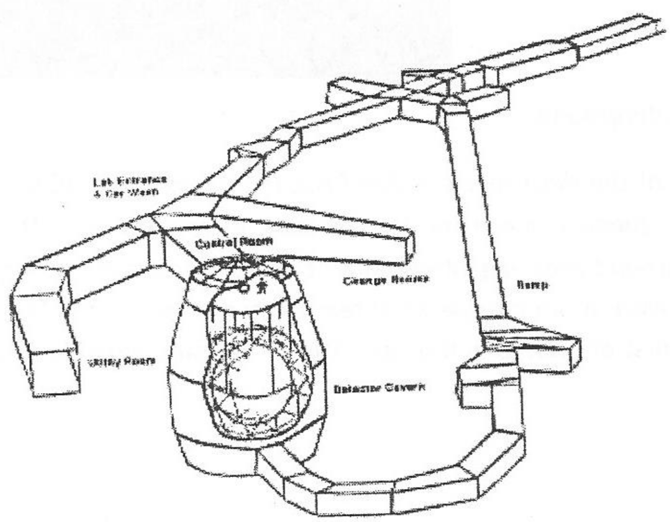
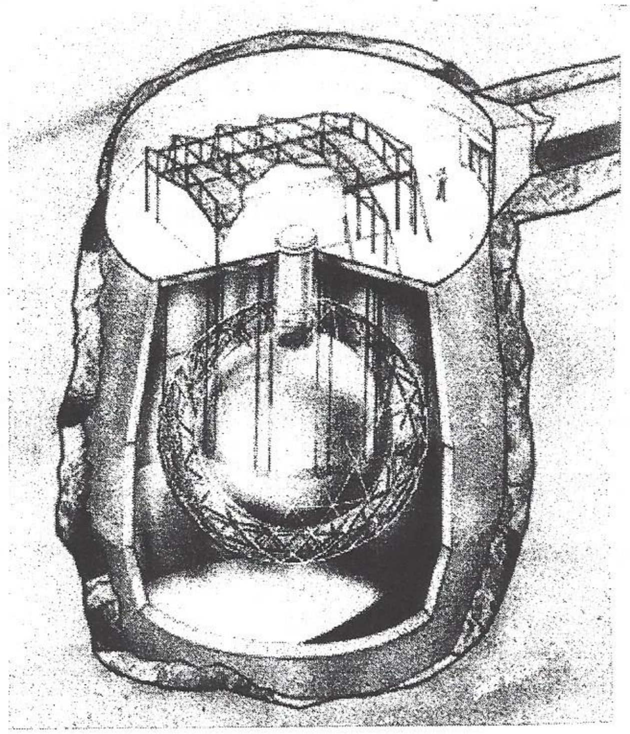
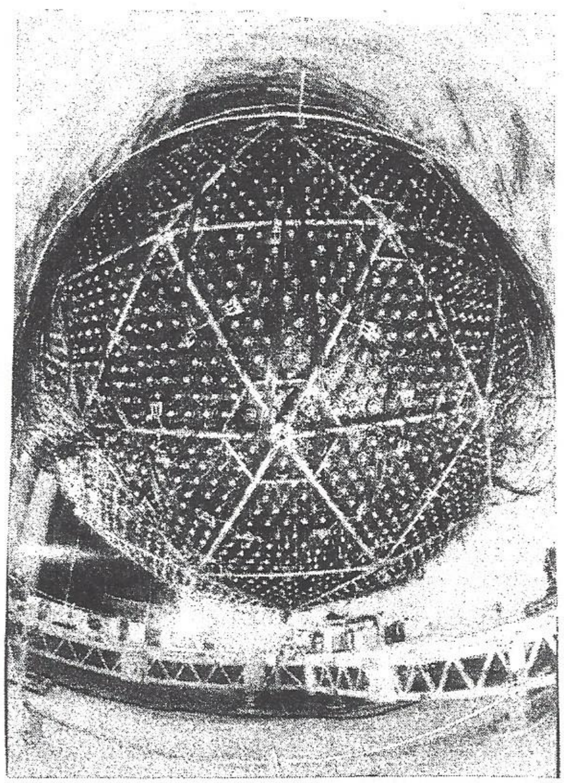


Diagram of SNO layout

SNO detector

chamber/cavern





SNO geodesic structure

Beginning in 2008, the SNO was enlarged, becoming SNOLAB. It has continued the study of neutrinos and has begun investigating so-called 'dark matter.'

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