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ENGINEERING HISTORY PAPER #50

"The Entrepreneurs Behind the Engineers"

by Andrew H. Wilson
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EIC HISTORY AND ARCHIVES

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Introduction

The saying goes that "behind every successful man there is a determined woman." This might be extended to say that "behind every successful engineer there is a determined entrepreneur." Both may well be exaggerations, but with some essential truth to them. The purpose of this paper is to identify a few of the notable North American and British entrepreneurs who were behind notable engineers and engineering efforts at several points in historical time. In some cases the engineers can be identified; in others, they are too numerous.

In this context, and combining several formal definitions, the entrepreneurs concerned were individuals who undertook to manage risky but exploitable environments that permitted engineers to convert their technical brain-children into useful economic assets. I make no apologies for my selection of entrepreneurs. I simply want to illustrate how different they can be…..and yet how similar.

But first, two points of clarification. One is that there have not always been people called "engineers." But there have been - for a very long time - activities that can be defined as "engineering" in either the military or civilian contexts. The second is that there have been notable engineers who have acted as their own entrepreneurs. During the 19th century in Britain there were, for example: Maudslay, Whitworth, Napier, Fairbairn, and the Brunels, father and son. More recently, in North America, there have been George Westinghouse, Thomas Edison, Hewlett and Packard, and Simon Ramo.

Early 17th Century

The first entrepreneur I want to talk about is Samuel de Champlain, one of the very earliest explorers of what is now Canada. He can, from the historical evidence, be identified easily as an *entrepreneur*…..but for engineers?

The historical evidence about him is not always clear. Was he born in La Rochelle or in Brouage, both towns on France's Bay of Biscay? In 1570? Was he of a member of the French Royalty or nobility or of much more humble birth? Was he baptized a Protestant, only to become a Catholic later in life? What did he actually look like? Portraits and statues of him have been based on other people. His grave at Québec has never been found.

Champlain played major leadership roles in establishing New France - and a possible westward way to China….but was he always the boss? Evidently not. He had very good connections to France's King Henri IV, but was held in less favour by the chief ministers - such as Sully and Cardinal Richelieu - of later kings after Henri's death in 1610.

Abstract

This paper was originally presented orally to the Ottawa Branch of the Canadian Society for Senior Engineers on 19 February 2013. It has since been modestly edited and some illustrations have been added.

Its theme is the connection between successful engineers (or engineering efforts) and the entrepreneurs who backed them. Although the number of such 'pairs' included in the paper is very small, it covers engineers/entrepreneurs operating in the 17th, 18th, 19th and 20th centuries in Canada, the United States and Britain and draws several tentative conclusions from the discussions.

About the Series

Principally, the Cedargrove Series is intended to preserve 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 has been active ever since in research, writing and editing historical material on behalf of that Society, the Engineering Institute of Canada and the Canadian Society for Senior Engineers. He has also served as president of CSME and EIC.

Champlain ?

Bridgewater

Brindley

Merritt

In his mature years he was an explorer, first of the West Indies and later of New France. He took a principal role in the establishment and fortification of the Ile-Ste-Croix, Annapolis Royal and Québec colonies in New France. Any *engineer* who worked for him on these was a military man. He introduced European tradesmen and tools into the new country, encouraged the development of water-power, prospecting for minerals, the fur trade and farming. At the same time, he was quick to encourage the adoption of the useful technologies of the aboriginal peoples. He fought frequently for the colonists and friendly aboriginal people, and ventured south on their behalf into what is now the Lake Champlain area of northern New York State, as well as north-west from his bases on the St. Lawrence River, up the Ottawa River. Eventually, by way of the French River, he reached Georgian Bay, which he called the "sweet water lake" and which he saw as a major stepping stone in the westward route to China.

Champlain was noted, among his contemporaries, for his ability to work with the Indian tribes in New France, such as the Algonquins, Montagnais and the Hurons, as well as for his hostility towards the Iroquois. However, it seems he often travelled back to France in the Fall of the year and avoided Canadian winters! He also lost the Québec colony to the Scottish Kirke brothers in July 1629, and New France nearly collapsed. He returned to Europe. However, in 1632, after lobbying by Champlain and others in England and France, the colony was restored to France by treaty. A year later he was back in Québec, bringing with him a fresh company of settlers to join those who had remained and survived. Champlain spent his final years rebuilding the Habitation at Québec. He died there after a stroke, in 1635.

I have included Champlain among my entrepreneurs because he *was* one, and because he played an important part in the founding of what later became Canada, from coast to coast to coast, and helped initiate the opportunities that Canadian engineers have taken since his time.

Later 18th Century

Next comes Matthew Boulton, whose partners included engineers James Watt and William Murdoch.

Bolton was born in 1728, in Birmingham, England, the third child of a metalworking manufacturer - known in these days as a 'toymaker' - who specialized in making buckles and buttons. Matthew has been described by some historians as an engineer. But although he was certainly technically literate, an innovator and a problem-solver, he was basically a businessman and manufacturer. He did, however, enjoy membership in the Lunar Society of Birmingham - a group that met regularly for scientific discussions and included such people as Erasmus Darwin, grandfather of Charles, Joseph Priestley, the chemist, Josiah Wedgwood, the ceramicist, John Smeaton, the first *civil* engineer, and James Watt. Also, by 1785 both he and Watt had been elected to the Royal Society of London.

Matthew was made a partner in his father's business at the age of 21 and, when he died in 1759, became the principal. By 1765 the Soho Foundry had been built. It was to become famous,

world-wide, thanks to Boulton, Watt and Murdoch. Boulton became a silversmith, turning out jewellery products, in partnership with John Fothergill. He also established a mint, which made coinage - mostly for jurisdictions abroad - and manufactured Sheffield plate. In the 1770s, when Roebuck's partnership in Watt's separate condenser patent faltered, it was sold to Boulton, and Watt became his partner. Boulton was also responsible for obtaining the extension of Watt's steam engine patent to 1800, which gave them longer to exploit it. These engines were not actually built at the Soho plant, but were assembled on site by Boulton's men - notably William Murdoch. They were used initially to drain the Cornish tin mines but were eventually used in many other applications, including small ship propulsion. The Boulton-Watt partnership was eventually dissolved and turned over to their namesake sons.

James Watt was born in Greenock, Scotland, in 1736 and so was eight years younger than Boulton. A sickly youth, his education was intermittent. However, he was the son of a master-wright and was given his own spot in his father's workshop. He developed talents for mathematics, woodworking and metalworking. He also made models. Through contacts, he got his first jobs in Glasgow and London as a scientific instrument maker. But he also learned surveying and took part, for example, in the routing of the proposed canal between the Rivers Clyde and Forth. He formed a partnership in 1759 with John Craig in Glasgow for the sale and repair of instruments and steel ornaments, but retained his connection with the University of Glasgow. Watt married in 1764. That same year he was asked to repair a Newcomen steam engine belonging to the University. This led to the development of the separate condenser and to Watt's famous patent. He formed a partnership to exploit it with John Roebuck, of Birmingham, who had an interest in draining a mine in Scotland. In 1773, Roebuck sold his share in Watt's engine to Boulton - the same year that Watt's first wife died. The following year he moved to Birmingham and began his partnership with Boulton. Watt died in 1819.

William Murdoch was also a Scot, born in Ayrshire in 1754, not many miles from Watt's birthplace. His father was a millwright, in whose workshop William learned the trade and for whom he first worked. Throughout his career, he made many significant inventions and improvements, principally associated with the performance of steam engines, and cooperated with Watt in some of this work. He was also significantly involved in the manufacture of gas for lighting, replacing oil and tallow. The first industrial factory to be illuminated by Murdoch's gas was a cotton mill in Manchester. He received the Rumford Medal of the Royal Society of London in 1808 for a paper on 'the economics' of gas. Murdoch was also involved in the building of a prototype steam locomotive, in the development of a pneumatic system for propelling a cylinder containing a message through a tube, and in the development of British isinglass - used in the making of beer - which replaced material previously imported from Russia.

Murdoch was hired by Bolton originally in 1777, at the age of 23 and having walked the 300 miles from Glasgow to Birmingham, to make patterns for castings for machine parts. After two years he was moved into the business of erecting, maintaining and repairing Boulton-Watt engines on site, mostly in mines in Cornwall. He also kept a wary eye out for patent infringements by competitors and, in this activity, his physical safety was sometimes at stake. In

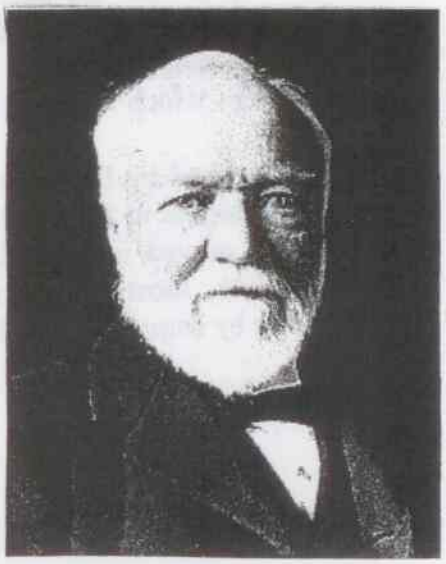
Boulton

Watt

Murdoch

Holley

Smith



Carnegie

1810 he became a partner in Boulton and Watt, by then run by their sons, and remained one until 1830. He died in 1839 at the age of 85.

Later 18th, Early 19th and Mid-20th Centuries

These next three entrepreneurs I call 'the ditchdiggers' since they were all involved in the building of canals of one sort or another.

The earliest historically is Francis Egerton, the third Duke of Bridgewater, and the entrepreneur behind the building of what was said to be the second 'true canal' in Britain (after the one at Sankey). It has also been said that he was inspired to do so after visiting the *Canal du Midi* in France.

His Grace was born in May, 1736, the younger son of the first duke and the younger brother of the second. He became duke at the age of 12. He never married, so he was also the *last* Duke of Bridgewater. He did in fact become engaged, at the age of 21, but when this was broken off he retired to his estates at Worsley, near Manchester in Lancashire.....and made canals. The first was needed, essentially, to transport the coal mined on his estates to its markets. This canal, from Worsley to Manchester, with its famous aqueduct across the River Irwell, was built for the Duke by engineer James Brindley and others and completed in 1761. Subsequently, in 1762, he obtained permission to build a more ambitious waterway between Liverpool and Manchester. This one involved the difficult task of carrying the canal over Sale Moor Moss. Again, Brindley was the engineer. His Grace was only 36 when the Liverpool-Manchester one was completed. He spent the rest of his life improving and extending the canals, as well as his estates, and enjoying financial success from his enterprises. He died in March, 1803, at the age of 66. The ownership of the canals was transferred from the Edgerton family to the Bridgewater Navigation Company in 1872 and sold to the Manchester Ship Canal Company in 1887.

James Brindley was born at Tunstead, Derbyshire, in 1716, into a family of yeomen farmers and craftsmen. At 17 he was apprenticed to a millwright at Macclesfield. He showed ability and, at the end of his time, set himself up in business at Leek, in Staffordshire, expanding it in 1750 at Oakham. In 1752 he built an engine for draining a coal mine at Clifton in Lancashire and, three years later, built a machine for a silk mill. His work and abilities came to the Duke of Bridgewater's attention and he was commissioned to participate in the building of the Worsley-Manchester canal. He also worked on Bridgewater's second canal and on the extensions. His reputation spread and he became involved in the building of the Trent-Mersey canal, which included locks. Since he had never built one, he first made a model before incorporating the full-scale versions into the canal. Its design influenced the construction of the 'narrow boats' that have since then carried freight on English canals. This canal included a long tunnel, which took a long time to build, with the result that the completed canal was not opened until some years after Brindley's death in 1772, at the early age of 56.

The second 'ditchdigger' - associated with the building of the First Welland Canal - is an

American-born (in 1793) Canadian, William Hamilton Merritt, whose Loyalist family settled on a farm at Twelve Mile Creek (now St Catherines) on the Niagara Peninsula. At school, he learned both mathematics and surveying as well as some of the classics, but returned to Lincoln County in late 1809 to the family farm. He also opened a general store. He served as a commissioned officer in the War of 1812, took part in several battles, was taken prisoner at the Battle of Lundy's Lane and remained a prisoner-of-war in the U.S. until the War's end. On his return to Canada, he became involved in farming and in a variety of commercial ventures, including several mills and the manufacture of salt, in and around 'the Creek.'

Some years later, he became concerned about the supply of water to his mills. He was also concerned about the threat to Canadian trade of the opening of the Erie Canal, from Buffalo to New York. At that time the Niagara Escarpment, rising more than 300 feet from Lake Ontario to Lake Erie, presented a barrier to transportation that meant water traffic had to be unloaded for a land journey over the escarpment. In January 1824, the Legislature of Upper Canada formed the Welland Canal Company, with Merritt as the first general manager and financial agent. He, in turn, recruited Alfred Barrett as the chief engineer of the project.

The first stage of the First Canal - "Mr Merritt's Ditch" - was opened in 1830. It ran from Port Dalhousie on Lake Ontario, winding up the Niagara escarpment and across to Thorrold and to Port Robinson on the Welland River, where the ships turned left and followed this river to Chippawa on the Niagara River and from there into Lake Erie. A southern extension from Port Robinson to Port Colborne on Lake Erie was opened in 1833. The canal then had 40 wooden locks and stretched 27 miles between the two Great Lakes. But while the minimum lock size of 110ft. by 22 ft., with a depth of 8 ft., could accommodate the original boat traffic, it was soon too small and had to be enlarged. This became the Second Welland in 1845.

I have been unable to find information about the engineer, Alfred Barrett. However, the Welland Canal in its various forms provided engineering experience for several generations of Canadian engineers, including Samuel and Thomas Keefer whose father, George, was a close friend and colleague of William Hamilton Merritt. And engineers John L. Weller and Alexander J. Grant played significant parts in the work of transforming the Third Welland into the Fourth in the 1930s.

Merritt's fame as an entrepreneur rests significantly on his participation in the building of the First Welland. But his business interests were, in fact, much wider and the activity that consumed much of his energy was raising the money for his projects. He was also in politics, in Ontario, for many years.

The third 'ditchdigger' is also a Canadian politician, although much more contemporary than Merritt - Premier Roblin, of Manitoba, who was the man behind the Greater Winnipeg Floodway, nicknamed "Duff's Ditch." Businessman, airman, politician and finally senator, Dufferin Roblin was born in 1917 and was premier from 1958 to 1967.

This Floodway was built to protect the city of Winnipeg from the severe spring floods in the upper Red River Valley that have occurred from time to time and had been especially destructive in 1950.

Essentially, when in operation, the Floodway supplements the flow capacity of the Red as it passes through the city. It was a major, major undertaking, involving much public discussion and a Royal Commission. Roblin championed it while the Leader of the Opposition in the Manitoba Legislature and, following the formation of the provincial government which he led, it took immediate shape with support from the federal government. In other words, Roblin was a 'public' rather than a 'private' entrepreneur.

The Floodway's construction involved such complications as the re-routing of transportation, communications and utilities facilities that crossed its path, the need for extensive soil mechanics studies, the need for model studies, and the unprecedented magnitude of the excavation required. The project was under the charge of the Manitoba Minister of Agriculture and Conservation, George Hutton, and the Red River Floodway Advisory Board was established under this Department to oversee its planning, design and construction. The inlet and outlet structures were designed by the H.G. Acres Company of Niagara Falls. It cost over $60 million.

Robert Passfield has written a splendid article on the history of the Floodway, which appeared in the Autumn/Winter 2001-2002 issue of *Manitoba History*. As he notes, it was an achievement of national importance and proved its worth beyond dispute during the "Flood the Century" in 1997.

Later 19th Century

Returning now to the 19th century and to two Scottish-born men whose entrepreneurial contributions to engineering - in Canada and the United States - were also on a very large scale. Both of them lived to be very old, white-bearded men, full of accomplishments.

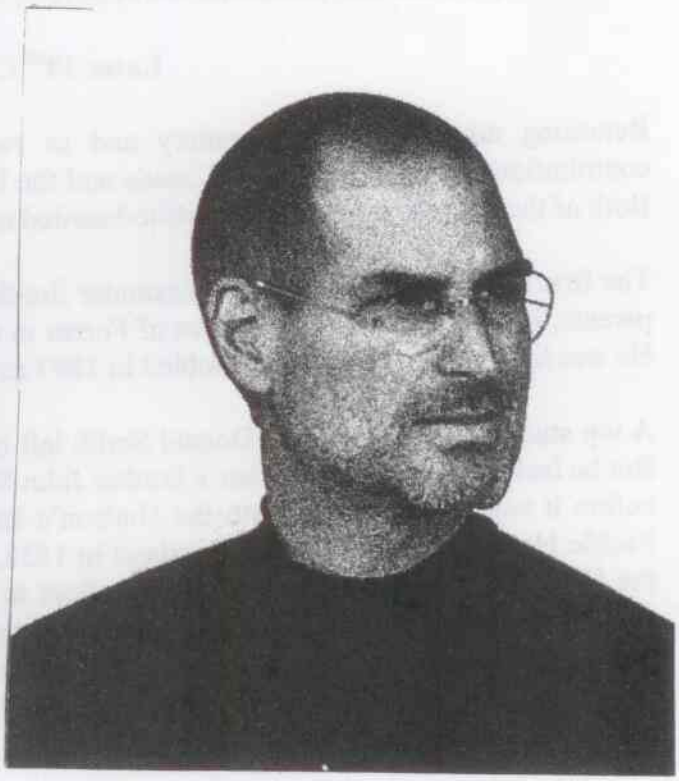
The first to be born was Donald Alexander Smith, the red-haired, blue-eyed fourth child of his parents, in October 1820 at the town of Forres in the County of Moray in northeastern Scotland. He was knighted in 1886, and ennobled in 1897 as Lord Strathcona.

A top student at school, when Donald Smith left he was briefly apprenticed to become a lawyer. But he had a kinsman, his mother's brother John Stuart, who had joined the Northwest Company before it was amalgamated with the Hudson's Bay Company (in 1821) and had served in the Pacific North West. On leave in Scotland in 1838, young Smith was persuaded by Stuart to join the HBC as an apprentice, which he did. Sent to what is now Labrador, he became a clerk in 1842 and remained there until the 1860s, rising to be chief factor. In 1868 he was sent to Montréal to take charge of the Bay's eastern operations. Also in 1868, he joined with his cousin, George Stephen (later Lord Mount Stephen) and several other partners to establish a textile manufacturing company at Sherbrooke, Québec.

Roblin

Solandt

Buchanan and Beck



Jobs

The following year, he was sent by the Canadian Government to the Red River Settlement in Manitoba to negotiate with Louis Riel, which he did with mixed results. In 1870 he was back in the east at HBC's headquarters, taking charge of the administration of the Bay's activities in Manitoba and the Northwest Territories. That same year, he was elected to the Provincial Legislature of Manitoba. And so began a decade when he was an independent conservative politician, as well as a businessman defending the HBC's interests, shuttling between Montréal, Winnipeg and Ottawa and falling in and out of favour with Prime Minister Sir John A. Macdonald. In 1873, Smith became the Bay's land commissioner, until 1879, responsible for all its real estate dealings.

Smith's HBC and political activities stimulated his interest in railroads. In 1875 he was among the incorporators of the Manitoba Western Railway and a partner in the Red River Transportation Company, which gained control over the St. Paul (Minnesota) and Pacific Railroad in 1878. He was elected a director of it the following year and was among those who persuaded investors to build a line from Minneapolis to the Canadian border to join a Canadian line running south from Winnipeg. Subsequently, Smith became a leading figure in the Canadian Pacific Railway and a director in 1883. He was deeply involved in raising the financing for the Railway's push westwards to the Pacific and famously hammered in the last spike at Craigellachie. He was never the president of HBC, but became its Governor in 1889. Instead, he presided over the Bank of Montréal. He re-entered politics in 1887 as a Montréal M.P. and was offered the Prime Minister's job by Bowell in 1896, which he refused. Tupper, who got the job, sent Smith to London as Canadian High Commissioner, where he remained until his death in 1914.

As an entrepreneur, Donald Smith principal connection to engineering was through railways. In the last quarter of the 19th century, most of Canada's senior engineers were associated with them, including Sandford Fleming, Samuel and Thomas Keefer, Casimir Gzowski, E.P. Hannaford, Alex Peterson, Herbert Wallis and Collingwood Schreiber - all but Fleming and Schreiber serving as presidents of the Canadian Society of Civil Engineers (now the Engineering Institute of Canada). Smith, by then Lord Strathcona, was elected an honorary member of the Society in 1900.

The second to be born was Andrew Carnegie - in Dunfermline, in 1835. He was the small, fair-haired first-born son of an impecunious handloom weaver and his wife. When hard times continued to intrude in 1848, the family - including Andrew and brother Tom - emigrated to the United States, to Allegheny City, then separate from Pittsburgh and not the healthiest or most pleasant of places. But there were lots of work opportunities. Undersized and having no education or skills to speak of, Andrew began work - in rapid succession - as a bobbin boy in a textile mill and as a boiler-minder before landing a job as a telegraph messenger in booming Pittsburgh. He also made his Scottish accent disappear. He now wanted to become a telegraph operator, and did, just as the telegraph systems in the United States were expanding rapidly, creating more business.

Andrew went to night school and began to read seriously, nurturing his intellectual appetite and

literary aspirations. In his job, Andrew got to know Thomas Scott and Edgar Thompson, Pennsylvania Railroad managers and, at seventeen, went to work for the Railroad, becoming Scott's telegraph operator and chief assistant. From Scott, he learned about the management of a company - and also about investing the money he was slowly accumulating. When Scott was promoted and sent to Altoona, Carnegie went with him. From Scott and Thomson he learned about cost accounting. From Scott's niece, he learned about manners and social graces. But all the time, he watched, listened and learned the railway business and how to manage it.

In 1855 Andrew's father died, but the family's collective fortunes rose rather than fell in the succeeding years. Both his mother and brother were able to improve their incomes and lives. Andrew became one of Pittsburgh's up-and-coming young men. By 1860, at the age of 25, he was the superintendent of the Western Division of the Pennsylvania Railroad. He had investments in sleeping cars, bridges, and oil derricks. Not long after, he was into Western Union stock, coal companies, an oil company and an iron company. One thing he wanted to get out of was *superintending* other men, and he wanted to scout out his own investment opportunities. When the Civil War began, he became involved in the construction of rail lines for the military at Washington. During it, he was exempt from the military draft because of his employment on a railroad. At the same time, he realized that the War would open up new opportunities for aggressive people and, after the War, even further opportunities would develop. He intended to be one of them.

In 1864 Carnegie began to invest seriously in oil, which proved to be very profitable, and in the iron business. After the war, he left the Railroad (but not his association with Scott and Thomson) and went into the ironworks business. He also had a year-long vacation in Britain and Europe and took time out of it to visit iron mills. When he returned to the U.S., the switch from iron rails and bridge girders to steel ones was underway and, from it, Carnegie experienced both ups and downs. He formed and re-formed several companies. But he made his fortune - said to be a million dollars by 1870 - in steel, a fortune he decided he should share with others less fortunate in the form of libraries and other facilities. His first gifts were to the town in Scotland where he was born. He also sold bonds and did a great deal of travelling to do so. In 1870, he moved his permanent residence to New York, taking his mother with him. But he was married, after she died in 1886, to a lady 20 years his junior, with whom - in 1897 - he had a daughter. He became the author of articles, pamphlets and books.

Carnegie came to control extensive, integrated steel operations that mass-produced steel using the process developed by Sir Henry Bessemer. This steel was, for example, rapidly applied to rails and bridge girders and was cheaper than other kinds. The successful use of his product on the Eads Bridge across the Missouri helped open up the new market. By 1889, Carnegie owned a large part of the total U.S. steel output - for example, the J. Edgar Thomson Steelworks, named after his former mentor, the Pittsburgh Bessemer Steelworks, the Union Iron Works, and the Keystone Bridge Works. He believed in what became known as 'vertical integration' and acquired the Frick Coke Company and the Scotia ore mines. Carnegie's reputation rested on his ability to have his companies integrated and profitable. J.P. Morgan noted this and, in 1901, as

Carnegie was considering retirement, bought him out along with several other steel producers to form the United States Steel Corporation.

My source for Carnegie has hardly any information about engineers who worked for him over the years in his adoption of the latest appropriate technologies for his businesses, for productivity improvement, cost cutting and so on. An exception is Alexander Lyman Holley. Born in Connecticut in 1832, Holley's father was a cutlery manufacturer. A 1853 graduate of Brown University, he became an inventor while still an undergraduate. On graduation, he went to work for the Corliss Company, on locomotives. He then branched out into technical writing. By 1861 he was back in the locomotive business, The next year he went to Europe to study the Bessemer steel-making process and bought the American rights to it. By 1867 he had designed and built his first Bessemer plant in the U.S., and followed this with several other plants, including Carnegie's Edgar Thomson plant at Pittsburgh, becoming the country's foremost technical expert on the manufacture of steel. He received 10 patents for improvements to the Bessemer process. Holley belonged to several American and European learned societies, joining the ASME when it was founded in 1880, serving as vice-president until his early death in 1882.

Early 20th Century

North, again, to Canada and to Adam Beck, of London, Ontario, and Ontario Hydro. Beck is another of the political entrepreneurs. The son of German immigrants, he was born in Baden, in 1857.

Beck's father was a foundryman and Adam began his working life in his plant. Later, with his brother William, he established a company in Galt that made cigar boxes. He moved the company to London in 1885, where it flourished, making him a wealthy man. He entered local politics, where he became prominent. In 1898, Beck ran provincially, but lost. He was also married that year. Two years later, following another of his interests, he founded the London Health Association that would emerge later as the University and Victoria Hospitals. In 1902 he ran successfully for mayor of London and, as a conservative, for the local Ontario Legislature seat. At that time, both offices could be held simultaneously. He was also mayor and MPP in 1903 and 1904.

An advocate of a publicly-owned electrical supply grid, Beck convinced Premier Whitney to appoint a board to look into this possibility for Ontario, with himself as chairman. Its report recommended the creation of a municipally-owned hydroelectric system, funded by the province, using water from Niagara Falls and other provincial lakes and rivers. In 1905, the Premier appointed him Minister without Portfolio and, in 1906, the founding chairman of the Hydro-Electric Power Commission (HEPC) of Ontario, which was established under the provincial Power Commission Act. By 1908, the Commission had entered into agreements with 14 municipalities. In 1914, Beck was knighted for his services to electric power distribution and other things. He retained the HEPC chair until his death in 1925.

When the city of London joined the HEPC scheme, Beck advised the mayor and city Council to make the management of electrical supply a function of the existing Board of Water Commissioners. This was the organization that a young Scottish immigrant electrical engineer by the name of E.V. Buchanan joined when he arrived in London in 1910 to help supervise the electrical part. The HEPC's transmission lines from Niagara Falls to London had just been completed and were switched on by Beck on November 30. But Buchanan also had responsibilities for machinery associated with the water supply. He first met Beck, close up so to speak, during a tour of this machinery. Buchanan notes in his autobiography *Roses in December*,

> He approached me brusquely and demanded to know who I was and all about me. He ended his conversation by saying, "Well I suppose Scotland is a good place to come *from*!" This was typical of him. He visited the job frequently and inspected everything closely. Nothing missed his sharp eye. As I accompanied him around the work he would peremptorily issue instructions, but being young and brash I frequently refused to comply with his demands, which made him very angry. Curiously, this increased rather than diminished my favour in his eye; he despised "yes-men" and the many people who "kowtowed" to him.

Interestingly, Buchanan spent the rest of his life in London and rose to head the Public Utilities Commission and other city organizations, retiring in 1951. Later in life he was known to smoke a long-stemmed churchwarden pipe. He received an honorary doctorate from his *alma mater* in Glasgow at the age of 95. Western Ontario had given him one earlier.

Also in 1910 - as a result of Beck's daughter having had the disease, from which she recovered thanks to being able to afford appropriate medical care - he founded a public tuberculosis sanatorium to help those whose resources could not cope with the treatment. During World War I he promoted the idea of having public ownership of inter-urban railways, but it failed. In 1919, he lost his provincial seat, although he regained it in 1923.

In 1950, a quarter-century after Beck's death, the HEPC renamed the Queenston-Chippawa Power Station after him. In 1974, the Commission became Ontario Hydro. Long before then, by the late 1950s, it had built a considerable reputation for the quality of its engineering vision and activities, including being the first electric power utility in Canada to become involved with nuclear generation. It had also become an 'employer of choice' for young engineers, including me.....But I never made it!

Mid-20th Century

Now to another Canadian, one born in this country, in Winnipeg in 1909, with a strong Scottish heritage on both sides of his family, and the second son of a Presbyterian minister: Omond McKillop Solandt - often referred to in later life as "OMS." For someone who trained as a medical doctor, his claim to entrepreneurship may seem a little thin. Yet he did risky but exploitable things in a variety of fields. And he had unusual connections to engineering. He was,

as the Scots used to say, "a man of many parts" and, as a young man, an active athlete. As David Grenville notes in his contribution to the 1994 seminar on Solandt's legacy, OMS was named after Hugh Omond, the husband of his father's sister. This unique first name and his unusual surname ensured a distinct identity. In his post-athletic life, he was not a large man and spoke with a quiet voice, giving him a misleadingly non-threatening appearance. But he was both aggressive, persistent and determined. In middle life, he was an enthusiastic canoeist and explorer of the remoter parts of Canada.

When OMS was 11, the Solandts moved to Toronto. In boyhood, he became enamoured with many things mechanical. He finished high school as the top student of his class and a member of the junior football team. That same winter, he enrolled in the Marconi Radio School and qualified as a radio operator and with a potential summer job on the Great Lakes. He also took flying lessons, but ran out of money before he went solo. In 1927 he registered at the University of Toronto in a science/pre-med course. He played football and won the gold medal on graduation in 1931. The recent success of Banting and Best in their discovery of insulin persuaded him to spend a year before medical school on an M.A. course - under Dr. Best. However, just as his medical course was about to start, Solandt contracted polio, from which he was lucky enough to recover fully. Having lost part of the year to illness, he spent the rest of it in Dr. Best's lab. He then went on to complete his medical degree. In the summer of 1935, he was in Russia for an international physiology conference, a heady experience for a young student. He graduated M.D. in 1936, again with the gold medal.

OMS then decided to specialize in clinical research in cardiology and went for a year to Cambridge, England, returning to Toronto in 1937 to complete his medical internship and, while there, took a special interest in blood transfusion. A year later he was off again to London to study for membership of the Royal College of Physicians - which he did successfully at the first try early in 1939, and then went back to Cambridge to lecture and to finish an M.A. degree. He spent the last peacetime summer before World War II travelling in Europe.

Solandt taught physiology and did blood research at Cambridge until May 1940, when he was appointed to take charge of the Southwest London Blood Supply Depot, under the auspices of the Medical Research Council. He has been credited with improving the methods for storing blood. In January 1941 he moved to the Army's Tank Gunnery School at Lulworth in Dorset to set up a physiology laboratory. From this base, he was introduced to operations research and began to concentrate on operational problems, which appealed to his underlying interest in things mechanical. In 1943, he was appointed civilian deputy superintendent of the Army Operational Research Group and in 1944 was commissioned in the Canadian Army, and was quickly promoted to colonel. At the War's end, he was a member of the British party that went to Japan to assess the nuclear bomb damage.

Returning to Canada from Japan, OMS was appointed director general of Defence Research. The following year he helped establish the Defence Research Board, becoming its founding chairman. In this position, he was responsible for a group of research establishments across Canada. After

the Korean War, however, there was less political interest in defence research. So Solandt accepted an invitation to become vice-president of research at Canadian National Railways in Montréal. In this position, he had much to do with engineering and industry. In 1963 he left CNR to join the de Havilland-Hawker Siddeley in Toronto as vice-president for R&D. In 1966 he left the aircraft industry to join the Electric Reduction Company as part-time vice-chairman. At the same time, he served as Chancellor of the University of Toronto, until 1971, and became the founding chairman of the Science Council of Canada, until 1972. After that, he accepted company directorships, as well as many consulting assignments and other part-time positions, including one with Mitchell, Plummer & Associates, a venture capital company and, in 1982, as a senior adviser to the Royal Commission on the Ocean Ranger Disaster.

In Solandt's case, his influence on engineering was actually extensive, involving leadership as well as management and consulting. He became involved in the professional side of engineering through the Engineering Institute, which granted him honorary membership in recognition of his contributions to it. And, unusually for an honorary member, as well as a medical doctor, he served a year on the Institute's Council, as Treasurer. As David Grenville writes in his paper to the 1994 seminar:

> Omond always got on well with engineers, thought of them as scientists who do things, and indeed considered himself to be one. He admired their robust approach and readiness to tackle difficult practical tasks, and their boast that they could do them more quickly, more cheaply and more effectively than anyone else.

Solandt received many honours for his wartime and post-war activities, including Companion in the Order of Canada in 1970. He retired in 1988 and died in May 1993, at the age of 83.

Late 20th (and early 21st) Century

Finally, Steve Jobs, whose death in 2011 removed an unusually effective designer/marketer from what might be called 'the electronic devices industry in the United States and around the world.'

His story has been well covered in books and articles: adoptee with a technically accomplished father, brilliant student, follower of Zen Buddhism, disciple of Bob Dylan, college drop-out, design and control freak, entrepreneur, promoter, showman and, while technically literate in both hardware and software, hard-driving, highly emotional and competitive. And, as it turned out eventually, a relatively stable family man.

Jobs was often right, and usually got his own way regardless of the fuss he created in doing so. He believed in the effectiveness of laboratories, but usually sought to have them 'do it his way.' His approach to electronic devices brought him into conflict, as well as into a form of friendship, with the other contemporary titans of the computing business: Bill Gates of Microsoft, Eric Schmidt of Google and Larry Ellison of Oracle. He was seldom the inventor of a new technique or device, but was more often the innovator taking someone else's invention to market and, as a

result, was often in court. He took Apple into the hardware as well as the software business, and he opened up immensely successful commercial outlets to boost the market shares for its products. He redefined the telephone and shook up the music business. In his mature years he forsook conventional business clothing in favour of black sweatshirts, jeans and sneakers. But it wasn't until Jobs had stumbled a time or two that he had learned enough and was able to build Apple into what has become the largest company in the world. And we must not forget his connections with the Macintosh computer and the companies called NeXT and Pixar.

Of the engineers Jobs influenced, the best known is his long-time friend and Apple co-founder, Steve Wozniak, who participated in the work in the Jobs family's garage that turned out to be the start of the journey. Woz was a graduate engineer, a technical wizard, but not a businessman - even although he became very rich through his association with Jobs. Others included Andy Hertzfeld, Jon Rubinstein, Avie Trevanian and Ed Catmull.

And, of course, Steve Jobs was strongly influenced by many other engineers inside Apple and his other companies, as well as influencing engineers in competitor companies. At the same time, he owed a great deal to the talents and persistence of designer Jony Ive, manager Tim Cook, marketer Lee Clow, publicity guru Regis McKenna, animator John Lassiter, apple farmer Robert Friedland, and Apple chairman Mark Markkula, and not so much, perhaps, at the end of the day, to John Sculley or Gil Amelio.

In Brief Conclusion...

The sample of entrepreneurs and engineers is far too small to provide definitive conclusions. However, it should be clear that entrepreneurs can come in different sizes, with different backgrounds/experience and different objectives. The engineers are the same. The main point is that they can help one another achieve economic and social goals that benefit people, generally, as well as companies and individuals. The entrepreneurs discussed have all shown entreprise in a number of areas, not only in relation to engineering.

As it happens, and with the exceptions of Boulton and Watt, those mentioned did not hand over the reins of their businesses or activities to sons - or to daughters for that matter. On the other hand, almost all of the entrepreneurs had entrepreneurial fathers, some of whom were also skilled tradesmen. Also, a political career does not appear to be a deterrent to entrepreneurship in support of engineering. And all entrepreneurs are *determined*.

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