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“A History of Canadian Inventions”

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Abstract

This paper was presented originally by the author to the Ottawa Chapter of the Canadian Society for Senior Engineers on April 17, 2012. The version now printed had been expanded to include additional material that could not be accommodated in the allowable speaking time. It includes copies of photographs of J.J. Brown, Morse Robb and Eric W. Leaver - but not the notes - from the Power Point presentation that accompanied the actual talk.

The objects of this paper are to present a much shortened version of the history of Canadian invention as given by Dr J.J. Brown in his book *Ideas in Exile*, published in 1967, and to discuss Brown's criticisms of the apparent failure of Canadians to exploit certain significant technological inventions in the marketplace. The history, by itself, makes a useful contribution to the literature of invention in Canada, but the author's criticisms of the lack of Canadian enterprise remain essentially unexamined.

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, a 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 25 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 of time until 2003. He has researched, written and edited historical material for both organizations, and is a past president of both.

Introduction

This paper has been deliberately titled **A** History of Canadian Invention rather than **THE** History because it is the subtitle of the book *Ideas in Exile* written by J.J. Brown and published by McClelland & Stewart in 1967. In fact, no definitive history of Canadian invention exists that deserves to have **THE** in its title. Brown's book may come closest to being one - and certainly much closer than Wikipedia!

When it appeared, *Ideas in Exile* attracted considerable attention, but it has since disappeared from sight. One of the reasons for this is the fact that the first printing was limited and a second one was not apparently attempted. Another is the perception of many people that Canada's invention problems are not greatly important. After all, the inventive might of the United States is right next door. Yet, at the time *Ideas* was published, some Canadians were becoming increasingly interested in what was being called 'science policy' or 'science and technology policy' - thanks in part to the establishment of the Science Council of Canada and the reports it had begun to publish.

Also, the first copy of the book that I bought fell apart quickly. So I bought a second one, which also fell apart and is now being held together by an elastic. I suppose other readers had the same experience. In any case, Dr Brown appears to have written nothing more that is noteworthy about Canadian inventions.

For the record, this particular John Joseph Brown was born in Alberta in 1916, graduated with a bachelor's degree from Victoria College, University of Toronto, in 1939, received an MA and a doctorate in the history of technology from Yale in 1941 and 1943, and collected several prizes along the way. On leaving Yale, he became a full-time writer - journalist might be a better term - who did a little teaching, although he had apparently begun writing and publishing articles as early as 1937. He thought of himself as a social historian, one of whose subjects was the role of technology in history.

At the time *Ideas in Exile* was published in 1967, Brown was described by Tom Alderman in a *Toronto Weekend Magazine* article as "a slim, serious ex-college professor of 50 who (was) also a tinkerer, having patented an inflatable pocket umbrella, which was never manufactured, and who made a name for himself as a management consultant and the author of books on investment, real estate and insurance." He was also, apparently, a remarkably successful investor on his own account, and was able to retire to do research and write articles - and books like *Ideas in Exile*.

When it appeared, this book garnered a good deal of favourable journalistic comment. For example, the magazine *Canadian Business* said that it was "a work of true scholarship and vast research, including much legwork," that took four years, \$120,000, and hundreds upon



J.J. Brown

(Canadian Business, February 1968)

hundreds of interviews with companies, institutions and individuals to research, and that this sum was underwritten by a number of Canadian corporations. In other words, Brown did a great deal of 'grunt work' on this project. But I would guess that not all of the original sponsors were in complete agreement with his conclusions regarding Canada's apparent failure to secure economic advantage from many of its most visible inventions.

Again, on the positive side, in a review in the *Financial Times of Canada*, Anthony J. Patterson wrote that Brown's book could be favourably compared with Arthur Porter's *Vertical Mosaic* and deserved a place in the home or office of every interested Canadian. However, Patterson also said that the book suffered from sloppy proof-reading and lacked important details in regard to some inventions. And, as I have found, it included some quite incorrect information. The scope was also incomplete. By the author's own admission, he omitted medical technology. But he also omitted pharmaceuticals and space technology, including the *Alouette* satellite and the STEM antenna.

Brown writes that his main complaint regarding the lack of appropriate exploitation of certain Canadian inventions was "economic backwardness" brought about because "our ideas have to be taken abroad for development." He goes on to say that, "while we have made contributions to world science and technology out of all proportion to our small number.....we are a timid people, afraid of ourselves and terrified by the demands of the real world.....we have been content to let others take the risk of presenting new ideas to a fiercely resisting world." The purpose of his book was, he says, to set down "some definite notions about what is wrong with invention in Canada."

Brown defined an 'invention' as "an idea embodied into a piece of physical equipment which provides some good or service we did not have before." He defined 'innovation' as "all of the above, except that it does not have to be embodied in any physical equipment." In other words, they may be more or less the same thing where physical equipment is concerned.

In my view, the definition of 'invention' is adequate enough, but the one for 'innovation' is not. The definition I feel to be more appropriate says that *technological* innovation is the completion of the process of bringing a technology-based 'invention' to market (my emphasis), and with the proviso that it may involve 'old' as well as 'new' technology.

Early History

Brown's training as an historian of technology serves him well in the early chapters of his book, when the inventive work he describes is not being criticized for its lack of success in the marketplace. He begins with the French settlements of the 16th and 17th centuries, when

invention was quite uncommon, since people were too busy just surviving. As a result, they copied a lot from the Aboriginal people. Their settlements also suffered from shortages of skilled artisans, and communications were slow. Competition with France was not allowed, so the marketing of most things there was difficult, and the home government's support could not be relied upon. Much of the technical work in the settlements had to do with the military situation and with the protection of civilians from warlike neighbours. Fur, fish and lumber, however, changed a lot of things. The country's interior was opened up as its rivers became its highways and trading was developed with the Aboriginal peoples. A few ships were built, and iron ore deposits exploited.

Things began to improve in the 18th century. More ships were built, including flat-bottomed craft suitable for shallow water travel. So were large defensive works, such as the fortifications at Québec, Halifax and Louisbourg. Metalworking was boosted when *Les Forges St. Maurice* began operations. Other industries included coal mining in Cape Breton, brewing, distilling and tanning and potash production from trees burned as land was cleared for farming. And the colonies' first primitive roads were built.

Change came more rapidly after the Treaty of Paris in 1763. The English settlers, unlike the French, inherited a tradition of trade. As well, the growing enmity between England and her American colonies shone a spotlight on Canadian sources of raw materials, such as timber. There was also the continuing military influence, again with the colonists to the south in mind, as well as the commercial ones of making and transporting goods. New towns appeared, as did new and rebuilt roads and the building of larger boats and ships. Rafts were developed to transport squared timber from interior forests to coastal ports. Canals were built, for both military and civilian purposes. The first one at Lachine, completed in 1781, was probably the first in North America to have locks. Surveying and mapping were pursued with vigour, and Canada acquired an international reputation for them. New crops were planted. And more trained and enterprising settlers arrived after the American Revolution, as well as from Europe.

The 19th Century

This trend continued into the 19th century and innovation increased in the Canadian colonies. The first paper mill in Canada appears to have been built at the turn of the century at St. Andrews East, Québec. By 1846 there were a half dozen mills in Canada West and three in Canada East. The first steamship made totally in Canada – the *Accommodation* in 1809 – was built and owned by John Molson, the Montréal brewer. It was followed three years later by the *Swiftsure*, which had an imported Boulton & Watt engine. Steam engines were built for ships and stationary applications in Montréal and in other places in Québec and Ontario. Armed sloops were built for service on the Great Lakes. As a result of the War of 1812, the Rideau and

Ottawa River Canals were built. The first Welland Canal was also built at Niagara, to meet competition from the Erie Canal in the United States. The first vessel to make the west-east passage of the Atlantic almost entirely under steam - the *Royal William* - was built at Québec, with engines built in Montréal. The Hudson Bay and Northwest Companies were merged in 1821. By 1835, with the building of the Chambly Canal round the rapids in the Richelieu River, there was a direct water route between Montréal and New York, which was time-shortened when the first railway in Canada was built in 1836 between the La Prairie on the south shore of the St. Lawrence and St. Jean-sur-Richelieu. In 1845, the Beauharnois Canal on the St. Lawrence was opened to traffic. By 1850 there were over 2 million people living in British North America.

Meanwhile, in 1824 the Canadian Patent Office had been opened. In his book, Dr Brown mentions a great many early inventions and inventors from this period - too many even to list in this paper. So let me simply give you some examples.

By 1846 a Maritimer, Abraham Gessner, had worked out a method of producing a lamp oil he called 'kerosene' from coal and pitch-like albertite and which replaced whale oil. In the early 1850s, Charles Tripp and his associates began the manufacture of asphalt, which they had discovered in the gum beds of Enniskillen Township in south-western Ontario. The first oil refinery in Canada was built in 1857 after James Miller Williams had discovered wells at Oil Springs, near Enniskillen, a year or so before the discovery of the first American well in Pennsylvania. This was followed by the discovery of a well at Petrolia in 1862, after which the first oil pipeline was built from Petrolia to Sarnia. Brown writes in his book:

By 1876, Canadian teams were going all over the world in the search for oil.....During the seventies and eighties, Canadian teams ranged from Central Europe to Australia, bringing in oil wells by techniques originally developed in Canada.

The 19th century saw the growth of wooden-hull shipbuilding in Halifax and other ports large and small around the Maritimes. Indeed, in his account of the industry, Brown praises the shipwrights for their ingenuity and unusual construction methods, especially when lacking the kinds of tools normally available in shipyards elsewhere. This industry reached its peak of technical development in the 1870s as the day of the sleek clipper ships approached its close.

Brown tells the story of Robert Foulis and the development of the first steam foghorn at his foundry at Saint John, New Brunswick, in the early 1850s. Apparently, like a number of other Maritime inventors, he went unrewarded for his ingenuity. So did John Patch, of Yarmouth, Nova Scotia, who played a part in the development of the screw propeller, and John Fraser of Pictou, Nova Scotia, who successfully used underwater diving equipment - of German origin - for the first time in wrecked ship salvage operations off Prince Edward Island. They missed

reward opportunities, as Brown explains, because it was the normal thing for a man to invent improved marine equipment. New devices appeared all the time, so local newspapers paid no attention. Also, it was unlikely that much money was spent by the local inventors on obtaining patent or other forms of protection. If the inventor got a reward, it was either through improvements in his own operations or in the offer of a better job from an employer.

However, transportation by rail stimulated engineering in Canada. The iron and steel industry, for example, benefitted from the construction of tracks, rolling stock and bridges. The first rails were made of wood, with their tops covered by thin strips of iron. But as the weight of the locomotives and cars increased, iron had to be used for the whole rail. Because of the lack of manufacturing facilities in Canada, until at least 1858, iron-based products were imported from Britain and the United States. There were problems, also, stemming from the initial use of two track gauges. The first Canadian-built locomotive was made by James Goode in his Toronto foundry in 1853. Canadians apparently contributed to the development of signalling, braking and coupling systems for trains. The basic patent for the rotary snowplough - a combination of a snowplough and a snowblower - was taken out by a Toronto dentist, J.W. Elliott. Henry Ruttan, an Ontario sheriff, invented a system for cooling passenger cars, the first to be installed in Canada. Theodore Woodruff contributed to the development of the sleeping car.

One of the 'by-products' of the coming of the railways to Canada was an improvement in the use of canals and of steamboats on lakes and rivers, and especially on the Great Lakes. The Welland Canal, for example, was expanded twice, in 1845 and again in 1887. The railway also changed the lumbering industry in the Ottawa Valley. By 1867 it had become an alternative to the use of rafts on the river. The mining and metallurgical industries expanded as new deposits were discovered in places such as Sudbury, Ontario, and Trail, British Columbia. Cheap and abundant supplies of coal were also discovered in south-eastern B.C.. And the world got standard time, thanks to its promotion by Sandford Fleming.

Canada also earned renown for its development of mechanized agricultural machinery, beginning in the mid-19th century, including labour-saving machines that ploughed, sowed, planted and harvested, as well as large steam-driven traction engines that became a feature of Prairie agriculture. The first major name in this business was Massey.

According to Dr Brown, Ebenezer Clemo was the inventor of a method of making wood pulp from straw, although he did not receive credit for it from the Patent Office. Nor did Charles Fenerty of Halifax for inventing a process for making newsprint from wood fibre, some 20 years before a similar process was invented in Europe. John Forbes, also of Halifax, invented the spring skate in 1854 and, in 1861, a company was set up at Dartmouth to manufacture it. In 1887, James Whelpley invented the racing skate, which used straps rather than rivets for attachment to boots.

With regard to a less well-known area of technology, Brown credits George E. Desbarats of Montréal with printing in 1869 the first publication, the *Canadian Illustrated News*, that used letterpress half-tone reproductions of photographs, although he *may* not have been the first to invent it. But Brown then proceeds to put one of his main messages across by writing:

Modern authorities on the history of printing and engraving are pretty well agreed that in the Desbarats half-tone process Canada has a definite world first. The only reason why Desbarats' accomplishment has not been recognized is that *in the past we have had no written history of Canadian invention and technology* (my emphasis). Scholars work from the written record, and if there is no mention of Canadian accomplishments in the learned journals found in world libraries, it is not surprising that the names of Canadian inventors do not appear in books. The curator of the graphic arts division of the Smithsonian agrees that the Desbarats illustrations appearing in the *Canadian Illustrated News* in 1869 were definitely the first half-tones to appear in any publication.

It is not surprising, therefore, that Brown and others saw a much-needed contribution - by *Ideas in Exile* - to the literature on Canadian technology.

The telegraph and the railway 'grew up' together, so to speak. Samuel Morse, in the United States, was the pioneer of the electric telegraph. The first one in Canada ran from Toronto to Hamilton in 1846 and the second, a year later, from Toronto to Québec, and by 1861 there were over 3,000 miles in use. The first submarine cable in North America was laid by a Canadian, Frederick N. Gisborne, with the help of an American, Cyrus Field, between Newfoundland and Cape Breton. By 1856 St. John's was linked to New York.

The invention of the telephone in 1876 by Alexander Graham Bell began an even bigger revolution in communications. While Canada can take much of the credit for this invention, it must share Dr Bell with Scotland and the United States. However, Brown complains that the Canadian company set up to exploit Bell's patent needed help from its American counterpart to do so. But he also notes that several Canadians made contributions to the early telephone. Cyrille Duquet of Quebec City probably invented the 'cradle' phone. Romaine Callender of Brantford received a U.S. patent for an automatic telephone exchange. And George Long built a model of the first pay phone.

Brown notes that the first electric light plant in Canada, based on Edison's d.c. system, may have arrived in Toronto in 1879 to serve a restaurant and, in 1881, to serve the Eaton department store. That same year, Thomas Ahearn built a plant in Ottawa and, the following year, there was one in Montréal. Ahearn also demonstrated that an electric stove could be used

safely for domestic cooking. Later in the 1880s, with the development of the a.c. transformer, Tesla's polyphase system and higher voltages supplanted the d.c. systems and Canada's electric power generation industry was born. Beginning with the Shawinigan Water & Power Company's plant on the St. Maurice River in Québec and at Niagara Falls, it also attracted new chemical and metallurgical manufacturing industries. One of the inventor-entrepreneurs in this field was Thomas L. Willson. Among the companies set up to exploit St. Maurice power was one that produced carbide and acetylene, developed by Willson. From his work also came a process for refining aluminum.

Dr Brown notes that the last two decades of the 19th century and the first of the 20th brought significant changes to the mining and metallurgical industries, due in large measure to the coming of the railways. For example, in the 1880s the Kootenay district of British Columbia was opened up. By 1897 there was a smelter operating at Trail and small operations were being consolidated into larger ones. Also, in 1898 the CPR line through the Crow's Nest Pass opened up a cheap and abundant supply of coal. In 1903 the world's first electrolytic lead refinery was opened at Trail. The production process was developed by a team of Canadian engineers led by Selwyn Blaylock. He was also responsible for guiding the development of a process for separating lead and zinc. By 1919 Canada's first electrolysis plant was built at Trail. Later, a flotation process was developed, which enabled Cominco and Trail to become the world's largest lead-zinc producer. Similar work, in another part of the country, led to the development of the Orford process and to Canada becoming the world's chief producer of nickel at Sudbury, Ontario. Canada also became the world's largest producer of asbestos, mined from deposits of olivine rock discovered by Sir William Logan in 1860 in the Eastern townships of Québec. The Jeffrey Mine at Thetford opened in 1881. And hard rock mining for silver and gold also began in Northern Ontario around this time. The techniques developed there were exported all over the world.

To 'round out' the 19th century, it should be mentioned - Brown does not discuss engineering in relation to invention - that in 1887 Canada's engineers formed their first professional society, the Canadian Society of Civil Engineers. This was possible, in part, because of the significant increase in the number of engineers working in Canada since the beginning of the century.

The 20th Century

From this point until the end of his book, Dr Brown discusses the quickened pace of invention and innovation (or the lack thereof) in Canada during the first two-thirds of this century which, obviously, I cannot do to the same extent. So my notes from here on will concentrate on specific or very visible inventions/innovations and on summary assessments that Dr Brown makes from time to time.

He introduces the 20th century with these (partial) comments:

The period between the turn of the century and the First World War was the great age of the private inventor. Several reasons can be found for this. Many major branches of technology were just beginning to be developed. Radio, electricity and air transportation were in their infancy, hence they were at their least complex stage, and a single inventor could make important contributions in these areas without expensive equipment or research facilities. At the same time, it was too early for the large corporations to show an interest in research.....(and) this period antedates the time when governments became interested in what research and development projects could do for them....

The First World War demonstrated conclusively that the nation with the most advanced science and the most rapid technological advance would be supreme in the 20th century. About this time, too, corporations began to realize that, in order to survive a period of rapid technical advance, they had to keep bringing out new products and improving old ones. Hence, after World War I, the environment in which the inventor lived underwent radical change. He found his talents accepted in government and industrial laboratories as never before. (But) while job opportunities opened up, the institutional restraints on the individual that come inevitably with large organizations made it more difficult in some ways for the individual inventor to carry out acts of pure creation.

One of the first people that Brown mentions is Rupert Turnbull, the inventor of the variable pitch propeller for aircraft. Turnbull was unusual in that he was really a researcher and not an inventor. His principal satisfactions came from seeing his work in print in the literature and not in the award of patent rights. Born in 1870, he received his engineering education at Cornell. After some industrial experience in the United States, and graduate work in Germany, he returned to Canada in 1902 and established his own laboratory at Saint John, New Brunswick. Like Bell, with whom he collaborated, he worked on propeller-driven hydroplanes. He built the first Canadian wind tunnel in his laboratory, tested propellers, and developed the variable pitch type, which was later flight-tested by the RCAF. During World War I, Turnbull worked on military research in Britain. He was working on deriving energy from the Fundy tides when he died in 1954.

Brown's quarrel with Turnbull is that the commercial development of the variable pitch propeller was carried out abroad. In 1929 he sold his patent rights to manufacturing companies, notably Curtiss Wright in the United States. Although he continued to receive royalties for the propeller, especially during World War II, he considered his work on it had been done when the

results were published. Nevertheless, Brown considers Turnbull to have lacked a flair for publicity. Even historians of aeronautics seem to have ignored him. It should be noted, however, that much later in the 20th century *both* the Historic Sites and Monuments Board of Canada and the Canada Science and Technology Museum's Hall of Fame recognized his contributions to aeronautics.

Dr Brown gives extensive coverage to the work of Alexander Graham Bell and his Aerial Experimental Association colleagues in regard to heavier-than-air powered aircraft. He also mentions their experiments with hydrofoils - especially the HD 4 with its cigar-shaped hull - which covered the first two decades of the 20th century. However, by the early 1920s military interest in this type of craft had evaporated in Canada and the United States and did not revive, in Canada at least, until the *Bras d'Or* was built and tested in the late 1950s.

Brown includes in his book the story of Marquis wheat and its connection to William and Charles Saunders, most likely since this early-maturing variety became commercially successful as the Prairie provinces were opened up to agriculture. But Marquis wheat was more the result of scientific research than it was a technical invention.

Charles Saunders was born in London, Ontario, in 1867. A University of Toronto chemistry graduate with a doctorate from Johns Hopkins in 1891, his first love was music. But his pharmacist and horticulturalist father, William, saw things differently. In 1884, William had become director of the new Dominion Experimental Farms and had taken a significant role in development work based on the Red Fife variety of wheat prior to the colonizing of the West. But administration was encroaching increasingly on his research. So he persuaded the Government to appoint his son Dominion Cerealist, to take charge of the work on Marquis wheat - which he did, successfully. Brown reckons that, by 1910, around 8 million acres of the cereal were being planted annually, and by 1966 Canada was earning over \$600 million from wheat and wheat-related exports. So in Brown's book, Charles Saunders was one of the most successful 'inventors' Canada has had.

Occasionally in *Ideas in Exile* Brown will tell the story of relatively successful inventions that have little to do with Canada's history since their Canadian-born inventors were working outside the country at the time of their inventions. Although he does question their inclusion in his book, his point in doing so is most likely to reinforce the message that inventions by Canadians were more likely to be developed abroad than at home.

One of these inventors was Frederick Creed, a Nova Scotian, born in 1871. At the age of 15 he started work as a messenger boy in a Nova Scotia telegraph office and quickly learned the Morse code. At the age of 18 he got 'itchy feet' - which took him to Peru. By this time, hand-punched tape was being used to transmit and record telegraph signals. Creed found this tedious and started searching for a better way. He began by matching up the tape with a

typewriter. The upshot was that, by the time he returned to Halifax in 1895, he had built a working model of a teleprinter. By 1898, after two years of dire poverty in Glasgow, Scotland, he succeeded in selling his first instrument to the British Post Office and the first system to the Great Northern Telegraph Company. Soon after the turn of the century, Creed teleprinters were taken up by the newspapers in England. Even his early machines could maintain a rate of 50-60 words-per-minute over long periods. And while Creed may not have been the first inventor of the teleprinter - Hoffman in Austria apparently was - he appears to have been the first to produce a workable and commercially successful one. However, he used the Morse code rather than the European five-unit code. Over time, this code gained the upper hand commercially and technically. Creed therefore redesigned his equipment and continuously updated it until 1928, when he sold his company to U.S.-based IT&T, and retired.

Apart possibly from *Ideas in Exile*, Creed has been ignored in the annals of Canadian invention and there is no mention of him in Hurtig's *Canadian Encyclopedia*. And Brown himself does not record that Creed did pioneering work on small-waterplane-area twin-hull (SWATH) ships in the 1930s, after his retirement, in England.

Brown's book also discusses the inventive work of another, better-known Canadian - Reginald Fessenden - who was born in 1868 in Canada, but who spent the majority of his working life in the United States. He was a contemporary of Marconi. In 1902, Fessenden discovered the heterodyne principle, but need a vacuum tube for it to work. There were none. In late 1906, he may also have made the world's first radio broadcast of music and voice. Over his lifetime, he accumulated a portfolio of over 500 patents.

Dr Brown comments that the two new industries of the early 20th century - automobiles and aircraft - benefitted significantly from technical progress made during World War I. With regard to the former, he notes that he found several 19th century references to single steam-driven automobiles having been made in Canada. However, no 'native' industry developed. The vehicles eventually manufactured here were all of foreign design. There was apparently more original activity on the aircraft front. For example, the first balloon flights were made in the 1850s. James E. Fraser of Saint John had, by 1895, designed an airplane that worked on the 'bird's wing' principle and had patented it in Canada, the United States and Britain. Brown notes that the first free glider flight took place at Montréal in 1907. Another early glider was built at Owen Sound, Ontario, in 1908. Also in 1908, William Gibson of Victoria, B.C., started to build a 'flying machine.' By 1910, he had also designed and built the first successful aero-engine in Canada - air-cooled, with six cylinders - which developed 55 horsepower and weighed 210 pounds. The machine, with two engines that used contra-rotating propellers, flew successfully in September of 1910. It flew again at Calgary the following year, but was finally wrecked during a forced landing. By this time Gibson's money had run out and he gave up. Before World War I a Canadian, James McCollum, invented the sleeve-valve aero-engine, which was used during the War. Techniques for obtaining gasoline from waste natural gas, the manufacture of helium for observation balloons, and the commercial manufacture of acetone from acetylene gas were

all, apparently, pioneered in Canada. Acetone production provided a start for the organic chemical synthesis industry after the War.

With regard to Canadian R&D and invention/innovation during World War I, and to the U-boat menace, Brown quotes Sir John McLennan of the University of Toronto - presumably in support of his principal thesis - speaking of it some years later:

I remember early in the Great War speaking to a Canadian Cabinet Minister of distinction and urging him to invite the scientists of Canada to devise some efficient means of dealing with the submarine menace with which the Empire was confronted. Instead of welcoming any proposals, he appeared to be amused in a deprecative way of what we might do. Although I tried, I failed to arouse his enthusiasm. He seemed to have no conception of what science meant or what it could do.

Brown adds that Sir John spent part of the War commuting to London to make suggestions to the Board of Inventions and Research for work that might be done in Canada. One such successful suggestion led to the manufacture of helium here. Although the Americans eventually took over the helium work, Sir John managed to persuade the British to donate to him the helium remaining in Canada after this happened. With it, he set up the first low-temperature physics laboratory in Canada, which became the first cryogenic laboratory in 1923.

A postwar offshoot of the wartime aviation business in Canada was aerial photography, mapping and surveying. Brown credits Daniel Owen of Annapolis, Nova Scotia, with being the first to put the techniques into operation - in a timber survey in Labrador in 1919. The first use of aircraft for forest fire control was initiated by Stewart Graham in the St. Maurice Valley of Québec, also in the summer of 1919. The first water bomber was used in Manitoba in 1921. These latter operations became more effective as aircraft engines became more powerful in the 1930s, making surface skimming possible and, with it, better use of the aircraft. Tom Wheeler of St. Jovite, Quebec gets the credit as the first practitioner.

Brown mentions the inventive work of University of Manitoba graduate William Stephenson - later Sir William, the spymaster - which involved sending pictures over wires. The year was 1921. But apparently no Canadian company or newspaper was interested, so Stephenson took it to England, where the response was warmer. By April 1923 he had applied for a patent. It was picked up by the British newspapers because it allowed pictures to be taken in one place and reproduced almost instantly in another, with savings of money as well as time. As a result, Stephenson was a millionaire by thirty, and could retire from business.

Brown also discusses the 'not invented here' factor - the case where the original inventor is deliberately deprived of credit for his/her invention. He uses the I.C. Mackie story to illustrate it. Briefly, Mackie was a metallurgist at DOSCO at Sydney, Nova Scotia. By 1931, he had developed a system of controlled cooling in the manufacture of steel rails that cured the tendency of rails cooled by other means to fail in service through cracking and shattering. The system was patented in most countries, including the United States (in 1938). Even so, Mackie was deliberately deprived of the credit due to him by an unexpected source - a learned body in the U.S.. The principle involved is the simple one that, to people in foreign countries, their own people invent everything!

One of the young, early 'electronic' Canadians was Edward S. Rogers, the father of Ted Rogers who died not long ago. Born in 1900, a rich man's son, he forsook the family's coal business for radio. In 1921 he was the first Canadian amateur to successfully transmit a radio signal across the Atlantic. One of the problems that plagued radio listeners at the time was a reduction in sound level as the d.c. batteries ran down. Rogers decided that the radios should be powered by ordinary house current, which was a.c., but it had the problem of 'hum' from the tube. By 1925 he had designed 'humless' tubes and had set up a company to make them. He then extended the battery-less idea to high-powered transmitters and, in 1927, brought into operation the first such radio station (now CFRB). He died at the early age of 39.

Dr Brown writes that one of the more spectacular pre-World War II 'missed boats' was the diesel electric locomotive. He claims that Canadians in Kingston designed and built the world's first successful locomotive of this kind, which was tested in August 1929 at Montréal. It combined a diesel engine with a d.c. generator and charged batteries which, in turn, powered the d.c. motors driving the wheels. However, the timing was bad. The Depression Years had begun and the CPR management was unwilling to make the change from steam to diesel, although some others in the industry were not so cautious. Brown claims that, with the help of hindsight, this was a mistake and Canada lost what might have been a major export industry. Since 1940, Canada has imported several hundred million dollars' worth of diesel locomotives. Further, he claims that in 1967, when he was writing his book, the world market for diesels was a billion dollar business. Strangely, he fails to mention that Montréal Locomotive Works was created to build steam locomotives - and later diesels - behind a Canadian tariff wall, albeit to U.S. designs, that the Canadian Locomotive Company in Kingston built steam and diesel locomotives to their own designs as well as importing them, and that General Motors Diesel Limited was created in 1949, again to defeat the tariff wall, in London, Ontario.

A contemporary Canadian pioneer in the mechanical field was Armand Bombardier of Valcourt, Québec. By 1926 he had developed his first 'snowmobile' and, by 1930, the first of his small, light snow vehicles for winter sports. After World War II he designed, built and marketed the SkiDoo. Another Quebecer, Arthur Simard, did pioneering work on snowblowers and the Thibaults at Pierreville built fire engines. All three inventors - contrary to Brown's thesis -

became successful from the business point of view. Less well known is Malcolm Dion of Georgian Bay, Ontario, who developed the 'scoot' - a sled-like boat driven by an air propeller that was used to bring supplies to islands in the Bay, and later became the 'swamp buggy' of the Florida Everglades. W.E. Thornton-Trump of Oliver, B.C., developed the 'dynast' wheel - powered by a radial motor inside the rim. And Bruce Nodwell of Calgary built tracked carriers, originally for use over muskeg.

In introducing his description of the electronic organ invented by Morse Robb of Belleville, Ontario, in 1927, Brown comments that, in the United States alone, \$300 million worth of electric organs were sold in 1965. He goes on to say:

If Canadians had taken advantage of their opportunity to become the world's supplier of electric organs, the way the Swiss have become the world's supplier of watches, that one item alone would have been enough each year to reverse our international trade position and give us a favourable balance.

Robb conceived the basic idea for the electronic organ in 1926, at the age of 24. He would record the wave form of a sound produced by a pipe organ and then reproduce the tone from a permanent recording. He was not the only one working on the idea; he was simply the first to do so. The Hammond Company in the U.S. was also working on it.

The Robb story told by Dr Brown is too long and complicated to repeat in the context of this paper. Suffice it to say that his machine was first demonstrated at Belleville in the fall of 1927 and later in Toronto. It impressed engineering people at the Canadian General Electric Company and its U.S. parent in Schenectady. But rather than deal with G.E. or another company, plus advice from his father, and in spite of having no manufacturing experience, Robb decided to find his own development money and to make the eventual product himself. The Canadian patent issued in 1928 and the American one in 1930. The stock market collapse around that time made financing difficult, but the Robb Wave Organ Company was set up at Belleville in 1934. The first commercial organs were delivered early in 1936. One was installed at the Canadian National Exhibition in Toronto in 1937. Brown comments that, at that time, the Robb organ was considered superior in musical quality to the Hammond one. It failed, however, as a commercial venture and Robb - having become ill - closed down the venture. By 1939, Hammond had captured the market.

Dr Brown discusses at some length what the period between the World Wars meant for the development of research laboratories by federal departments in Canada, as well as the first research councils on the NRC model in the provinces. He also mentions the increase in individual and team research in the universities. Notable among the latter, in his view, was the University of Saskatchewan's engineering investigation in the 1930s - led by Dean C.J.



Photography: Don Newlands

Morse Robb

(*Weekend Magazine*, Toronto, 1967)

Mackenzie - into the effects of alkaline water on the failure of local concrete structures and the application of the solutions found to this problem by the indigenous construction industry. As another example, he cites the work done around the same time at the University of Toronto on the electron microscope. In this case, however, the results were exploited in the United States, where the three principal UofT researchers also found their long-term employment. While Brown admits that the Depression years were not good ones for university-trained researchers to find work in Canada, he comments, in his customary critical vein:

Our leading tax-supported industry is the education business, which consists of training young people to the point where their services are valuable to an American corporation. By subsidising this industry, we make certain that our most highly-trained and therefore socially valuable citizens will leave the country. This is also an indirect subsidy to the large American corporations and the United States' government, both of whom need the money less than we do. Typically, Canadian research institutions now buy their electron microscopes from the United States because they are not made in Canada.

Brown seems not to have considered the point that American or other foreign experience, while young, could help Canadians in their own country later on in life and that the real objective should have been to develop the opportunities that would bring them back to Canada.

Brown then discusses research in general terms in the context of Canadian industry. He states that the problem for business is as follows: research is seen as a two-edged sword; it is feared by the financial people because it can make securities insecure and can down-grade assets; but if it is not done, and competitors do it, they may take away Canadian industry's markets. On the other hand, protective high tariffs may keep markets intact. So industry's job is not research. It is to lobby to keep high tariffs in place. He cites the inter-War period as one of low industrial research, whether by teams or individuals, although there were exceptions. For example, a consortium of companies in the pulp and paper industry - one of Canada's most important - established and supported the work of the Pulp and Paper Research Institute (more recently, PAPRICAN), which contributed new information that the industry as a whole could use.

Dr Brown states that between 1940 and 1946 Canada spent \$400 million building up research laboratories and manufacturing facilities for radar work. The company, Research Enterprises Ltd. of Leaside, Toronto, produced a variety of radars, gunsights and rangefinders and employed thousands. In fact, one of Canada's main claims to wartime fame was its mass production of radar sets. Over the years, Canadian contributions to the development of radar were not as extensive as those of some other countries. Brown notes however that as far back as 1926, Col. W.A. Steele and Major A.G.L. Mcnaughton patented a device that resembled a latter-day radar. It used a cathode ray tube for radio direction-finding. John Henderson of NRC

was concerned with identifying and locating thunder storms in the 1930s. By 1939 he was working on CRT direction-finding equipment small enough to be used on ships and aircraft. By the end of 1940, NRC had a large staff engaged on radar. However, during the middle War years, the Americans used equipment that was British-designed and Canadian-built. The NRC was also involved in studies of the de-icing of aircraft in flight.

For the army, George Klein, of NRC, helped develop a vehicle called the *Weasel* that could go almost anywhere. He was also involved with Pitt and McKay of Toronto in work on proximity fuses. For the RCAF, Gordon Wilson developed a smoke cartridge bomb. Other wartime inventions of importance included the 'anti-G' suit by W.R. Franks, Ferguson and Frye's rubber oxygen mask, Berton and Shortreed's portable oxygen tank, and Webb's work on protective clothing. Ross, Schiessler and Wright contributed to the development of RDX explosives. Also mentioned is the nuclear research carried out in Montréal and moved to Chalk River towards the War's end, the building of large hydro plants - for example, the one at Shiphaw on the Saguenay River in Québec associated with the production of aluminum - and the development by Lloyd Pidgeon of a new process to produce magnesium for wartime applications.

He mentions the Habbakuk Project, which did not lead anywhere, and which makes a good story - but he got it wrong. According to Brown, its objective was to build landing stages - a line of 'seadromes' - for aircraft being ferried from North America to Britain. Its actual objective, which proved to be quite unrealistic, was to build several large 'bergships' of reinforced ice from which limited-range fighter aircraft could attack German targets in places such as Norway. Since information on Habbakuk was top secret at the time and was not declassified until 1980, Brown could not possibly have known the real story.

He also mentions the wartime work done in Britain by a Canadian electrical engineer, Charles (later Sir Charles) Goodeve, although once again the question arises of whether - in spite of its intrinsic interest and importance - this work belongs in a book on *Canadian* invention. However, this story does have a later Canadian component.

Goodeve was a member of the U.K.'s Royal Naval Reserve when World War II broke out. Called up immediately it began, he was assigned to devise counter measures for the Germans' magnetic mines. This he did quickly, using electrically charged cables towed behind a pair of minesweepers. His next project was to neutralize the magnetic field generated by steel-hulled ships that caused magnetic mines to explode. By early 1940, he and his assistant had developed 'degaussing' - whereby a copper cable carrying an electric current encircled the hull. This technique was immediately successful. At Dunkirk, during the evacuation of British troops, only two of 218 ships lost during the operation were victims of magnetic mines. The first degaussing testing range built outside the British Isles was at the Bedford Basin in Nova Scotia.

Undeterred by Goodeve's work, the German Navy produced the acoustic mine, detonated by

the sound of a ship's engines. Since a ship's noise level could not be easily reduced, the solution to this new menace was to generate a noise level loud enough to set off the mine before the ship got close to it. The pipe noise-maker, conceived in the United States, was developed by a research team at Halifax to do this job. However, the key work was done by an NRC team under G.S. Field, who made a careful study of the power of ships' noises to set off acoustic mines.

The Germans also produced an acoustic torpedo that could home in on any noise-making target. This was countered with a noise-making device towed behind the ship. To identify lurking submarines, the Canadian and other Allied navies used a submarine detection system (ASDIC or sonar) throughout the War. A number of Canadians made improvements to it, including a Captain Peers of the RCN who developed a variable depth sonar that spotted a submarine's position more accurately.

World War II brought about the development and use of the 'atomic' bomb. In Canada, it began the development of power generation using uranium nuclei. Canadian research to test the possibilities for nuclear fission began at the National Research Council early in 1940, under George C. Lawrence and Bernard W. Sargent. By 1942, a joint Canadian-British atomic power research project had been set up at the Université de Montréal. The decision to use heavy water as the moderator for the Canadian 'pile' led to the building of a plant to make it at Trail, B.C.. Canadian uranium would provide the fuel. In 1945 the project was transferred to a permanent site at Chalk River, Ontario, initially under the jurisdiction of NRC, and later as Atomic Energy of Canada Limited. On September 5 of that year, the ZEEP reactor - the first to be built outside the United States - went 'critical' there. This was the beginning of Canada's participation in the world markets for nuclear reactors.

In his book, Brown draws attention to the invention-encouraging advertising and suggestion schemes of the governments in Britain and the United States during World War II and the lack of them (again) in Canada. He also complains that Canada failed to compensate its contributors of wartime inventions properly, as Britain and the U.S. did - in the case of Watson-Watt for radar, and Goddard for his rockets - although a few Canadian inventors were eventually minimally rewarded after acrimonious lawsuits. He also blames the government for its failure to capture postwar advantages of wartime developments. He writes, critically:

....our failure to follow through on Canadian wartime developments must be laid on the doorstep of our government and its economic advisers. Aided by a complete misreading of the signs and portents, most people in positions of power in 1945 predicted a postwar depression and hard times. Plans were made not to expand into international trade from a firm wartime base, but rather to contract war-developed plants as quickly as possible.

Instead of a depression in 1945, we entered the greatest economic boom in recorded history, one that still (in 1967) shows no real sign of coming to an end....

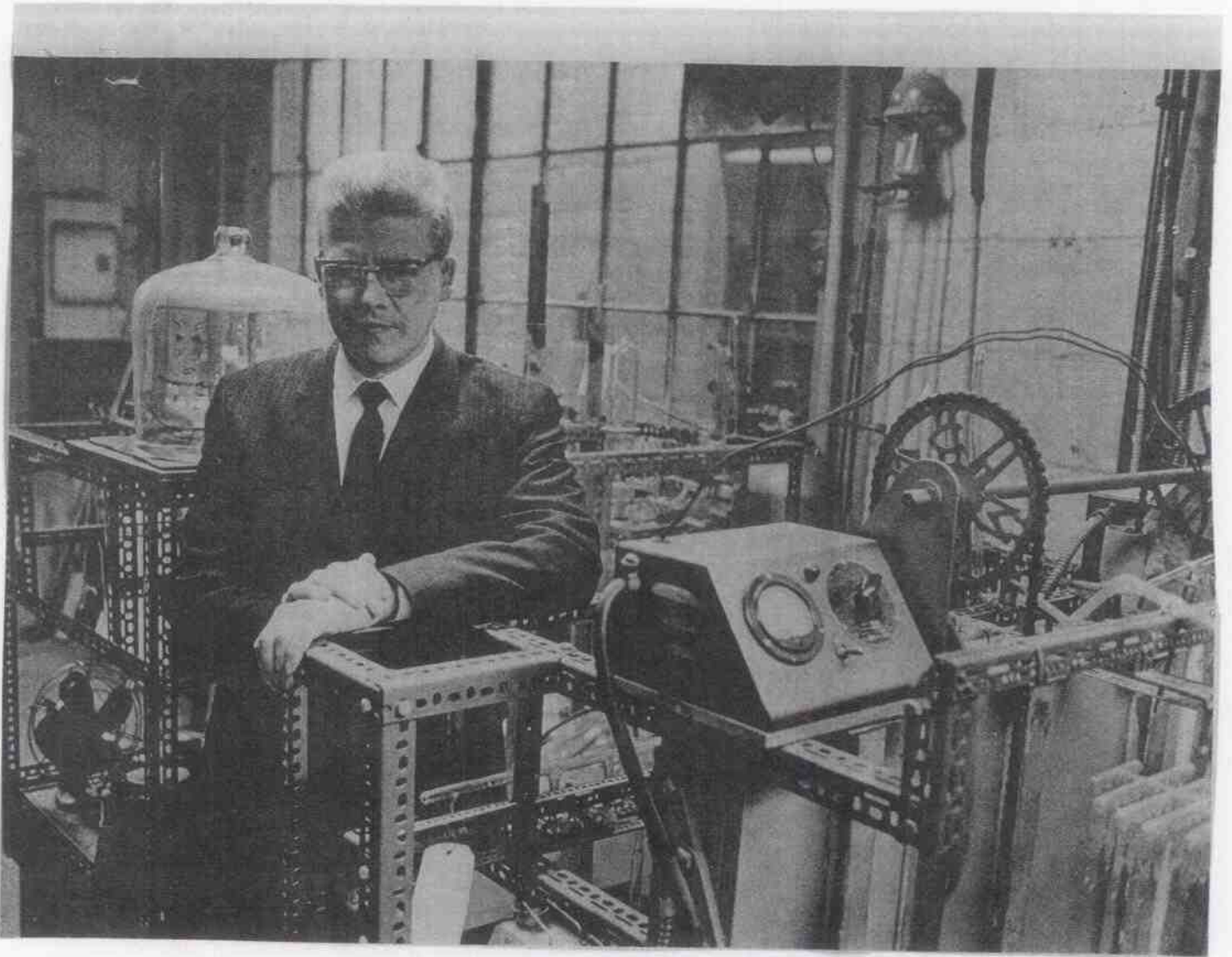
One of the quickly-closed plants was Research Enterprises of Leaside, Toronto.

Dr Brown uses two chapters of his book to describe the 'invention' situation in Canada between the end of World War II and the mid-1960s when he was writing it, and does so in great detail. He also says that, post-World War II, corporate inventors held sway although individual ones did not disappear altogether. At the same time, he admits that it can be difficult to assess the effectiveness of the exploitation of patents during the postwar years.

Rather than present a long and probably unsatisfactory summary of the inventions, I propose to mention a few and to concentrate on what were, for Brown, three major missed opportunities about whose lack of *Canadian* exploitation he is particularly critical. I will also deal very briefly with some of the postwar inventive activities of federal departments and agencies that he discusses, including NRC and AECL. In this context, I should mention that Brown has ignored the important incentive and tax-related programs established by the federal government during these years to foster and promote R&D and technology development in Canadian industry. As well, he all but ignores the activities of Canadian Patents and Development, originally a subsidiary of NRC, which was set up to exploit patentable inventions by government scientists and engineers.

One of the post-war inventors who 'captivated' Dr Brown was Eric W. Leaver, a Saskatchewan farm boy who became an electronics whiz. One of his first inventions - in the 1930s - was a device for landing aircraft in fog. He sold it in Chicago. Then he worked on experimental television. By 1945 he had a string of patents in his name and had become interested in translating his wartime experience into hardware for the postwar period. For example, Leaver was involved at that time with a 'hand-arm' machine for the remote control manipulation of machine tools, already a reality in the handling of radioactive materials, which was called AMCRO, and it is the first of the three major missed opportunities. In 1946, Brown wrote an article for *Fortune* magazine describing Leaver's ideas. Meanwhile, along with G.R. Mounce, he had formed a small company in Toronto (Electronics Associates Limited - EAL) and proceeded to build AMCRO. It used an analog rather than a digital system, and was patented in Canada, the U.S. and elsewhere. But it did not find its expected market and, in time, gave way to competing systems. Brown bemoans this in his book and writes:

In terms of dollar potential, the loss of AMCRO is probably the largest loss in the entire history of Canadian technology. Today (1967), the automatic control of machine tools is a \$1.2 billion dollar business and it is rising every year. Leaver and Mounce were clearly the first in the field,



Eric W. Leaver

(Weekend Magazine, Toronto, 1967)

and had a clear head start of something of the order of six years. But their little company, founded with \$10,000 capital in 1945, was in no position to take out patents and build a patent fence around the basic idea. Hence they were able to patent only one way of doing the job, and this left the field clear for the patenting by others of a whole range of alternative methods.

In his book, Brown then cites the experience of another Canadian, by the name of Nimick, an immigrant from Hungary, who developed a tracer-type lathe in the early 1950s, only to find no market in Canada until buyers could import *his* lathe from American suppliers.

Eric Leaver is mentioned several more times in the balance of Brown's book - for example, in connection with his participation with NRC support in the development of airborne instrumentation for aerial surveying and photogrammetry; in the development of the first, rugged, low voltage Geiger counter for uranium exploration; in the development of a slow neutron detector which was sold internationally; and in a variety of aircraft-related computer-based devices. There were also contributions to the automatic control of papermaking and to the location of railcars.

The idea that the National Research Council's laboratories, using taxpayers' money, might develop a potential product for market was, Dr Brown notes, greeted initially with scepticism. However, not long after they were established in the late 1920s, these laboratories discovered how to make firebrick out of lime that had magnesia in it. Out of this grew a company - Canadian Refractories Limited - the world's first plant of its kind and, based on its marketplace success, a case was made for the further development of NRC's laboratories. Retrospectively, however, Brown makes these comments;

While no one has yet made an objective study of NRC to see exactly what has been accomplished over the years, and at what expenditure of money, it seems that they have gone far beyond the original narrow conception of their function. By and large, the scientific staff at NRC seems to be very good, dedicated to its work and highly idealistic in tone....The NRC has done many good things, and normally has accomplished them against tremendous odds but, by and large, has received very little appreciation.

However, Brown has either ignored, or disregarded, an assessment of NRC that was authored by Mel Thistle - granted, an employee of the Council - and published in 1966, before his own book. He said little about the work of the Defence Research Board laboratories. He also failed to take account of the studies by the Science Secretariat within the Privy Council Office in Ottawa and by the Science Council of Canada, both of which were actively examining the work

of NRC and other federal agencies, although he was just too early to read of the deliberations of the Lamontagne Science Policy Committee of the Senate. He did, however, provide an extensive description of the work of AECL in developing the Canadian reactors and of its Commercial Products Division in the marketing of radioisotopes for medical and other purposes.

Brown did make specific mention of the contributions of S.G. Gamble of the Department of Mines and Technical Surveys to aerial surveying and photogrammetry, as well those of two companies (P.S.C. Applied Research led by J.M. Bridgman and Canadian Airborne Geophysics Limited led by Douglas N. Kendall), and the work of U.V. Helava of NRC, whose plotter could work with photographs taken by orbiting satellites from 30,000 feet, but no Canadian company could be found to manufacture it. It was licensed eventually to an Italian company. Also mentioned were NRC's contribution to the food technology field, as well as the Department of Agriculture's work on instant potato flakes and its assignment to a Toronto company for marketing. In the marine field, he mentions the slotted-wall breakwater developed initially by G.L.E. Jarlan at NRC. A full-scale breakwater was built at Comeau, Québec. Noted in the textile field is the development by two National Defence engineers of the first 'engineered' yarn. Brown notes that, again, that Canadian industry was not interested in manufacturing cloth made from it, and it was later licensed to Belgian and Dutch companies.

Regarding the application of research related to mining and metallurgy, Brown mentions the work of Dr Frank Forward of the University of British Columbia on the refining of the nickel-copper-cobalt ore at Lynn Lake, Saskatchewan using chemical leaching rather than smelting with heat - a process adopted by Sherritt-Gordon Mines Limited, which had encouraged the research. Also mentioned is the process developed by G.R. Heffernan of the Peace River Mining and Smelting Company and G.C.P. Gravenor of the Research Council of Alberta to manufacture steel strip from a difficult-to-smelt ore. In the field of computers, Canadians apparently made significant contributions to the development of the IBM 101, solving a problem that arose originally from the slowness of the analysis of the population census. The 1950 census in Canada was influenced by it.

In the field of aeronautics, Wing Commander J.G. Wright invented the R-Theta computer, the first practical navigation instrument that was completely automatic and could free a fighter pilot to fire his guns rather than worry about where he was. It earned Wright the McKee Trophy in 1954. A more sophisticated jet aircraft computer was later invented by J. Stewart Parsons of Computing Devices of Canada. The Canadian Marconi Company sold, world-wide, the Doppler radar it manufactured, for which its chief engineer, K.G.M. Glegg, was responsible.

Canada enjoyed success in the design and manufacture of 'bush' planes, most notably the Noordyn *Norseman*. It was a high-winged, single-engined aircraft that could carry heavy loads and get in and out of confined landing areas. It became the work-horse of the North. In the

1950s, the De Havilland Aircraft Company of Toronto produced the single-engined *Beaver*, and the twin-engined *Caribou* in the 1960s, and sold them around the world. Other aviation successes in the early postwar years included the *CF 100 Canuck* - the first all-weather interceptor jet fighter designed and built in Canada and adopted by NATO and NORAD Air Forces, the *Orenda* series of engines, and United Aircraft's Canadian-designed and -built *PT 6* engine. Later, Canadair in Montréal designed and built the *CL 215* water bomber, and the *CL 84 Dynavert*. This two-engined plane was able to take off with its wings in the vertical position and, when at a safe height, swing the wings down to the horizontal.

The second of Brown's major missed opportunities is the Avro *Jetliner*. Near the end of World War II, Avro decided to develop a medium range jet airliner and assigned the task to their Malton plant and to James Floyd. It was to replace the wartime production of Victory Aircraft Ltd. Trans-Canada Airlines, as it then was, showed enthusiasm and placed a tentative order. Floyd began work in February 1946. Originally, the plane was to have been powered by two Rolls-Royce *AJ65* engines, but they were still in the development stage when needed for the Avro prototype. Four R-R *Derwent* engines were substituted, as a result of which, TCA cancelled its order, although several other airlines remained optimistic. On August 10, 1949 the *Jetliner* successfully made its first flight at Malton. Early in 1950 the aircraft flew from Toronto to New York in half the normal flying time. It was the first commercial jet to fly in the United States and the first time mail had been carried in a jet. American commentators apparently considered this flight, and a later one between New York and Chicago, as a 'wake-up call' to U.S. commercial aircraft manufacturers! James Floyd won the prestigious U.S. Wright Medal for his work. Yet the *Jetliner* project was cancelled. Brown quotes a litany of reasons for this - technical, managerial, operational and political, including the need for Avro to build *CF 100* fighters for the Korean War. Work stopped in 1951 on the second aircraft and the first one was scrapped. As Brown writes:

Thus, after spending some \$10 million, of which \$5.75 million was taxpayers' money, Canadians in charge of this magnificently successful project suddenly got cold feet and abandoned their child.

The third major missed opportunity is also in aviation - the *CF 105*, better known as the Avro *Arrow*. In accepting the challenge of designing and building this aircraft, Avro obviously sought to repeat its success with the *CF 100*. It was not to be. Books have been written and films produced about the demise of the *Arrow*, so I will not dwell on the details. Suffice it to say that the Canadian government, having searched but found no foreign-built design then both available and suitable, gave the job to Avro. By mid-1955, production drawings for the *CF 105*, with its two side-by-side jet engines and delta wing configuration, were ready for the manufacturer. In view of the short time-frame available for the production of the new aircraft, Avro decided to skip the prototype stage and head straight into production. The first *Arrow* flew, successfully, on March 25, 1958. Brown notes that Avro's 14,000 staff members took this

to be a personal triumph, and it looked as if Canada would - for the first time - make what he called "a lasting mark on world technology." As we all know, on September 14, 1958, Prime Minister Diefenbaker suddenly announced that the program had been cancelled. The Avro plant was shut down and its carefully assembled and highly skilled employees began to scatter to other plants and other countries, some notably to NASA in the United States.

While the *Arrow's* cancellation picture has turned out to be somewhat 'murky,' Brown clearly blames the Prime Minister for the way in which the program was cancelled and simply disbelieves that the aircraft was both obsolete and too costly. It was said to have cost, up until cancellation, as much as the St. Lawrence Seaway, and was going to cost more. Among Brown's words analysing the situation are these:

For Canada, and particularly the Canadian aircraft industry, the *Arrow* decision was a calamity pure and simple. In 1958, the program had poured a third of a billion dollars into the Canadian economy in the form of contracts and orders. Some two thousand Canadian firms had quoted on parts of the aircraft as sub-contractors. In a word, in economic terms alone, the decision was one that was to impair our standard of living for decades to come.

Brown exaggerated. He also did not realize that a steep upward thrust in development costs for new civilian and military aircraft had come into play. In a word, his economics was not as good as his journalism. However, the debate and mourning over the *Arrow's* fate have continued, albeit with diminished fury, ever since.

In any event, Brown has practically nothing to say in his book about the Seaway - a major *engineering* project, but not really an invention!

Brown lists many developments by companies and industries in the postwar period. In the pulp and paper industry, for example, he writes that the development and adoption of new products and processes continued all the time. These included new logging methods, gigantic trucks for moving logs over rough terrain, the use of helicopters for lifting, the development of the dumping barge for transporting and unloading logs, and paper quality control. Isotope Products - an Oakville, Ontario, company - developed and installed radiation devices for measuring the basic weight of paper. In 1957, John Hart of the E.B. Eddy Company in Hull, Québec, invented a device for measuring the moisture content of paper continuously. Nash & Harrison of Ottawa patented an optical detection machine for sheet materials such as paper. This machine sold chiefly in Europe and was used principally by companies making fine papers. Professor Howard Rapson of the University of Toronto became well known for his work in support of industrial papermaking.

In other industries, Dofasco in Hamilton was the first company in North America to adopt and perfect the oxygen process of steel-making, which originated in Europe. R.A. Kipp, founder of Kipp Kelly Limited, developed a series of machines that solved the problem of separating one material from another. The world's first aluminum-sheathed high voltage, oil-filled cable was designed by H.D. Short when he was director of research at the Canada Wire & Cable Company in Montréal. Bruce Nodwell, an Albertan, invented several types of self-propelled drilling rigs, which developed into a business making and selling off-road vehicles, world-wide. The firm that became ATCO Industries - another Alberta company that grew into a world-wide business - began with the building and renting of trailers to the oil industry. It developed ingenious systems of hooking up several trailers to provide bunkhouses, recreation halls and other configurations.

However, Brown claims that the ideas of another Canadian - Winnett Boyd, a graduate engineer and, in 1967, president of Arthur D. Little of Canada - were ignored by the authorities. After 1950, he had worked for the C.D. Howe Company on the design of the NRU reactor for AECL at Chalk River. With a colleague, he then designed "an advanced type of power reactor" but found himself at odds with the technical management of AECL over its adoption. While Brown admits to ignorance of the necessary technical knowledge "to adjudicate between the views of Boyd and the vastly differing views of AECL" he notes that Boyd tried, unsuccessfully, to get a Royal Commission set up to investigate the technical and marketing decisions of the company.

To end the descriptive part of his book, Dr Brown mentions three examples of inventions that might have vital consequences in the future. The first was the discovery by Neil Bartlett, a chemist, in 1962 that the 'noble' gases, such as xenon, can in fact combine with other substances - a development which, among other things, got the attention of chemical laboratories all over the world. The second was the potential being developed by Gerald Bull for launching satellites into space using a hypervelocity gun. This work attracted both positive and negative attention, the advantage being that gun firings were less expensive than rocket launches. The third was the system developed by Eric Leaver for tracing freight cars during their trips from points of origin to their destinations, something that worried both the shippers and the American Association of Railroads.

Brown's book has a 16-page concluding chapter which he begins with a reiteration of his principal thesis:

The paradox that enlivens the history of Canadian inventions is that Canada is a great producer of ideas, yet it has virtually no native technical industries. The story of Canadian invention and technology can be seen as a melancholy procession of golden opportunities which we have let slip through our fingers. We have let them go abroad to be

developed by other nations because we have not the vision to see their potential. The definitive statement on this problem was made some years ago: "Without vision the people perish."

While it is true that Canadian financial institutions, because of their conservative bias, trap potential risk capital and render it useless, the problem goes much deeper than mere reform of finance. The problem of invention and technology in Canada is basically a psychological rather than a financial one. Our whole attitude towards innovation, not only in science and industry, but in government and social life, is that of the pre-adolescent who hates anything new. What we Canadians have to do is grow up.

To cure our collective problem, Brown recommends we pay attention to redressing our balance of trade and the 'brain drain' to the United States. It matters not (to him) that in his text he discusses the extent of neither. He also claims that great breakthroughs have come from unsubsidized individuals and not from corporations, foundations or institutions, including the engineering schools within the universities. Governments cannot be of much help either because the politicians and public servants have no experience or incentive to take risks.

Brown is right to suggest that an *invention* will not reach a customer by itself and that other inputs are needed, but he ignores the *engineering* component of the invention/innovation process, the one that may turn out to be the key in getting the invention to the market. He is also right to suggest that an appropriate defence may be needed to retain the commercial value of a patent and that this can be an expensive business. But he also wants to see 'competent scientists' rather than lawyers sit in judgement over patent cases in the Exchequer Court. This would never be allowed!

In the end, to reach such conclusions, and especially in regard to the post-World War II years - even up to 1967 - would require much more analysis than even Brown provides. He does not, for example, examine in any detail the many *impediments* to innovation, or the differences that exist between product and process innovation. Nor does he analyse the effectiveness - or otherwise - of the federal and other government programs then in place to foster research, development and innovation, including legislation such as the Patent Act. There are no market analyses. While some of his pre-World War I conclusions may have some validity, those for the years from then until 1967 are mostly quite inadequate and, in many cases, are limited simply to critical statements. He has also, by his own definition, made *innovation* almost synonymous with *invention*, which it is not. And for a social historian, the author provides no analysis of the changes in Canadian society that were taking place over time. In other words, he simply 'shot from his journalistic hip.'

To Sum Up.....

- We have to remember that Brown's book was written 50 years ago and that there have been enormous changes in science, technology, engineering, invention and innovation since then, not to mention markets. Just think of the computer....
- The book should, perhaps, be considered a work of journalism rather than history, in spite of the author's academic qualifications.
- As it stands, and if you subtract the wilder statements and assessments the author makes, the book's strongest feature is that it *attempts* a history of invention in Canada - not an easy task; if nothing else, it brings readers' attention to many of the less 'visible' inventions that have been made by Canadians; but there are simply too many missing pieces to the 'puzzle.'
- The positive comments it generated in the press when it appeared were likely influenced strongly by the uniqueness of the book and by sympathy for the vast amount of 'grunt work' the author did while writing it; its value, however, is also diminished by a lack of authoritative economic/business/market comment, especially in those cases where the author is most critical of 'lost opportunities.'
- The word 'engineering' is very seldom mentioned in the text, and the word 'engineer' not often enough; however, it will be recalled that, in the mid-1960s, there was a great deal of talk about *science* policy, perhaps less about *technology* policy, but nothing whatsoever about *engineering* policy; these are not discussed.
- Also, at the time the book was written, the word *innovation* was coming into frequent use in the context of science policy, with *invention* often linked to it; understanding technological innovation as a process was really just beginning - Schumpeter, Schmookler, Freeman, Rosenberg, Harvey Brooks and many others notwithstanding!
- As far as I know, there were no published critiques of Brown's book in the years immediately following its publication; attention seemed to gravitate quickly to the publications of the new Science Council, the PCO's Science Secretariat and the Ministry of State for Science and Technology (MOSST) and to sporadic political discussions in Parliament and its committees.
