CHAPTER 1

THE BEGINNINGS OF ENGINEERING IN CANADA

The first regular course of instruction in engineering in British North America began on the fifteenth of February, 1854. Thomas McMahon Cregan, at the behest of the Lieutenant-Governor of New Brunswick, Sir Edmund Walker Head, began teaching that day to a class of twenty-six students. Cregan gave his lectures at King's College, that great stone structure which was to become the nucleus of the University of New Brunswick. Offering such a course was a daring experiment for its time. It was a desperate attempt to preserve the college against the rising tide of those who would have it closed. A significant proportion of the population of the province were increasingly hostile to the Tory appointees who had so long held control of the province. King's College, seen as a part of the Tory empire, stood as an obvious target for the popular faction. There were some who felt that the College should offer a more practical curriculum. The curriculum should include details of telegraph and railway construction, or agricultural principles: others felt it should be closed. It was not long before the fate of the college became the favoured subject of debate in the House. The Methodists and Baptists sought to divert the college funds to some other purpose, whilst the Anglicans and a few others attempted to preserve them. It was not totally unexpected that certain of the college faculty should exacerbate the problem by their own uncompromising stand on the matter.

But we get ahead of ourselves: the seeds of this destructive temperament did not flourish overnight. The problems of the College were inherent in its founding; indeed they were to be found in the political and social turmoil of the century before. With the growing political awareness in British North America, aggravated by events south of the border, social and political structures were undergoing profound changes. Additionally there came daily news of the wonders of the "New Age" brought on by the Industrial Revolution. The impetus to establish a "practical curriculum" at King's College came as much a reaction against the controlling interests as from the very pith of the province's needs for security in the new technological era.

Engineering had already played a substantial, though unsung, role in the nation's founding. As soon as settlements began to appear in the New World, fortifications for their defense arose with them, and sometimes before. The expertise to design and build forts, and the roads connecting them, was a rare commodity. It was a need on which the pioneers depended for their very survival[1].

The Anglo-French hostilities and related Indian uprisings in the seventeeth and eighteenth centuries dictated that constructions be of a military and strategic nature.From the very beginning forts sprang up along all the major routes of travel. They were sometimes for the protection of settlements and the furtherance of the land claims made by various governments. More usually, however, they were private affairs given under license to protect the lucrative industries of fur, timber and fisheries claimed by competing organizations. The early engineers could turn their attention to civil works only after military supremacy had been established in the region. Hence roads, fortifications and harbours were constructed with a view towards

military defense strategies. Consideration of the needs for civilian settlement came a distant second, if at all.

The French developed a strong engineering presence in the New World, enabling them to take bold action against the English forts without fear of reprisal. One such foray resulted in the destruction of the fort of St. Johns in November 1696. This action at last awakened the British Home Office to the need for military engineers. The relief force sent out the following year included chief-engineer Michael Richards, as well as engineer Isaac Petit and three assistants. They were the first British Engineers of record in Canada.

The French and English traded hostilities back and forth around the globe for the next half century. Most of the action in the New World involved the fortress of Louisbourg on Cape Breton. By 1745, the various engineers on both sides had forged Louisbourg into a vast arsenal, with thirty-foot high walls surrounded by an eighty-foot ditch. In that year, there was a further outbreak of hostilities. A militia party under command of William Pepperell took Fort Louisbourg from the French by seige. Richard Gridley, later to become the Chief Engineer to General Washington, assisted in the campaign[2]. The victory was short-lived. In return for French recognition of the Hanoverian claim to the English throne, England returned Louisbourg to the French by the Treaty of Aix-La-Chappelle. The English engineers had repaired and strengthened the fort so that it represented a constant threat to the British settlers in Nova Scotia. In an attempt to appease the British colonies the Home Government agreed to request the English defenders who were vacating Louisbourg under the terms of the treaty, to establish themselves at Chebucto. Chebucto, later known as Halifax, became an armed town, designed to protect His Majesty's Dominions in the New World. The first settlers, numbering 2,576,

arrived on June 14, 1749. The first Canadian military artificer, or engineering unit, was founded there on December 10th of the same year with the initial objective of securing the town's defenses. The military engineer attached to the expedition, Inigo Bruce, together with his surveyor, Charles Morris, established the townsite on the slopes of Citadel Hill[3].

Hostilities between French and English broke out again in 1754. Franquet, the French engineer at Louisbourg, had strengthened and improved the fortress over the intervening years so that it was virtually impregnable. Additionally, it housed a garrison almost as large as the British garrison in Canada. Louisbourg was the bastion of the French hopes in the new world. It was the pinion of the line of French fortifications extending down through the disputed territories to the Mississippi Valley. This line was meant to contain the English advance westward. But it depended very much for its success on the thin veil of communications between forts throughout this frontier. In our era of daily transit to almost any point in the world, and some places out of it, it is difficult in the extreme to conceive of the hardships of travel in that era. The engineers who prepared roads and bridges for the advancing troops throughout the ensuing land campaigns played a powerful hand in the success of any encounter. The subsequent fall of Louisbourg precipitated the end of French hopes in Canada. This event proved that the key to a secure settlement often rested in the hands of the military engineers. George Washington began his career as a surveyor, during these altercations, gaining first-hand evidence of the necessity of engineering enterprise for military success.

Squabbling was breaking out between the colonists and the Home Office in the southern colonies, resulting in more armed conflict. Again, the logistics of military transportation played a considerable part in the outcome. For example, Washington refrained from any action against

Nova Scotia, even though invited to come by a delegation of disgruntled Haligonians. These sympathizers insisted that little powder would be required for the show of force necessary to take the town. However, such an action would have weakened the American forces at Boston for an unconscionably long time. In any event it was unlikely to succeed. Washington's campaign got off to a poor start, particularly because of the want of appropriate engineering skills. Since the military engineers remained more or less loyal to the British Crown, the revolutionary militia had very little expertise to draw on, save that of Washington and a few others like him. Indeed, Washington complained early in the campaign of[4]: "... a want of engineers to construct proper works and direct the men. I can hardly express the disappointment I have experienced on this subject; the skill of those we have being very imperfect."

Out of these sentiments grew Washington's determination to found a school for the training of engineers. The school eventually opened at West Point in 1794, but burned shortly thereafter. In 1802 Congress gave West Point Military Academy its seal of approval. This was very likely the first engineering school in the entire English-speaking world. The only other claimant to the title was the engineering school of the University of Glasgow. The forerunner of the Glasgow school was Anderson's college[5], founded under the beneficence of John Anderson. Anderson was Professor of Natural Philosophy at the University of Glasgow, and dedicated to "the good of mankind and the improvement of science." The establishment and support of this school was evidence of the public concern for scientific endeavour. It was probably the first British institution to provide regular instruction in "the practical arts."

Meanwhile, France had experienced a remarkable period of construction during the reign of Louis XV. Jean Rudolphe Perronet, Chief Engineer of Bridges and Highways, provided the

expertise behind this revival of construction skill. Perronet was so successful that Louis XV ordered him in 1747 to found a school to train individuals for the engineering wants of the country. The three-year curriculum included study of the design of bridges, roads, buildings, canals and other works. To some extent, it laid the basis for the modern engineering instructional method, especially that practised in North America.

The French Revolution disrupted the educational scheme. However, Napoleon, perhaps with an eye to the military want, maintained the school of engineering. In 1794, he sought to improve on Perronet's school by establishing L'École des Travaux Publiques. This school became the basis for L'École Polytechnique, and ultimately came to serve as a model for the American colleges of engineering. As in France, the first civil engineering schools in America grew up either independently from the universities, or as colleges of engineering only loosely affiliated with the universities. It may be assumed that the first curriculum in civil engineering dates from 1747, and that it developed in France. The concept was transplanted to North America, before ultimately finding its way to Britain.

Civil and military engineering were not the only disciplines to receive early attention. Mining and metallurgy were taught at Freiberg from 1765 at what became known as the Bergakademie; and mining received due attention in Paris at L'Ecole des Mines, established in 1783. By the early nineteenth century, France and Germany were recognized as the leading centres of training for the practical arts throughout the world. This situation was not to change much for almost a century, although the United States laid early claim to a position of preeminence in engineering.

Following the successes of West Point graduates in the War of 1812, the School was

given leave to reorganize under a much broader mandate. Col. Sylvanus Thayer travelled to France to study the organisation of L'École Polytechnique, and its curriculum. Returning home, he was appointed superintendent of West Point. He immediately rearranged the curriculum after the French model, even to the adoption of some of the French texts[6]. For much of the century to follow, the other American schools followed the example set by West Point, modelling their organizations, structures and curricula on the French model.

The Situation in British North America

The rough pioneer community of Halifax, meanwhile, was being treated to the spectacular largesse of Prince Edward. The Prince Regent had arrived as Commander-in-Chief of his Majesty's Forces in Nova Scotia on May 8, 1795. Owing to the mystique surrounding Napoleon's adventures, the young prince quickly became obsessed with the notion that the French were making ready to attack the British possessions in North America. To effect some safeguard against attack, he contrived to build a signal system, in fact America's first semaphore telegraph, to provide a communication network throughout Nova Scotia and New Brunswick. He set his engineers to survey a route from what subsequently became known as Signal Hill in Halifax to Annapolis. Thence the line went around the Bay of Fundy to Saint John, up the Saint John River to Fredericton, and from there on to Quebec. This grand and magnificent scheme was not entirely implemented, being completed only as far as Fredericton[7]. Nor is there any record that anyone else but the Prince made use of it. However we do know that the line was used under his direct orders to send messages at least as far as Annapolis[8]. It is quite likely that the "famous Fundy fog" obscured visual signals over long periods, thus hindering the operation. This first bold communication effort all came to naught after the Prince's departure from Halifax in 1802. By the time of the War of 1812, the signal telegraph had fallen into decay through

disuse, with fresh foliage obsuring the carefully surveyed sight lines. What a boon it might have been to later generations had its true worth been recognized and its benefits available to all.

Communication and travel in the Eastern Provinces were difficult in the extreme. The roads were simply cleared mud tracks with the stumps left in the way, in hopes they would decay. In summer, the roads were dust and dirt. Winter travel by sleigh was easier. In spring, travel was quite impossible since the river was unsafe and the roads were awash in mud. Dr. James Johnston[9], who reported so extensively on the agriculture of the Province of New Brunswick, remarked in 1851 "... my recollection is very vivid of the execrable condition of the roads... Deep ruts, heavy mud, and large pools almost covering the road, compelled our willing horse to linger." Christopher Atkinson[10] reported in 1844 that: "In the month of May, the weather has but little improved over that of April. The snow falls heavily at intervals, and melted by the increased power of the sun, mixes with mud till the streets are like a bog, and would be considered in any other part of the world impassable. The variations of temperature are excessive - keen frosty winds and a warm sun, acting together, try the weaker constitutions."

Not only were the roads bad and travel slow, but also, the hapless voyager often found himself in distress due to the vagaries of the elements. There were few stations. If it rained, the traveller stayed wet; in winter he was cold; in summer he endured paralyzing heat.

Sir George Head gives a long and detailed account of a winter journey from Saint John to Fredericton by sleigh[11]. Head describes not only the frustration of a three-day wait for the weather to clear, but also the hardships of travel in an open conveyance over an extended period. Such a trip usually took at least. Seasoned travellers were aware of just how primitive conditions

were compared to European travel.

Travel in Britain

John Smeaton (1724-92) was probably the first Briton to call himself a Civil engineer[12]. He had already captured the public imagination with many important constructions including the Eddystone Light off Plymouth. However his design of the Forth Clyde Canal opened the way for the Grand Trunk Canal System, and a whole new mechanism of transport. Smeaton also designed several bridges in Scotland, as well as a number of harbour constructions. He was well travelled and schooled in the engineering arts on the continent. Noting the success of the French engineers, he advocated a society to advance the profession. At his suggestion, the British society was founded on April 15, 1793. The Society of Civil Engineers, as it was known, was the forerunner of the prestigious Institution of Civil Engineers, chartered in England in 1828.

Canal transport was revolutionized by John Rennie (1761-1821) whose canal constructions included the Kennet and Avon[13], which ran 57 miles through 48 locks up an ascent of 400 feet. He also engineered the Lancaster Canal, 76 miles in length. Eventually, canals linked most industrial markets with other centres, as well as with international harbours. Inland cities were deriving great commercial benefit from the new canals, and the great ports had already entered an age of unprecedented activity. Commercial shipping was well advanced by the first quarter of the nineteenth century. Then a new development occurred, the invention of "macadamized" roads. The originator was John Loudon McAdam (1756-1836), who had surmised that the key to rapid vehicle transit was the preservation of the road bed of natural soil

in a dry state by making the surface layer watertight. By 1830, tar and asphalt were used to seal McAdam's roads. When mixed with sand and stones, the mixture came to be known as tarmac. Macadamized roads connected every major city and village in England early in the century, further providing impetus for the industrial revolution.

This should be contrasted with the hardships of travel in the New World, and especially in New Brunswick. Witness, for example, John Mann's travels[14] in 1821 from Upper Canada to Saint John. He made his way by foot and canoe through primitive forest and rugged terrain, with only the occasional dwelling, a log cabin, along the route. Mann, and others like him, had only lately come from the Old World. Although of the lower classes and not at all well educated, he was still keenly aware of the primitive state of the society in which he found himself. He records a visit to an Upper Canadian farm in company with an acquaintance: "The next day he accompanied me to visit one of his neighbours, who had newly settled here. The house of this individual was about twelve feet in length, and ten in breadth. It contained only one bed occupying the whole length of the house, in which all the family slept. There was little furniture of any description in it excepting a chest or two, and a few dishes for cooking." Thereafter, Mann travelled through the wilderness from Quebec to Fredericton, principally down the Saint John River. Although he was alone, he engaged Indians, from time to time, to carry him across lakes. The total length of the trip was thirteen days. But during that time, he was well aware of the danger of starvation or accident, as he records in his notes.

While the Canadian pioneers struggled to eke an existence from the land, mainly by export of raw resources such as timber, fur and fish, James Watt was struggling with the steam engine. And very shortly after his modifications rendered it a practical device, George

Stephenson (1781-1848), used it in the construction and successful operation of the World's First Commercial Steam Railroad, the Stockton-Darlington (1825). Any hesitation in accepting the new transport medium was quickly dispelled when Stephenson constructed the Liverpool and Manchester railway. He commissioned the famous Rocket to do service on the line on 15 September, 1830. There was a great public ceremony to mark the occasion, attended by the Prime Minister and several members of parliament as well as many thousands of spectators. The age of cheap and rapid transit had opened with a flourish. Within eight years, most of England was accessible by canal or by rail, with over 500 miles of passenger rail in service.

Travel in Canada

The first railway in Canada was put into service on July 21, 1836. It was a 16 mile run between LaPrairie and St. Johns, constructed to circumvent the Richelieu Rapids. It was initially horse-drawn, but steam locomotion came the following year[15]. The first railway projected for New Brunswick was to run from St. Andrews to Mars Hill, thence to Montreal and Upper Canada[16,17]. Preliminary surveys had already been carried out before the Aroostook Wars broke out. The settlement of the boundary between Maine and New Brunswick was unfavourable to the interests of the railway, and the defence of the province left no alternative but the abandonment of the project. However, St. Andrews did provide the terminus for the first railway construction in New Brunswick. In 1850 a line was projected to connect the port of St. Andrews with Woodstock, New Brunswick. Shortly thereafter several railway projects were co-ordinated during the Great Portland Railway Convention, held at Portland, Maine[18]. It was proposed during the convention that the line run from Halifax to Shediac, thence to Saint John and Portland, Maine. However, up to this time, there was little capital available for such an

expensive venture. There were few people capable of promoting it, and almost a complete dearth of the engineering expertise necessary to undertake the construction. For many years, the province was to labour under the high costs of imported talent to effect her works. Certainly, in 1850, almost all of the most competent engineers in the world were employed in more lucrative markets.

By this time the British Crown had finally awakened to the threat of invasion from the south. The War of 1812 had been fought chiefly in Upper Canada. Since there was little support for "Madison's War" in New England, hostilities were minimal in New Brunswick, so much so that Murray[19] comments in 1839: "Scarcely any of the evils of war were felt, the government of Maine having expressed a wish to observe mutuality on the New Brunswick frontier, a proposal which was readily acceded to; so that though the militia were ordered to hold themselves in readiness, their services were not required."

In Upper Canada, however, the contest was bitter. As a result, the use of the St. Lawrence and Great Lakes system for transport of supplies was seen to be open to attack from the south. It was early noted that a concerted attack on the St. Lawrence waterway by the Americans might well have cost the Canadas dearly. To circumvent the possibilies, the Rideau Canal was undertaken by the British Government to provide a safe military route in the event of future hostilities.

In May 1826 Lieut. Col. John By of the Royal Engineers, newly arrived from England, began work on the canal. It was to follow a run from just below the Chaudiere Falls on the Ottawa River to Kingston on Lake Ontario, about 130 miles distant. The difficulties attendant

upon the completion of this project were immense; great rocky promentories to be cut through, swamps deepened, and masonry and other heavy supplies transported over the cow tracks which passed for roads. Of all the problems, the danger to the workers from accident or diseases such as malaria was most hazardous. In spite of the hardships, the work was completed and the canal opened for service on May 24, 1832. Together with the associated canals on the St. Lawrence, the project ran to over 1,000,000.

Upper Canada was not able to supply the demand for engineers either[20]. When William H. Merritt of St. Catherines undertook the promotion of the Welland Canal around the Niagara Falls, he was forced to involve the Americans, not only as investors, but also as engineers and contractors. Few engineers were to be found in British North America. Certainly there were none in Canada with the requisite skills. The Welland Canal was operational by 1829. It was a factor in the increased prosperity of Upper Canada. Goods could move from virtually anywhere in the river system through the Welland Canal to Oswego, and thence through the Erie Canal, completed in 1828, to destinations in the Northern States. Alternatively, goods could travel down the Hudson River to New York City, thence to international markets.

The third great Upper Canadian canal project, the Trent Canal, was begun by W.H. Baird. He was a civil engineer commissioned by the government to make preliminary surveys for an inland route to Lake Huron. The projected canal was to follow the Trent River to Rice Lake, thence to Lake Simcoe, and finally to Lake Huron. Although it was started in 1827, the work was not completed for almost a century. Then, rather than fulfilling the commercial and military objectives of its founders, it was to become a haven for holiday craft, bringing the tourist industry to the heartland of Ontario for the profit and pleasure of succeeding generations.

Other areas of engineering endeavour were also making an impact on the western world. Andre Marie Ampere's (1775-1836) experiments had finally resulted in the practical applications of electricity. It was not long before a plethora of inventions using this ancient energy form captured the world's imagination. Samuel Morse (1791-1872) sent the first telegraph message over a distance of a third of a mile in 1837. Shortly thereafter (1844), regular telegraph service was inaugurated between Washington and Baltimore. After overcoming enormous technical difficulties, the first submarine cable was laid between Dover and Calais, France, in 1850, ushering in a whole new era of international communications technology. Gesner discusses the merits of telegraph in aid of commerce, especially a possible route between Halifax and Quebec, and thence to the United States. He also remarks on the extension of the New Orleans line to Portland, Calais, and finally Saint John[21].

Each new scientific or engineering accomplishment was hailed with as much enthusiasm in New Brunswick as elsewhere and note was duly made of the difficulties in the province, the lack of roads and communications facilities, and worse still, the want of duly qualified persons to rectify the situation.