



**THE ENGINEERING INSTITUTE OF CANADA**

*and its member societies*

**L'Institut canadien des ingénieurs**

*et ses sociétés membres*

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## **EIC's Historical Notes and Papers Collection**

(Compilation of Articles, Notes and Papers originally published as  
EIC Articles, Cedar Grove Series, and EIC Working Papers)

## **ENGINEERING HISTORY PAPER #32**

### **“Biographical Sketches”**

**by Andrew H. Wilson**

(previously published as EIC Working Paper 20/2004 – Mar 2004)

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EIC HISTORY AND ARCHIVES

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### Abstract

In the late 1990s, the Engineering Institute of Canada's History & Archives Committee and its Life Members' Organization co-operated in the collection of autobiographical material from LMO members in regard to their careers and in order to add it to the Institute's Archives. Submissions were received from 30 respondents. Some of these were expanded into full papers in this Working Paper series. The others have been reproduced here, in whole or in part, in order to provide a wider audience for the material, to demonstrate what it is that engineers have done, and to encourage young people to consider engineering as a career. The Paper ends with a short general summary.

### About the Working Paper Series

In June 1995 the Council of the Engineering Institute of Canada agreed that Working Papers on topics related to its history and development, to the history and development of other institutions serving the engineering profession in Canada, and to engineering generally should be published from time to time.

These Papers have limited initial distribution, but a supply is maintained by the EIC History & Archives Committee for distribution on request. They are listed and summarized in the History & Archives section of the EIC's website ([www.eic-ici.ca](http://www.eic-ici.ca)), and electronic copies may be obtained through this same source. The individual Papers may also be published later, in whole or in part, in other vehicles, but this cannot be done without the expressed permission of the Institute. The series is presently administered by the Publications Sub-Committee of the main Committee in co-operation with the executive director of the Institute.

Opinions expressed in the Working Papers are those of the author(s) and are not necessarily shared by the Engineering Institute of Canada or its History & Archives Committee.

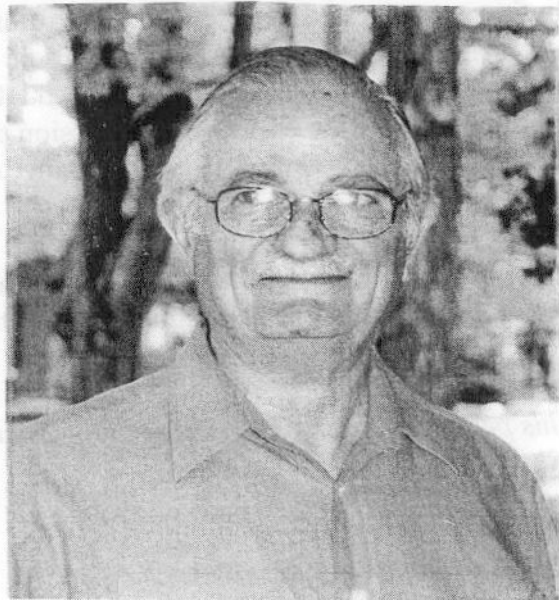
*The editor of this present Working Paper was Peter R. Hart*

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### About the Compiler

Since 1975, Mr. Wilson has been associated with work on the history of engineering in Canada. However, most of it has been done since his retirement from the federal public service in 1986. Professionally, he is a mechanical engineer but also has academic training in economics and history. He served for many years as chair of the History Committee of the Canadian Society for Mechanical Engineering. He has also been a member of several Engineering Institute of Canada committees dealing with the history of the Institute itself and Canadian engineering generally, and recently stepped down from the chair of its Standing Committee for History & Archives. He has served as president of both CSME and EIC, as well as in a variety of other positions. He is the author of over 200 published reports, papers and articles on a wide range of subjects.

Mr. Wilson's contributions to the profession and to its history have been recognized by a number of organizations, including the Canadian Society for Civil Engineering, from which he received the W. Gordon Plewes Award in June 2003.



## Introduction

In the years just before and just after the Millennium, the EIC's History & Archives Committee and its Life Members' Organization (LMO) co-operated in the collection of 'CV-type' autobiographical material from LMO members. These were designed to illustrate the kinds of careers enjoyed by Canadian engineers during the middle and later years of the 20<sup>th</sup> century. The original material is to be kept in the Institute's archives for use by researchers studying the history of engineering in Canada. In order to bring it to the attention of a wider audience, to demonstrate what it is that engineers do, and to encourage the younger generations, it is now being published in the Committee's Working Paper series.

Thirty submissions were made, varying considerably in the amount of information each provided and in the style of presentation. A few were subsequently expanded by their writers into stand-alone, memoir-type Working Papers<sup>1</sup>. Those remaining have been edited (by the compiler) for use in this present paper. Some have been put into a narrative format and others have been shortened. A number of quotations from the original submissions have been included. The information given terminates at the time of its submission.

The biographies appear in alphabetical order and, since head-and-shoulders photographs were not specifically included in the original request, none appear in this Paper. For the same reason, but with one notable exception, personal information has also been omitted.

In addition to asking respondents for career information, the LMO asked which of their projects gave them most satisfaction, and why. Although not all submissions included such a statement, some did, and these have usually been quoted verbatim in the text.

No rules were made for the format of the submissions, as the idea was to allow the respondents to view their careers in their own ways. This also helped to avoid a lot of repetition in the text. Although variations in length, content, format and style in these are many, the diversity makes them more human than technical.

The EIC Standing Committee for History & Archives is particularly grateful to former LMO chairs, Douglas Thierman and Leonard Bateman, and to Bill McKay and Harold Page, the LMO secretary and treasurer respectively during this period, for their strong and continuous support for the project.

The respondents, of whom 17 graduated in civil engineering and four each in mechanical and electrical engineering, were:

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<sup>1</sup> Working Paper 2/1996 *Memoirs of an Experimental Stress Analysis Engineer 1945-1980* by John B. Mantle; Working Paper 3/1997 *Odyssey of an Engineering Researcher* by Ken Rush; Working Paper 10/2002 *Letters Home...* by Robert S. Sproule; and Working Paper 11/2002 *Memoir* by William G. McKay. A fifth Working Paper, 22/2004 *An Engineering Career in the Hydro-Electric Industry* by Leonard A. Bateman, remains to be published.

George Chisholm Baker  
 Alastair D. Cameron  
 A. R. W. (Ross) Clayton  
 William A. Devereaux  
 Anatol Didkowsky  
 George V. Eckenfelder  
 Roy W. Emery  
 Raymond I. Fiske  
 Samuel D. Foote  
 James Chalmers Gordon  
 Gordon Keen Hunter  
 B. George Lawlor  
 Ottis I. Logue

Ernest C. B. Macnabb  
 T. Arthur McLaren  
 John B. Milne  
 William J. Milhausen  
 Herbert C. Moulding  
 J. L. (Jack) Reid  
 Emil J. Sanden  
 John A. Scott  
 W. J. C. (Jack) Sissons  
 V. Douglas Thierman  
 L. Martin Wedepohl  
 Lawrence David Wickwire

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### **George Chisholm Baker**

George Baker was born in October 1918 at Dartmouth, Nova Scotia. He received a diploma on graduation from the Royal Military College and a BASc degree in electrical engineering from the University of Toronto. He served in the Royal Canadian Corps of Signals from 1939 until 1946.

Mr. Baker's first post-war job, from 1946 to 1947, was with the Canadian General Electric Company. In 1948, he joined the Kentville (Nova Scotia) Publishing Company, becoming president and serving until 1981. From 1960 until 1981, he was an engineer with the Kentville Electric Commission and, also in 1960, began an even longer association with the Hiltz & Seamone Company Ltd. as an electrical consultant. Between 1968 and 1974, he served as a member and vice-chairman of the Nova Scotia Medical Care Insurance Commission and as a consultant to it. He was a director of the Tidal Power Corporation from 1971 to 1989 and executive vice-president from 1976. He served as a member of the Tidal Power Review Board's Engineering and Management Committee from 1972 until 1978.

Of his work for Hiltz & Seamone, Mr. Baker noted that it included the following:

- distribution design, rate design, utility system planning and supervision of operations for a number of distributing utilities, as well as hydro design;
- engineering advice on matters related to power utility regulation given to the regulatory commissions in Nova Scotia, Newfoundland, Manitoba, New Brunswick and Prince Edward Island;
- for utility boards, the evaluation of project benefits, cost of service analyses and rate design, and technical support associated with public hearings;

- participation as an expert witness at hearings before the National Energy Board and the Northern Canada Power Commission;
- technical analyses and economic evaluations for such clients as Environment Canada, the federal Department of Indian Affairs & Northern Development, the Government of Nova Scotia and Deuterium Canada Limited; and
- cost of service studies and rate designs for steam and water plants, sewage systems and sewage collection plants.

For the Tidal Power Corporation, Mr. Baker's work included economic evaluations and executive responsibility for the Annapolis Tidal Power Project, the first such development undertaken outside Europe. He chaired the task force updating the economic portion of the 1977 report of the Tidal Power Review Board. For this Board, and as a member of its engineering and management committee, he shared responsibility for the reassessment of Fundy tidal power and had special responsibility for the optimization of plant design, hydrodynamic numerical modelling and environmental investigations. Mr. Baker wrote in his submission:

"Living in close proximity to the Bay of Fundy, I became convinced about 1949 that the tides of the Minas Basin should be able to supply some 4000 MW of electric power, and it became a personal objective to ascertain the feasibility of Fundy tidal power development. While I was not involved in the first major studies of the resource in the sixties, editorials in the papers published by my company may have helped to bring them about. I did take part in the reassessment of the 1970s, which reached a more hopeful conclusion.

"During the next decade, the Tidal Power Corporation was able to achieve a clear understanding of the economic, social and environmental consequences of power development at leading sites. Along the way, the Annapolis tidal plant was built, and many of the conjectured environmental damages were found to be groundless, and progress was made in finding solutions to the real environmental problems.

"But, by the mid-eighties, oil prices were dropping and real interest rates remained high: the conditions of feasibility ceased to be met and interest in tidal power waned. For any proponent of it, this would be disappointing.

"There is little doubt in my mind that feasible conditions will recur in the future, and that this source of non-polluting energy will be developed.

"However, it is a source of personal satisfaction that, to the extent I was able to control the course of affairs, the objective was not to build a large-scale tidal plant, not to serve any special interest groups such as 'environment' or business, but rather to promote the welfare of society. And as it turned out, the best interests of society are served by waiting

for the opportune time to build a tidal plant.”

In 1989, Mr. Baker was elected to the Canadian Academy of Engineering, the same year that he was elected a Fellow of the Engineering Institute of Canada. He was also a member of the Association of Professional Engineers of Nova Scotia, the Institute of Electrical and Electronic Engineers and the Canadian Society for Electrical Engineering (now IEEE Canada). Mr. Baker has received honorary doctoral degrees from the Royal Military College, the Technical University of Nova Scotia and Acadia University. He was awarded a Centennial Gold Medal by IEEE, and became a Member of the Order of the British Empire (MBE).

Mr. Baker's submission was dated 9 March 1998.

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### **Alastair D. Cameron**

Alastair Cameron received a BSc degree in civil engineering from the University of New Brunswick in 1942. He was then commissioned in the Royal Canadian Artillery and served abroad in the United Kingdom and Northwest Europe, during which time he became a military Member of the Order of the British Empire (MBE).

During his working life, Mr. Cameron gained broad experience in the power generation sector. Earlier, he was involved in the design and construction of hydroelectric, thermal and industrial power plants and, later, in the organization and regulation of this sector, as well as in the management of electric power companies, in corporate planning, and in financial, economic and feasibility studies, valuations, electric power rate studies and negotiations.

His first post-war job, during 1946 to 1947, was as a draftsman and design engineer with the Dominion Bridge Company Ltd. of Montréal. For the next nine years he had various assignments for the Montréal Engineering Company Ltd. (later Monenco) as a design engineer, resident engineer and supervisor in the civil and construction department of the Company, including responsibility for field projects in Québec and Newfoundland.

From 1957 to 1963, Mr. Cameron was general manager of the Maritime Electric Company Ltd. in Charlottetown, Prince Edward Island,, which provided electric power to consumers on the Island. He had responsibility for general administration.

In 1963 he rejoined Montréal Engineering as the assistant manager having responsibility for the economics and valuation division. This position also included the co-ordination of the Company's joint venture associated with the Bay d'Espoir hydroelectric development in Newfoundland, supervision of economic forecasts and demand studies for the water resources of the Maritime provinces, responsibility for electric utility planning, the preparation of capital and operating budgets, and feasibility, economic and rate studies and valuations. In 1969 he was promoted to the

position of manager of the division.

In 1970, Mr. Cameron received a diploma in management from McGill University.

In 1972 he was appointed vice-president and manager of operations for Monenco's management consulting division. In 1975 he became responsible for the organization and direction of both the management consulting and the management sciences and systems divisions. From 1976 to 1984 he was vice-president, utility management, responsible for management and service contracts with four public utilities. He was a director and held senior corporate management responsibilities in the line organizations of three of these utilities. One of his specific responsibilities during this period was the negotiation of an agreement covering interprovincial submarine cable interconnections.

After 1984, Mr. Cameron served as a senior consultant within the Monenco group of companies, providing advice to electric power company clients in Canada and abroad in the areas of management, organization, corporate planning, finance and electric power rates. He advised on market studies and system planning and assisted in interventions before the National Energy Board on international exports of electric power. He was still acting in this capacity when his LMO submission was made in August 1996. He has been chairman and managing director of Monenco Jamaica Ltd. and a director or senior officer of electric power companies in Atlantic Canada and elsewhere.

Alastair Cameron joined the Engineering Institute of Canada as a student in 1943. He joined the Canadian Society for Civil Engineering after it was formed in 1972. He has been a member of the Corporation of Professional Engineers of Québec, which later became the Order of Engineers, as well as the provincial associations in Alberta, Prince Edward Island and Newfoundland. He has been a member of the Canadian National Committee for the World Energy Conference.

Mr. Cameron wrote that the projects that provided him with the greatest satisfaction were the small hydro plants in which he was involved in both the design and construction.

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#### **A. R. W. (Ross) Clayton**

Mr. Clayton received his engineering degree from the University of British Columbia in 1951 and, on graduation, joined the staff of Sandwell & Company Ltd., consulting engineers in Vancouver, spending the next four years as a design engineer. He was then assigned as a field engineer to a project in the United States, followed by a two-year period in Sandwell's Montréal office, where he worked as assistant project engineer on a mill being built in Mexico. He returned to Vancouver to work on various engineering activities related to commercial and industrial projects in North America and abroad.



In January 1963, Mr. Clayton was appointed assistant chief engineer in the Sandwell office in Stockholm, Sweden, where he participated in a variety of projects for Scandinavian clients. In 1966, he was sent to Portugal to be the resident manager responsible for the construction and start-up phases of a major bleached kraft pulp mill. Returning again to Vancouver in 1967, he became project manager on multi-million dollar pulp and paper projects.

In 1971, Mr. Clayton was appointed chief engineer of the Sandwell office in Vancouver, becoming vice-president and regional manager in 1980. From then until his retirement in 1989, he combined office management with business development and the direction of specific projects. In his submission, made in December 1996, Mr. Clayton wrote:

“Two projects which I managed that gave me particular satisfaction were the Cariboo Pulp and Paper project at Quesnel, British Columbia, and the Alto Parana S. A. pulp mill project in Argentina. Both won awards of excellence from the Association of Consulting Engineers of Canada, the former in 1973 and the latter in 1983.

“The Alto Parana project was particularly challenging considering its location in the remote northern province of Misiones and two major disruptions due to financial problems in Argentina - plus complications arising from the Argentine invasion of the Falkland Islands in the spring of 1982. At one point, Sandwell had 96 men, women and children in residence at the mill site, and they were on the verge of evacuation during one of the crises. However, things settled down and full scale performance trials took place early in 1983.”

Ross Clayton joined the Institute as a student in 1949. His principal extra-curricular activity was with the Consulting Engineers of British Columbia (CEBC), the major industry association for consulting firms in B.C.. He served as co-chair of the group that formed this organization, was a director from 1984 to 1987 and was elected president the following year.

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### **William A. Devereaux**

William A. Devereaux was born in 1915 in Georgetown, Ontario. After graduation from the University of Toronto in mechanical engineering in 1937, he began his career in instruments and controls, joining the Bailey Meter Company of Cleveland, Ohio, and Montréal. During his 23 years with this Company, he was responsible for many installations of equipment in thermal plants, pulp and paper mills, mining and metallurgical plants, water and waste treatment plants, and various other industrial applications in all parts of Canada. His main location was Montréal, but he also served in Winnipeg and was the firm's resident engineer in Vancouver. He established the district office in Halifax for work in the Atlantic region, and was its first manager. In this latter location, he was involved in some of the first marine installations for the early destroyer escort vessels of the Royal Canadian Navy.

In 1961 and 1962, Mr. Devereaux was general manager of Yarway Canada Ltd., where he was responsible for establishing its first plant and office in Guelph, Ontario, and for building up its marketing organization for thermal power plant and other industrial equipment

After Yarway, Mr. Devereaux joined the Montréal Engineering Company Ltd. (later Monenco) in Montréal as manager of Canadian business development. During this time, he acted as project manager for the study of marine propulsion systems using gas turbines, in collaboration with a consortium of British manufacturers. He served as a member of two Canadian Trade Missions, one to Eastern Europe to study the potential for Canadian engineering services and equipment in the mining, pulp and paper and power industries, and the other to the Middle East to study the possibilities for automation in oilfield gathering systems, pipelines and terminal loading facilities. Mr. Devereaux then returned to Halifax and, for over three years, was manager of Monenco's Atlantic division. Reassigned to Montréal in 1975, he became manager of the professional affairs division and began to upgrade the expertise of the Company's engineering services, through professional development courses and seminars. He was also responsible for its relations with the various professional organizations. He retired in 1982.

Bill Devereaux joined the Institute in 1946. He has occupied the chair of the EIC's Halifax and Montréal branches and has been the Institute's treasurer, chair of its finance committee and a member of its Council. He is now a Fellow of the Institute and received the John B. Stirling Medal in 1992 for long and distinguished service.

In 1967, he served as chair of the social functions committee for the Centennial Congress of Canadian Engineers held in Montréal. A member of the Canadian Society for Mechanical Engineering since its founding in 1970 and the EIC's General Members' Group (now the Canadian Society for Engineering Management), he has also been a member of the Order of Engineers of Québec, the Associations of Professional Engineers of Nova Scotia and Ontario, and the American Society of Mechanical Engineers.

His industry memberships included the Canadian Institute of Mining and Metallurgy, the Mining Society of Nova Scotia, and the Technical Section of the Canadian Pulp and Paper Association. He represented Montréal Engineering Company in the Canadian Electrical Association and the Associations of Consulting Engineers of Canada and Québec.

Mr. Devereaux's submission was made in the spring of 2000.

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### **Anatol Didkowsky**

The submission for Anatol Didkowsky was made in March 2002 by his wife, Marina, since her husband had been disabled by a series of strokes. He was also 92 years old. The account that follows is unusual, in that some details of Didkowsky's personal life have been included. Attached to the

submission was a photocopy of an article, written by Ron Johnson and published in the *Lethbridge Herald* on July 28, 1954. The headline read: 'Russian-born Engineer, Survivor of Nazi Prison Camps, Makes New Career for Himself in Canada.'

Anatol Didkowski was born in October 1909 in Kupech-Zutomir in the Ukraine, the eldest of three boys. In 1927 his father was arrested for being a landlord and sent to Siberia, but returned home 18 months later. In 1928, Anatol married for the first time, but he and his father were both arrested in 1929. His father was again exiled. Anatol managed to escape. He never returned home. His younger brother was arrested, but also managed to escape. His mother and youngest brother were sent to Siberia, but they - too - managed to escape. Eventually, the whole family was reunited in Siberia, including Anatol's wife and son. Anatol found work as a carpenter in a coalmine, but later sought work in another city, where he decided to enroll in a technical school.

This was the first step towards his graduation. After further uncertainties and travels, he succeeded in doing so in 1937 from a transportation institute in Leningrad. He served briefly in the military. His next work was mainly with locomotives and rolling stock. When the war with Germany began, Anatol reported for duty as a officer with a railway regiment at Vitebsk, about 500 kilometers west of Moscow. He was captured and taken prisoner in July 1941 and, with many others, experienced great hardships in prison camps in Poland. In the summer of 1942, he was sent to a work camp in Prussia and then to another in Germany. Along with around 30 others, who had worked as engineers in Russia, he was sent to a barracks in the suburbs of Berlin, where conditions were marginally better. Those who were confined to the barracks were divided into groups and given drafting assignments. In March 1945, Anatol and two-dozen others were sent into Berlin to dig trenches for the German defence of the city, after which they returned to the barracks.

They were liberated by the Americans, but it was the Soviets who took over administration of the area. They were interested in finding Soviet citizens to send back to Russia. Anatol fled once again - and became a civilian. He made his way to Munich where, with several other displaced people, he formed a company to make wood products, a business that began to grow and expand. However, an old friend of Anatol's had emigrated to Canada and sent him papers that would allow him to emigrate there. Anatol had lost all of his family, but had become friends with Marina, whose parents had fled Russia in 1918. After the death of her father, she received an invitation from a niece then living in Alberta to come to Canada. The couple received clearance from the Canadian consul in Munich to emigrate - and to marry. Marina went west to find her cousin, while her mother and Anatol waited briefly in Montréal before following, to settle in Lethbridge. Marina, a dental nurse, worked in a variety of jobs, as well as raising two children. Anatol first found a short-lived job as a mechanic's helper in a sugar factory before being hired by the Prairie Farm Rehabilitation Authority (PFRA). He began as a draftsman before moving up to technical officer. His main work at this time was designing and building bridges.

Anatol sought reinstatement as an engineer, successfully, through examination. By 1954 he had an iron ring, was a member of EIC, and a Canadian citizen. That year, he was involved in the completion of the Travers Dam project. In 1959 his office, which had been in the district of

Vauxhall, was moved to Calgary. His main activities until his retirement in 1974 were concerned with irrigation. For the next 20 years he spent his winters in Mexico and summers in Canada. Meanwhile, his health deteriorated, becoming more difficult to regain after each crisis.

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### **George V. Eckenfelder**

One result of using an alphabetical last name order for the biographies in this paper is that, of the first six engineers, half were associated with the Montréal Engineering Company/Monenco. George V. Eckenfelder is the third of these.

Mr. Eckenfelder graduated from the University of Alberta in 1933 with a degree in civil engineering. There were only three students in his class. That year the Great Depression was at its worst and jobs were very scarce. George found a summer job as a deck hand on a hydrographic survey of the harbour at Tuktoyaktuk, as an employee of the Hudson Bay Company's Mackenzie River transport division. He was paid \$30 a month with board and was pleased to have the opportunity to see the Canadian North.

His next job, beginning that same fall, was as a gang-boss at one of the relief camps for the single unemployed in Alberta. He stayed for over two years, ending up as engineer-superintendent of a group of four camps in the Kananaskis Valley, west of Calgary, doing forestry and road work. His monthly salary reached \$150. During his sojourn in the Valley, Mr. Eckenfelder met some of the people who worked for what was then the Calgary Power Company. In 1936, when the camps closed, he was hired by the Company as an apprentice engineer. Most of the tasks assigned to apprentices were menial but did provide basic training in the electrical utility business.

Mr. Eckenfelder joined the Royal Canadian Corps of Signals when World War II began, serving in Canada, England, North Africa and France, where he landed in Normandy on D-Day. Two days later, he was taken prisoner by the Germans but, as the fortunes of war can reverse themselves, his captors surrendered to him a few hours later! He returned to Canada in September 1945 and rejoined Calgary Power to work as resident engineer on the Barrier Hydro Plant on the Kananaskis River - a stone's throw from the relief camp of ten years earlier. Not long after, he was transferred to Calgary Power's sister company, Montréal Engineering (MEC), where he spent the next 30 years.

After joining MEC, he went to the Snare Rapids Hydro Development, north of Yellowknife. This project generated at least two new challenges: permafrost; and transferring all of the required materials and equipment across 700 miles from the nearest railhead at Grimshaw, Alberta. When the Snare job finished 18 months later, Mr. Eckenfelder went back to Alberta to become resident engineer at the Spray Development near Canmore. Of this project, he said in his submission:

"The development comprised a two-hundred foot high earth fill diversion dam on the Spray River, a canal system and tunnel leading to a nine-hundred foot head hydro plant,

and a second plant, with a head of three hundred feet, at Canmore. There were many difficulties, including the sudden, major failure of a side-hill canal. Later it was concluded that the fine sand, underlying the canal at a depth of about one hundred feet, liquified. This disaster set the completion back one year. Despite those difficulties, the cost of Spray energy was one of the lowest in the west."

The Spray project lasted four years, during which time Mr. Eckenfelder married. At its conclusion, he and his wife decided that they had had enough of construction camp life. He asked for, and got in October 1951, a transfer to MEC's head office in Montréal. He spent the next eight years on the design and supervision of a variety of projects of various sizes in various places - including supervision of the first survey of the storage system for the Churchill Falls hydro development, the work for which was done entirely with air support and canoes, and the utility system for the new town of Inuvik on the Mackenzie Delta, which included the electric power supply, water supply, sewage and central heating to serve the whole town. Permafrost was again a major challenge, one result of which was the development of insulated, above-ground 'utilidors' to carry the service pipes.

In 1959, Mr. Eckenfelder went back west to open the MEC office in Calgary and to pursue pipeline work, as well as engineering that was related to the oil industry. He spent three years on this assignment, finding one of his biggest problems was to convince American-owned oil companies that Canadians were, as he put it, "capable of more than tramping through the woods on snow-shoes chasing rabbits." Eventually, MEC overcame this problem. He left Calgary in the spring of 1962 for a joint-venture project to carry out a study of the hydro resources of South Central Brazil and to prepare a plan for the development of electrical power to supply the needs of the region for the next 20 years. The power to be harnessed included hydro, thermal and nuclear. Its transmission was also to be studied. This was a four-year project, financed by the United Nations and administered by the World Bank. Mr. Eckenfelder took charge of the hydro survey centred on Minas Gerais, which involved a reconnaissance of potential sites on seven major rivers, preliminary ground studies of the most likely sites, and pre-feasibility investigations of the most promising. The possibilities for irrigation were also to be examined. The overall project director was Jack K. Sexton, then chief engineer of MEC. The eventual result of the Minas Gerais work was that nearly every site studied in detail was developed.

In his submission, Mr. Eckenfelder wrote that the Brazil project gave him his greatest satisfaction. He had a relatively free hand, almost limitless scope, excellent staff and successful results. He also learned to appreciate and respect Brazilians and the competence of their engineers.

For this project, the Eckenfelder family had moved to Brazil. But after four years, the work he had been sent to do was largely finished and George and his wife were anxious to have their children back in Canadian schools. He was offered, and accepted, the management of MEC's hydro division in Montréal and became responsible for all hydro and water resources projects - as well as scouring the world for new projects. Of this assignment, he wrote:

"Thus, for the ten years until I retired I spent a good part of my time flying over oceans

and living out of a suitcase. My efforts, with those of others, resulted in a number of projects, some very successful, some not. Among the better jobs was one in Sri Lanka, where rock is much like that of the Canadian Shield. The large Bayano dam in Panama was a concrete gravity structure built on a very soft tufa foundation, which acted somewhat like a mattress. Bayano now provides a large part of the power in Panama City. A small development in Madagascar involved a number of meetings in Paris with the consultants, hired by the owner's insurance company, who had reservations about our Canadian approach to rock work. These meetings were accompanied by lengthy lunches where we enjoyed the best of French food and wine, but which rendered us completely useless in the afternoon. I am happy to say we won our points.

"The (two) largest of the foreign projects were in Nigeria, on the Niger River. The first was an extension to the Kanji Development, which had recently been completed by a British and Dutch consortium. Then came the Jebba Development, which comprised a rockfill dam about one hundred and thirty feet high, a 560 MW power plant, a spillway and an one-flight navigation lock. The latter was among the highest one-flight locks in existence. The dam was founded on two hundred feet of sediments, which included some moderately loose sand, considered to be susceptible to liquefaction under earthquake loading. With the help of specialist consultants..., we undertook the densification of the sand by vibrocompaction and by blasting at those depths beyond the reach of vibrocompaction equipment. The blasting technique then in existence was not capable of this task and modification to methods and equipment were carried out on the job. The results were successful."

Mr. Eckenfelder retired as MEC/Monenco's vice-president hydro in 1976, but remained as a special consultant for another ten years. He continued working as an independent consultant until 1997, in which capacity he served as a member of the Churchill Falls and Newfoundland Hydro Dyke Board, whose main function was the inspection of the eighty-two dams and dykes that contain the Churchill Falls reservoir and forebays and which include the massive spillways and control structures and the enormous underground powerhouse. He served on review boards for environment and public works projects in Alberta, including the Dickson Dam, the Oldman River Dam and the reconstruction of the Saint Mary River Dam spillway.

George Eckenfelder joined the Engineering Institute as a student in 1932. He became a Fellow in 1990 and was elected to the Canadian Academy of Engineering in 1995. His submission was dated February 1997 and was a summary of what was intended to be a full account of his career. But this objective was abandoned when the account simply became too long! However, he had already published autobiographical material. It appeared as Appendix 3 (pp 276-287) in *Monenco: The First 75 Years*, by his colleague, Jack Sexton, published by Monenco in 1982.

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**Roy W. Emery**

Mr. Emery was born in Hamilton, Ontario, in December 1908, educated there and at the University of Toronto, graduating in civil engineering in 1932.

From 1932 until 1942, he was a construction and mining engineer in Canada, South America and the West Indies. He was a paper mill designer and project engineer in Canada for a succession of companies from 1943 until 1952, when he entered private consulting practice, undertaking mining and pulp and paper projects. In 1956 he established Roy W. Emery Ltd. and Emery International Developments Ltd. in 1974 for the development and supply of new pulp and paper mills, pulp moulding plants, mining and ore dressing plants in Canada, the United States, Latin America, Europe and the Middle and Far East. These companies have since merged and have been owned and controlled by his son, John R. Emery, since 1988. They have received national awards for innovation and for exports.

Roy Emery joined EIC as an associate member in 1938, and was elected a Fellow in 1974. He registered as a professional engineer in Ontario, Québec and Michigan, was a director of the Association of Consulting Engineers of Canada and of the Consulting Engineers of Ontario. He has been a member of the Technical Sections of the Canadian and American Pulp and Paper Associations, the Canadian Manufacturers' Association and the Recycling Council of Ontario. He was awarded patents in industrial machinery and moulding processes. He was elected a member of the Engineering Hall of Distinction at the University of Toronto in 1980. At the time of his submission in December 1998, he was officially retired.

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**Raymond I. Fiske**

Ray Fiske's submission, in October 2001, was more of a short, narrative comment on safety in electrical power transmission and distribution systems. It has been quoted in its entirety:

"Prior to graduation in 1950, I was nearly electrocuted from what I saw as an unsafe construction standard. In 1950, I went to Antigonish as zone engineer. At that time, hotline work using sticks and platforms for high voltage was being introduced. Before long we had one fatality from an unsafe structure and a number of leg burns and shocks when linemen were replacing broken insulators using hotline sticks.

"The problem was the thru-bolts holding the top pin. I was given permission to move the top pin from being in-line to the street side of the pole, except on some corners where it was put on the far side of the pole. This solved that problem. Another problem was distribution transformer poles where both transformer and cutouts were mounted on double cross arms. We moved the transformer to a direct pole mount on the back of the pole, the cutout direct as well - no cross arms. This made operation safer and, in going

to joint use with telephone cable, there was no need to replace a transformer pole with one five feet longer. This saved \$500 to \$1000 for each installation.

“In 1957, I was moved to Halifax in charge of both transmission and distribution line construction. Later on, I was made manager of a distribution planning and standards department. In planning, the engineer promoted 25 kV distribution, which is now standard. We put a young engineer to work revising the distribution standard drawings using his own initiative. In three days, he told me he was finished - all drawings that needed it were redone. He was right about being finished as, after reviewing them, I fired him.

“In the search for a suitable distribution construction standards engineer, we selected Kripa Mathur. He did a thorough job, taking over three years. He redrew a construction standard, had a line crew build it, watched every move having safety, cost and aesthetics come into it. When he was satisfied, it was reviewed and approved. This included 30 transformer banks as well. In my opinion, the use of these standards of construction has saved at least two fatalities a year. Other utilities across Canada bought copies of our distribution standards after having a close look at them. Also, I have seen our standards copied in the United States.

“The one thing that was missing was that it takes years to prove the added safety to using these construction standards, and the engineer responsible is overlooked. In the past 20 years, I know of only one lineman being electrocuted. In this case, it was not the construction standard but his replacing of the bucket in order to do some hotline work.

“The purpose of this memo is to hope those reading it will give Kripa Mathur the credit he deserves.”

Ray Fiske graduated from the Nova Scotia Technical College. He joined the Engineering Institute as a student in 1949. He was an active member of the Halifax Branch and represented the Atlantic Region on EIC Council for several years. He became a Fellow in 1979.

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### **Samuel D. Foote**

Sam Foote's submission, dated in January 1999, was a letter to Douglas Thierman, then chair of the Life Members' Organization. It was quite informal and quite short - and quite entertaining. It has been quoted in its entirety in what follows:

“Your suggestion for my biography is also on my desk. I am waiting for something exciting to happen. In the meantime, I can say this much: engineering seemed to fit me, whether or not I fit it, someone else will likely decide, after which he may have to re-



classify me or re-define engineering.

“One thing that was in my favour during all of my working life was the plenitude of work. This allowed me to drift or to be pushed from one job to another as projects waxed and waned. I did what I called work for 37 years and was on at least 12 payrolls.

“I spent well over half my time in offices in Toronto and enjoyed trips to Montréal. One time, two of us went on what was doubtlessly a very important mission. I remember having lunch at a sidewalk café on Sherbrooke Street and debating whether or not we were working.

“One job at a refinery went from October to July, while it passed from construction to normal operations. There were 117 men on the crew, most of whom had names that were difficult to pronounce and impossible to spell. I was rather pleased to be able to boast that I knew every man by name. At the farewell party, I was given a manure fork with the comment that they wanted to give me something the workings of which I would probably understand!

“One sunny summer’s day, a while after I had ‘discontinued regular attendance at the office,’ my neighbour and I were bringing in the last load of hay from the west field, when Mary (my wife) came out to tell me there was a call waiting. I went in to answer it. It was from an oil company and the voice said that they had a sizeable project underway and were concerned about the estimates.

“The trouble was that everyone available had some more or less vested interest in the numbers. They wanted someone completely detached. In their search for someone answering such a description, they had spoken to an engineer in Calgary, who had said, “The man you want is Sam Foote, because you will never find a more detached fellow no matter where you look.” So I went back to Montréal for more lunches on the sidewalk.

“A month or two ago, I read *Victory* by Joseph Conrad. In it, he writes about a person who ‘obediently followed his instincts.’ Now I believe that is what I have done most of my life, and for that matter, what I am still doing about this steady job I have. You see, in 1929, when I had almost finished growing up on our farm on the northeast corner of what is now Kennedy and Bloomington Roads (in Toronto), my sister brought her friend Mary Weir home from school for the weekend. We were married in 1939.”

Sam Foote graduated in civil engineering from the University of Toronto in 1937. He joined the Engineering Institute as a junior member in 1939 and was elected to full membership in 1949.

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### **James Chalmers Gordon**

The submission for James C. Gordon was supplemented by a letter dated 12 May 1999 from C. Gordon Lindsay to the president of the Engineering Institute recommending his admission to the LMO. Both sources have been used in what follows.

Jim Gordon was born and educated in England. His engineering training was done 'the hard way' - through the British national certificate program and an apprenticeship rather than through a university course. He received the Ordinary National Certificate from Gateshead Technical College in 1945 and the Higher National Certificate from the Rutherford College of Technology in 1948. From the latter, he received an industrial mechanical engineering degree in 1954. He served a five-year apprenticeship with the Bren Manufacturing Company. In 1965, he was registered as a chartered engineer and corporate member of the British Institution of Mechanical Engineers (IMechE), having passed the qualifying examinations.

Mr. Gordon's early work, before leaving Britain, included thermal power station pipework design for Aitons of Derby, naval armament research in hydraulics for Vickers Armstrong, and aircraft gas turbine development for the BTH Company. He was a machine shop superintendent with Associated Electrical Industries (AEI), a systems and materials handling engineer with Total Transportation Systems in London, and general manager of the U.K. Division of Munck International of Norway. In 1962, while at AEI, he received a staff course diploma from Corpus Christi College.

Mr. Gordon came to Canada in the 1970s. In 1983, he formed the Gordon Crane & Hoist Company in Vancouver in the materials handling field and became its president. In 1985 he chaired the Western Canada Branch of IMechE. He has been a very active member of the Engineering Institute's Vancouver Branch since joining it and CSME in 1975. He began a multi-year chairmanship of the Branch in 1990. He was also instrumental in forming the Vancouver Branch of the Canadian Society for Engineering Management (CSEM) and has again served a multi-year term as chairman.

In 1985, Jim Gordon was elected a Fellow of EIC in 1995. He is also a Fellow of the British Institution.

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### **Gordon Keen Hunter**

Gordon Hunter was born in Toronto in 1923 and received his high school education there. Serving in the Royal Canadian Air Force from 1943 to 1945, he returned to Toronto to study at the University, completing his degree in civil engineering in 1950. He attended the University of California at Berkeley from 1958 to 1959 on an Imperial Oil Scholarship for post-graduate work, sponsored by Standard Oil and the International Road Federation, and awarded by the Canadian Good Roads Association. He completed a master's degree, specializing in air and highway

transportation. His thesis was on air traffic control, the research for which was done in the control tower of San Francisco Airport. His scholarship included a two-month tour of various transportation facilities, manufacturing companies and major airports in the Eastern United States.

His career as a practicing engineer was spent doing highway work. From 1950 to 1953, he worked as a project supervisor on, for example, road surfacing and the construction of interchanges on the Queen Elizabeth Way, and controlled accesses on Hwys. 427 and 401. In 1954 and 1955, he was a district construction engineer, responsible for all the projects within it. In 1956, he worked as a field design engineer on various highway projects, including the relocation of highways in the Kingston-Brockville area due to the construction of the St. Lawrence Seaway. From 1957 to 1962, with the exception of his time at the University of California, he was a senior project design engineer for Northern Ontario, responsible for the design of highways from Orillia to the Manitoba border. His staff included design groups located at North Bay and Thunder Bay, and his workload included the supervision of design consultants.

From 1962 until 1970, Mr. Hunter was a regional road design engineer for the Central Region of Ontario, based in Toronto, and responsible for the design of highways from Fort Erie, east to Trenton, and north to Orillia. There were 150 engineers and technicians on his staff, but 75% of the work was assigned to consulting engineers. Among his projects were the Welland and Thorold Tunnels, new freeways accessing Toronto International Airport, and the Bay of Quinte Skyway.

In addition to his design responsibilities, Hunter had administrative ones. In his submission, he described them in this way:

“Administrative duties included: public meetings, property meetings, court appearances, accident inquests, assisting the Legal Branch in the settlement of property purchases, contractors’ claims, accident claims, municipal subsidies and drainage law; meetings with municipalities, cities and townships - both engineering and political - in regard to the reconstruction of highways; interpretation and application of various federal and provincial Acts relative to navigable waters, pipelines, railways, air transportation, municipal subsidies, maintenance subsidies, water controls, pollution control, property rights, utility location and control of access; meetings with politicians, senior levels of government; presentations to substantiate engineering decisions; and the preparation of replies to the public’s letters to elected representatives...”

In 1970, Mr. Hunter was appointed regional systems design engineer for the Central Region, responsible for both planning and design, and a staff of 250 engineers and technicians.. In 1972 he was transferred to the head office of the Ontario Ministry of Transportation and Communications as a systems design engineer responsible for the development and monitoring of highway policies and procedures. From 1975 until 1981, he was a special assignments engineer, developing and monitoring policy in areas such as maintenance, traffic management and environmental specifications.

Mr. Hunter took early retirement from the Ministry. However, he was in demand as an expert witness, investigator and consultant and formed his own consulting firm in 1981. Between 1988 and the time of his submission in 1999, he was a technical advisor on highway design and maintenance with the Walters Consulting Corporation.

Gordon Hunter joined the Engineering Institute as a student in 1950. At the time his submission was made - November 1999 - he had belonged to the General Members' Society of the Institute and to the Canadian Society for Civil Engineering, and was a life member of both EIC and CSCE. He was also registered as a professional engineer in Ontario and was a member of the Roads and Transportation Association of Canada, the successor of the Canadian Good Roads Association, and the International Road Federation, Washington, D.C..

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### **B. George Lawlor**

Mr. Lawlor's submission was received in November 1999. It was handwritten and full of detailed technical information. What follows is a brief distillation of the material.

George Lawlor graduated from the University of Manitoba in mechanical engineering in 1950. His final year thesis concerned the use of gas turbines in stationary power plants, such as those driving the large centrifugal compressors in cross-country natural gas pipelines. His first job, in 1950-51, was as a draftsman with the Winnipeg Dyking Board, dealing with the aftermath of the 1950 Manitoba Flood.

From 1951 to 1953, he was chief field draftsman during the construction of a huge petro-chemical plant in East Edmonton, Alberta, being built for a Canadian subsidiary of the Celanese Corporation of America. He was with this Corporation as a project engineer from 1953 to 1965, during which time he was appointed to its subsidiary, the Canadian Chemical Company Ltd., as project manager for the first methanol plant in North America at Cornwall, Ontario. Except for a short spell in London, England, he was actively involved in its engineering and construction, from 1963 to 1965

In the fall of 1965 he joined cigarette manufacturers, Rothman's of Pall Mall, as chief engineer. His responsibility was for high-speed manufacturing, including chemical, mechanical and electrical instrumentation and, eventually, computerization.

In 1981, Mr. Lawlor was invited to become deputy project manager for the construction of a methanol plant in New Zealand. The equipment was being procured from Calgary. This meant dividing his time between the two countries, but included visits to other countries, such as Japan, where he went to review a new welding technique. In late 1983, he returned to Winnipeg, where he set up his own firm, B. George Lawlor & Associates.

In 1986, he had two interesting proposals for full-time positions. One was from a Belgian source,

heading up a cigarette manufacturing company in Brazil. For several reasons, he declined. The interview for the other, he described this way:

“In the fall of 1986, my name was on a short list of five from around the world for the position of technical director of a plant in Saudi Arabia. Had an interview with two gentlemen from Riyadh and a gentleman with a British accent. Salary and perks were out of this world. Didn’t get the job as I was 64 years old at the time, but looked like in my 50s. They must have added up my years with various companies. In the past six months, I had got from the Internet the number and location of the methanol plants around the world. Saudi Arabia had two. Methanol experience was probably what the Arabs were looking for!”

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### **Ottis I. Logue**

Mr. Logue’s submission was received in late 1999 and was based on the citation written when he received the C.C. Kirby Award in February 1995. This is the premier award of the Association of Professional Engineers of New Brunswick (APENB) and is given in recognition of outstanding service to the engineering profession in the province. It was named in honour of the founder of the Association, who was also the founding president of the Canadian Council of Professional Engineers (CCPE) in 1936.

A native of Saint John, Ottis Logue graduated in civil engineering at the University of New Brunswick in 1946. At that time, he was also awarded the Ketchum Gold Medal. He spent the following year studying in England at University College, London, on a Beaverbrook Overseas Scholarship. He received a master’s degree from the University of New Brunswick in 1954 and a doctor of science degree from it in 1996. The Kirby citation says:

“Ottis Logue has been director of works for the city of Saint John, New Brunswick, instructor in analytical geometry at the University of British Columbia, construction engineer for Caldwell & Ross Ltd., and the first full-time employee and managing partner of Associated Designers & Inspectors, now ADI Ltd.. He served ADI Ltd. as director, president and retired as chairman of the board in 1984. Mr. Logue was involved in many significant projects, not the least of which was the expansion of the UNB campuses at both Fredericton and Saint John in the early sixties and seventies. During this time, Lord Beaverbrook was taking a very active interest in the development of educational and recreational facilities in the province. ‘The Beaver’ held many private consultations with Mr. Logue concerning matters related to this work.”

Mr. Logue joined the Engineering Institute as a student in 1944. He later served EIC as a branch chairman and a national vice-president. Most recently, he was a member of the board of directors of the LMO. He was the Maritime regional director for the Association of Consulting Engineers of

Canada for 15 years and the Atlantic regional director for the Canadian Testing Association for 12 years. He served on numerous committees of APENB, and as its director of professional affairs. At the time of the submission, he was chairman of the Association's Foundation for Education and was serving on the Beaverbrook Scholars Awards Committee. He was senior warden of Camp IX for the Iron Ring Ceremony for 25 years.

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### **Ernest C. B. Macnabb**

Mr. Macnabb was born in 1914 and received a degree in civil engineering from McGill University in 1937.

In 1938, he began his career, lasting over 40 years, with the Canadian Pacific Railway. During the early years, he held positions in the engineering department as a transitman, building inspector, roadmaster, division engineer and assistant district engineer. In 1951, he was appointed engineer for the operating district of Saskatchewan, covering 3600 route miles (5800 km), with responsibility for co-ordinating the operating divisions for track, buildings, fixed plant and right-of-way maintenance. In 1954, he was promoted superintendent of two operating divisions, with a combined total of 2400 track miles (3900 km) and 1470 employees. He had responsibility for the hiring of staff and supervising training, monitoring the work of technical and professional specialists, maintaining the safe and on-time performance of trains, and restoring services following floods, landslides and accidents.

From 1963 to 1964, Mr. Macnabb was seconded to the Office of the Vice-President for special duties related to market potentials and the economic future of the railway. He then became the assistant manager for traffic research, co-ordinating staff investigations into the rail freight market and rolling stock requirements. He planned and co-ordinated the development of a unique system of multi-modal handling of cement and construction materials for the construction of the large dams on the Columbia watershed in the interior of British Columbia. In 1966, he performed a variety of duties and executive management assignments as assistant to the chairman, president and vice-president of the CPR. This work included long-term planning, internal reorganizations and special development projects, as well as being a special advisor on railway operating matters, undertaking business negotiations and appearing as an expert witness.

In 1972 Mr. Macnabb was appointed project manager for the CPR on the redevelopment of railway-controlled lands in downtown Toronto, also involving the Canadian National Railway, Toronto Terminals Railway and Marathon Realty - a \$1.5 billion project that did not proceed beyond the design stage. From 1975 until 1979, he was manager of development for the Eastern Region of the CPR, based in Toronto. During this time, he had general responsibility for a \$35 million upgrading project involving 30 miles of multiple track for the operation of the Government of Ontario's GO Train commuter service to Milton, and for a \$30 million project involving major renovations to Toronto Union Station and the rail plant of Toronto Terminals Railway. In 1980, he retired to

Vancouver where he began business as a self-employed consultant, among whose initial clients were CP Rail Consulting Services Ltd. and CP Rail Vancouver.

Ernest Macnabb's submission was based on a CV dated February 1982, when he was still active professionally, and a covering letter written in January 1999. In regard to the project(s) that gave him most satisfaction, he wrote that the majority of them did, at the time of doing. Although some were not initially successful, there were those whose results vindicated his judgement later on, as circumstances changed.

He joined the Engineering Institute as a member in 1950. He was also a member of the Association of Professional Engineers, Geologists of Alberta (APEGGA).

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### **T. Arthur McLaren**

Mr. McLaren's submission came as a letter dated 27 October 1999 - signed by Audrey D. M. Dillon, executive secretary - from Allied Shipbuilders Ltd. of North Vancouver, together with a profile of his career. The letter advised that he had died in February 1999.

The profile stated:

"Arthur McLaren was born in Montrose on the east coast of Scotland. His father, W. D. McLaren, had worked at the famous Fairfield Shipyard on the Clyde before forming the Coaster Construction Company in Montrose. Coaster Construction built a number of vessels for the Union Steamship Co. for service in B.C., including the *Catala* and the *Lady Alexandra*. In the 1920s, the Montrose shipyard closed and the family emigrated to Vancouver.

"From early childhood, Arthur wanted to 'build ships.' His father was a strong advocate of the old-time apprenticeship system and saw to it that Arthur apprenticed as a boilermaker with Vancouver Iron Works prior to graduating with a B.Sc. in mechanical engineering at UBC.

"From 1941 to 1945, Arthur was in charge of the drawing office at the False Creek yard of West Coast Shipbuilders where fifty-five 10,000 ton capacity freighters were built by a 4000-person work force during World War II...

"In 1948, Arthur founded Allied Builders against the advice of his father and his landlord, who had suggested he get into business with more 'future.' Arthur and his young work force from the big West Coast yard started designing and building small tugs and barges. They became specialists at building and erecting shallow draft vessels for the remote rivers and lakes of northern Canada.

“In response to losing the lease at the False Creek location, Arthur built a new facility on the north shore of Vancouver harbour in 1967. During 50 years of operation, the ‘Allied’ crew built 257 large and small commercial vessels. Arthur had the knack of always securing the ‘next’ job so he could provide near continuous employment for much of the work force.

“A shipyard needs good tradesmen and Allied has always had many of the best, from all corners of the world. “Our shipyard is like the United Nations,” Arthur would say.

“T. A. was an eager student of the engineering aspects of shipbuilding; he was a Fellow of several marine technical societies and served a term as president of the B.C. Association of Professional Engineers. He had a deep sense of public duty and was a member of many boards where his engineering expertise and his common sense attitude were appreciated. Always ready to give of his experience and knowledge to others, Arthur guided any and all who were prepared to pay attention.

“T. A. led by his example of common sense, honesty and hard work. Arthur’s sense of humour was delightful. He would often relieve a difficult situation with a well-placed quip or story.

“In the 1990s, declining health forced a gradual slowdown of Arthur’s tremendous output.

“Arthur was intensely interested in Allied’s business, employees and customers and could accurately recall and recount the essence of his life’s work until the end.”

Arthur McLaren joined the Engineering Institute as a member in 1950.

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### **John B. Milne**

Mr. Milne’s submission was dated February 1999. He began it by saying that he should have graduated in 1943, having entered Scotland’s Aberdeen University in 1940 to study civil engineering. However, as a member of the University’s Air Squadron, he was ordered to switch to mechanical or risk being called up for war service. He refused to do so and went immediately to volunteer for service with the Royal Air Force. He was allowed time to complete his second undergraduate year - and to pass. His RAF career included pilot training in the United States and service as a pilot until 1945.

Returning to Aberdeen and the University, Mr. Milne chose to repeat the second year of his course - which he had already passed - before entering the third and final one. (There were only three years in the Aberdeen engineering course.) He graduated with honours in 1947 and went to work for Sir



Wm. Halcrow & Partners on the construction of hydro-electric projects in the North of Scotland. The first of these was the Mullardoch Dam, in a relatively remote Scottish glen. His job was to carry the bench mark elevation six miles up a narrow winding road, through several areas of peat bog, which was a real challenge. He had to repeat the run several times before achieving the required closing error of less than a quarter of an inch. Then he set out the main lines of the dam to the satisfaction of the resident engineer. This entailed what he described as "a great deal of mountain climbing, waiting for the weather to clear or clearing ice off the survey points." From these experiences, he learned a lot about levelling, surveying and setting out.

Mr. Milne's next project was the Quoich Dam, in an even more remote glen. He was the No.2 man on the staff - and married. Then came Lower Moriston which, he wrote, was "almost in civilization" - quite close to Loch Ness. He went on to say:

"The small dam was quite a complex structure incorporating spillway gates, power intake, low level outlet and a fish lift which automatically raised the salmon from river level up to reservoir level so that they could continue on their way upstream to their usual breeding streams. The underground powerhouse had rockbolted walls and a concrete-lined roof and was accessed by a mile-long tunnel, also rockbolted. Water was fed to the turbines by a 200 ft. deep shaft which branched into twin penstocks. The tailrace tunnel emptied into Loch Ness, five miles away... Married quarters were in the small town of Fort Augustus..."

Mr. Milne's last hydro-electric project in Scotland was at Strathfarrar on the River Cannich. He was the design section head responsible for the preparation of specifications, designs and contract documents for two gravity dams, two surface power stations and associated works, such as fish passes, roads and bridges. He worked from Halcrow's head office in London and made regular trips to the site.

In this part of the submission, Mr. Milne wrote that his experience with Halcrow had been excellent. Each move appeared to be planned to ensure he got a good grounding in "practically everything." The firm also had a pension plan, which was unusual for the early 1960s, and this followed him to Canada when, in 1962, and still with Halcrow, he was sent to work as the assistant chief engineer on the design and construction of a prototype smelter at Baie Comeau, Québec, for the Canadian British Aluminium Company (CBA). The designs were complete and construction about half complete when CBA sold out to Reynolds Metals and the Halcrow job came to an abrupt halt. Mr. Milne went to Halcrow's B.C. office in Vancouver, but found the work conditions to be rather less than satisfactory. In 1965 he moved to CASECO Consultants (Crippen Acres Shawinigan Engineering), also in Vancouver, to work on the design of the Mica Dam project on the Columbia River. He visited the site two or three times a year. In his submission, he wrote:

"At the time I started work on Mica, it was still the largest fill dam in the world and this increased interest in an otherwise very large earth moving project. Interest was added following the failure of the Viont Dam in Italy when it was overtopped by a huge wave

generated by either a landslide or an earthquake. As there was a large potential for landslides into the reservoir close to the dam, Mica was given an enlarged crest and raised, following a series of hydraulic model tests and other analyses. The upstream and downstream faces were also strengthened with added large rockfill. This work attracted a considerable amount of international attention."

In 1971, Mr. Milne moved again at the end of his involvement in Mica, to Crippen Engineering in the hope that the company might get some of the work on the powerhouse. But this did not happen. Instead, he went to work on irrigation projects in the Far East. Having been born in what is now Sri Lanka, he was familiar with oriental people and got along well with most of those he met. Apart from a stay on the Island of Lombok in Indonesia from 1972 to 1974, during which his family joined him, he usually spent two and three months at a time as a 'bachelor,' in the Far East. He also acquired a 'working' fluency in an Indonesian language. Mr. Milne took management responsibility in all his Far East projects - in Afghanistan, Timor, Malaysia and Nepal as well as Indonesia. These were mainly in irrigation, but there were also hydro-electric projects. They were done during the years up to 1979.

From 1974 to 1979, he was also Crippen's manager of engineering for a series of flood protection dykes, culverts and diversion structures, as well as pumping stations, on the Fraser River in British Columbia. From 1979 until 1982, he was manager of the Crippen-Acres work on hydroelectric projects in Saskatchewan, including the one at Nipawin, which was technically one of his most interesting jobs. From 1982 until 1986, he was executive manager on a number of water- and hydro-related projects in the Far East and in South America. He also worked on several small hydro projects in the northwestern United States and on a large pumping station and a flood control project in British Columbia.

Towards the end of his career, Crippen sold out to H. A. Simons and Mr. Milne found it difficult to work with the new management. He was able to announce his retirement 18 months beforehand - and to be asked to stay on for a further two years as a consultant!

Mr. Milne answered the 'most satisfaction' question this way:

"This was the Lower Moriston project in Inverness-shire in Scotland... It turned out to be visually attractive as well as being quite a challenging one to construct. We had to make several design changes on site to suit the topography and the geology, and the setting out was complicated. Here I was able to help those who did the surveys and setting out work by drawing on my own lessons of eight years previously. The project, though tiny by North American standards, attracted great interest from overseas and we had visitors from USA, Japan, Italy and the Mid-East. In addition, I probably had the best group of engineers and inspectors that I ever worked with. We worked as a real team and everyone gave of his best. I still keep in contact with people who were on that job and indeed with many I used to work for in Halcrow. I also keep in touch with Glen Crippen although, like me, he is 'getting on a bit.' There was considerable team spirit on the Mica

job too...

“Perhaps the most valuable lesson that I learned was the value of respect. Without it, you get nowhere, and respect has to flow from you and to you.”

During his years in Vancouver, John Milne took a number of post-graduate courses in engineering subjects at the University of British Columbia. He was a member of the Engineering Institute of Canada and chaired its Vancouver Branch in 1971-72. He belonged, also, to the Associations of Professional Engineers of British Columbia, Saskatchewan and Manitoba, and to the Institution of Civil Engineers in the United Kingdom. He has been engaged as an individual consultant by the Asian Development Bank and as an expert witness.

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### **William J. Milhausen**

William Milhausen was born in Manitoba and received his public and high school education at Morden. He graduated in civil engineering from the University of Manitoba in 1940. As an undergraduate, he served as senior stick, or president, of the Engineering Society Council in his senior year.

His first job was as a draftsman with the Surveys Branch of the federal Department of Mines and Natural Resources. He enlisted in the Royal Canadian Engineers (RCE) on 1 January 1941, with the rank of second lieutenant. After initial training at Petawawa and promotion to first lieutenant, he was posted to the RCE Training Centre at Dundurn, Saskatchewan, as an instructor. He went overseas to England in March 1942 and, in 1943, embarked for Sicily and Italy. In March 1945, now a captain, he was transferred to the First Canadian Corps in Northwest Europe and took part in the liberation of Holland. He left the regular army in October 1945 in Winnipeg, enlisting again in the army reserve in 1948 as second-in-command of No.6 Field Regiment, with the rank of major. In the spring of 1950, this Regiment was called up for active service during the Manitoba Flood. He was in command of the army units and volunteers that successfully saved the city of St. Boniface. He resigned from the army reserve in the fall of 1950.

On leaving the regular army in 1945, Mr. Milhausen decided to join the Highways Branch of the Manitoba Department of Public Works and, in April 1946, was appointed assistant district engineer for the southwest portion of the province, working from Boissevain. He moved to Brandon as assistant district engineer of the west-central part of the province in 1947 and, in 1948, to Winnipeg in the same position in the eastern part. In 1949, he was appointed executive assistant to the deputy minister of Public Works. In 1950, at the time of the Manitoba Flood, he was district engineer for the northwest, with headquarters in Dauphin, and moved there after the Flood.

The following May, Mr. Milhausen was back in Winnipeg, on loan to the Central Housing & Mortgage Corporation (CMHC) as assistant supervisor of construction for Western Canada. This was

a busy time for CMHC, due in large measure to the Korean War. Its projects included the programs of Defence Construction Ltd. (DCL) at naval, military and air force bases, the construction of the Pine Tree Early Warning Radar Line, and installations at the Cold Lake Air Force Base. After a year in Winnipeg, he was offered the job of assistant chief engineer with CMHC in Ottawa, accepted it, left the Department of Public Works, and moved to Ottawa. He was appointed CMHC's chief engineer in December 1953 and held this position for two full years. In it, he was responsible for hundreds of construction contracts at military installations across Canada and north to the Yukon.

In December 1955, as DCL's program was winding down, Mr. Milhausen left CMHC and joined the architectural firm of Marani & Morris in Toronto as an engineering associate. This firm was one of the three largest architectural firms in Toronto. His responsibilities were for the administration and supervision of projects, from tendering to completion. Over the years, the principals and the name of the firm changed. In 1964, he became a partner in Marani Rounthwaite & Dick (MR&D) - and eventually was made the managing partner - until his retirement in 1984. He also served as president of Ardec Consulting Engineers, a firm created by MR&D to carry out electrical and mechanical work on some of the architectural projects.

Among the buildings with which Mr. Milhausen was associated were: the head offices of the Metropolitan Life Insurance Company in Ottawa; London Life in London and Mutual Life in Kitchener; Sheridan College in Oakville and Conestoga College in Kitchener; York Central Hospital at Richmond Hill and Womens' College Hospital in Toronto; the Law and Social Science Buildings at Queen's University; the Science Building at the University of New Brunswick; the Osgood Hall Law School of York University; the head office of the Bank of Canada in Ottawa; and GO Train renovations at Union Station, Toronto.

Mr. Milhausen has been a member and life member of the Engineering Institute, a member and designated consulting engineer of the Association of Professional Engineers of Ontario.

His 'most satisfaction' paragraph said:

"It is hard to pick out one project that gave me the most satisfaction as, over the years, I was involved in many interesting and varied projects, and it was always of great satisfaction to see the start of a project and be involved in its construction and eventual handover to the owner. Each one was different and had its own problems. The two specific experiences that stand out in my mind are my time in the army in England, Italy and Northwest Europe, and the success we had in fighting the 1950 Manitoba Flood and saving the city of St. Boniface. However, of the projects I was involved with, the one I feel was the most interesting was the construction of the head office of the Bank of Canada in Ottawa."

The Milhausen submission was dated in February 1999.

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### **Herbert C. Moulding**

Mr. Moulding was born in Hartney, Manitoba, in June 1922, received a diploma in agriculture from the University of Saskatchewan in 1942, a degree in civil engineering from the same institution in 1947, and a special class certificate in watershed management from Colorado A&M in 1949. His military service was with the COTC at the University of Saskatchewan. In 1941 and 1942, he was a farm manager. In 1943, he began a 46-year association with Ducks Unlimited Canada (DUC). For the first seven years, he worked as a field surveyor in Alberta. He served as provincial manager with headquarters at Regina from 1950 to 1973 and, from 1973 until he retired in 1986, as assistant chief engineer of DUC with headquarters in Winnipeg.

Mr. Moulding joined the Engineering Institute as a student in 1947. He joined the Canadian Society for Civil Engineering in 1972 and was later elected a Fellow. Among the awards he has received are an Honorary Award from the Saskatchewan Natural History Society, a Saskatchewan Annual Conservation Award, and the Award of Merit from the American Association for Conservation Information.

Mr. Moulding's handwritten submission is dated November 1999. This is an extract from it:

"Currently (in retirement) I'm working with the city of Kelowna to regain control of the Lake Okanagan shoreline Crown land for public use. In the past, I encouraged the development and preservation of the Wascana Waterfowl Park in the centre of Regina. I designed and oversaw the development of the Saskatchewan River delta. I located and designed the Heart River diversion, which serves as a water supply for a number of towns in north-central Alberta. In New Zealand and Australia, I contributed time and money to wetland development.

"My main endeavour since graduation has focused on improving the environment for the benefit of Western Canadians..."

Additional information on Mr. Moulding's career was obtained from the 1998 issue of *The Okanagan Valley Who's Who*.

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### **J. L. (Jack) Reid**

The following information was included in an undated biography published by the Northern Alberta Branch of the Military Engineers' Association of Canada (MEAC).

Jack Reid was born in October 1910 and died in April 2000. He was raised in Edmonton, where he attended public and high schools and the University of Alberta. He left the University in the early 1930s, part way through his course, to work as a surveyor for the Highways Branch of the Alberta

Department of Public Works as a chainman, rodman and, eventually, instrument man. In 1937, following formal survey training at Montana State College, he joined the Aviation Division of the Alberta Department of Transport as a land surveyor.

In 1941, he joined the Royal Canadian Engineers and was commissioned as a first lieutenant. He was posted to the headquarters of Military District 13 at Calgary, where he was involved in the design and layout of new army camps at Wainwright, Wetaskiwin and Lethbridge in Alberta. In 1943, he took charge of the construction of the buildings, water, sewer and gas systems for a POW camp at Medicine Hat. He was promoted to captain later that same year and was sent overseas, in February 1944, to the European Theatre where he served in the Second Canadian Corps, where he was involved primarily in the construction of roads and bridges. He was wounded in March 1945 during a major Rhine crossing and spent many months in convalescence prior to returning to Canada. He retired from the army in September 1945.

Mr. Reid worked on power line construction in Saskatchewan until 1947, when he began a long career with the Alberta Power Commission. He was director of hydroelectric development at the time of his retirement in 1975. However, he interrupted this career in 1961 to take a two-year contract position with the Hunting Survey Corporation to conduct hydrological assessments of water resources in Somalia for the United Nations.

Jack Reid joined the Engineering Institute as a member in 1951, the same year that he fulfilled the requirements for membership of APEGGA. From 1977 to 1979, he served as president of the Northern Alberta Branch of MEAC.

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### **Emil J. Sanden**

Emil Sanden was born in Kelowna, but soon moved with the many members of his family to the Prairies, east of Calgary. He was educated locally, benefitted from the dedication of his teachers, and went to university with a scholarship. He graduated from the University of Alberta in civil engineering at both the bachelor's and master's levels, later becoming a sessional lecturer there. He worked for CM&S, Davis Ripley & Associates and Bennett and White Construction before joining the Alberta Department of Transportation where, in 1962, he was appointed chief bridge engineer - a position with responsibility for all planning, design and construction work, as well as the maintenance of the province's 12,000 bridges. Building some 300 new structures each year required the development of new designs, the use of new materials and the use of mass production techniques, in co-operation with industry.

Mr. Sanden was appointed Alberta's assistant deputy minister for engineering and operations, which included highways, roads, airports and railways. He was active in national transportation matters, belonging to the Roads and Transportation Association of Canada (RTAC), and was the author of several publications. He served as chairman of the Western Association of Canadian Highway

Officials. He retired from government service in 1979 and set up his own firm, his primary interest being in renewable energy. He retired to Victoria.

Mr. Sanden joined the Engineering Institute as a student in 1945. He was also a member of APEGGA and served on its Council, and held the office of president in 1977. He received a number of awards, including the Queen's Silver Jubilee Medal and the L.C. Charlesworth Award of APEGGA.

The submission for Emil Sanden is undated. Its authorship is not recorded, but it could have been written (in the third person singular) by Emil himself. It includes this paragraph, which serves to answer the 'most satisfaction' question:

"The outstanding aspects of his career? Emil notes the effects of good leadership in the Manning government; that he, himself, served a remarkable 20 years under one Minister of Transportation, the Hon. Gordon E. Taylor, who insisted on absolute honesty, individual accountability, economy and recognized the importance of engineering, long range planning, and working in co-operation with industry and other authorities. All this was key to personal incentives for everyone to continually improve the way of getting things done, with well-earned satisfaction. It made the extra time and effort of 50-60 hour weeks, for so long for so many, feel worthwhile."

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### **John A. Scott**

John Scott was a Border Scot, having been born in Kelso in 1922, educated there and in Edinburgh. He received a degree in civil engineering from the University of Edinburgh in 1947, following service from 1942 to 1946 as a pilot in the Royal Air Force. He received an M. Eng. degree from the University of Toronto in 1971.

Mr. Scott joined Gore & Storrie, consulting engineers, in Toronto in 1948 and was a director of the firm when he retired in 1982. During his career, he was involved in the design of a significant number of municipal engineering projects, among them:

- \* sewage treatment plants in Metro Toronto and 21 other municipalities in Ontario, one in Saskatchewan and one in Alberta;
- \* water purification plants in Metro Toronto and 10 other municipalities in Ontario and one in Alberta;
- \* pumping stations in Metro Toronto and two other municipalities in Ontario;
- \* underground reservoirs in Metro Toronto and seven other municipalities in Ontario and one in

Alberta; and

\* miscellaneous projects, including the Brampton flood relief channel and bridges, a 'watts from waste' plant in Toronto, various large sewage tunnels, and various large watermains.

Mr. Scott records his 'most satisfaction' project as the Brampton flood relief channel and bridges which, he said, were finished just in time for the famous 'Hurricane Hazel.' The channel was full almost to the brim at the height of the flooding; no damage was done to Brampton!

His submission is undated.

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### **W. J. C. (Jack) Sissons**

Mr. Sissons was born in Redcliff, Alberta, in July 1923 and received his schooling there and in Medicine Hat. He began his engineering education at the University of Alberta in 1942 but interrupted it to serve, from 1943 to 1945, with the RCAF and the RCNVR. He graduated from the University of British Columbia in mechanical engineering in 1948, and subsequently took several design and marketing management courses at the Banff School of Advanced Management.

His first job as a graduate was design-sales engineer with the Trane Company of Canada, initially in Toronto, then, in 1949, in Calgary. In 1953, he joined the Medicine Hat Brick & Tile Company and its associated companies in promotion and sales capacities, working from a base in Calgary. In 1958, he was promoted to general sales manager for all company divisions, and moved back to Medicine Hat in 1959, later becoming vice-president (marketing) of the successor company, IXL Industries Ltd., and president of this company. By 1985 he had retired.

Mr. Sissons has been active in the Canadian Construction Association, serving as vice-president for Alberta., and the Alberta Construction Association, serving as its president. He was a director of the Clay Brick Association of Canada and was president of the Unit Masonry Council of Alberta. He has been a member of the construction advisory committee of the Southern Alberta Institute of Technology and a member of the Senate of the University of Lethbridge.

Jack Sissons joined the Engineering Institute as a student in 1946. He has been a member of APEGGA since 1951, and is also a member of the Associations in Saskatchewan, Manitoba and British Columbia. His submission was dated December 1999.

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### **V. Douglas Thierman**

Douglas Thierman was Saskatchewan-born, in August 1927. He graduated in civil engineering in



1948 from the University of Saskatchewan. In 1969, he attended courses at the Banff School of Advanced Management and, in 1971, the University of Alberta's first Arctic Summer School at Inuvik.

His first job after graduation was with the Saskatchewan Department of Highways, as a resident engineer in charge of what he called "a government-owned grading outfit." In 1949 he joined a consulting engineering firm in Saskatoon - Underwood McLellan & Associates - as a municipal engineer and remained there until 1954. In 1955 he joined another firm of consulting engineers - Haddin, Davis & Brown (HD&B) - working briefly in Calgary but mostly in Edmonton, where he became a director and manager of the HD&B office. When this partnership was dissolved in 1964 and the firm became part of Reid Crowther & Partners, he joined them. He became a vice-president and a director of this firm, as well as regional manager for Northern Alberta and the Northwest Territories. In 1975, he set up on his own firm, Thierman & Associates, in Edmonton, became its principal, and from which he retired.

Mr. Thierman's professional responsibilities have included an extensive variety of projects, involving both engineering and management. In the municipal field, for example, he was involved with the towns of Jasper, Spruce Grove and Hinton in Alberta, the city of Yellowknife and the hamlets of Frobisher Bay and Pine Point in the Northwest Territories (before Nunavut). In urban development, he was involved with 11 sub-divisions in the Edmonton area. He did planning studies for at least six municipalities in Alberta, has been involved in transportation studies, with institutional, recreational and other buildings and with several river flow regulation studies.

Douglas Thierman joined the Engineering Institute as a student in 1946. He served as Edmonton Branch Chairman, vice-president Western Region and was national president in 1980-81. He later chaired the Life Members' Organization. He was also a member of APEGGA and was awarded its L. C. Charlesworth Award. He was awarded a Queen's Silver Jubilee Medal. His submission was made a short time before his death in 2001.

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### **L. Martin Wedepohl**

Martin Wedepohl was born in South Africa in January 1933. He matriculated in 1949 at Grey College, Bloemfontein, where he was the top graduand of his year, and graduated *summa cum laude* in engineering in 1953 from the University of Witwatersrand. He was a graduate apprentice with the British General Electric Company in Birmingham, England in 1954 and, from 1954 to 1957, a research engineer with A.Reyrolle & Company of Newcastle-upon-Tyne, while at the same time studying at the University of Manchester for his doctorate, which he received in 1957.

In 1958, Dr. Wedepohl joined the Electricity Supply Commission, in Johannesburg, South Africa, as a telecommunications planning engineer. In 1961, he joined L. M. Ericsson in Pretoria as a manager but, a year later, returned to England to the Reyrolle company to be the section leader of

protection relay research and development. He was appointed a lecturer in the Faculty of Technology at the University of Manchester in 1964 and, three years later, professor of power systems engineering. From 1970 to 1974, he was also head of the department. He was a member of the University's Board of Governors from 1968 to 1971, a member of the North West Council for Higher Education from 1968 until 1972 and a governor of Bolton College from 1972 to 1974.

Dr. Wedepohl was appointed dean of engineering at the University of Manitoba in 1974, and held this position for five years. He was a member of the board of directors of Manitoba Hydro from 1975 until 1979 and, for the final months of this term, the vice-chairman of the board. In 1979, he was appointed dean of the applied science at the University of British Columbia, a position he held until 1985. From then until 1997, when he became dean emeritus, he remained at UBC as a professor of electrical engineering. He was also a member of the Science Council of British Columbia, a member of the board of BC Hydro and chairman of its Energy Committee. In 1985 and 1986, he was vice-president of Quantic Labs in Winnipeg.

Dr. Wedepohl holds a number of patents for protecting high voltage transmission lines, and developed the first transistorised protection relay system, which went into field service in 1958. As an academic, he is the author of numerous papers. He was elected a Fellow of the Engineering Institute in 1987, and is also a Fellow of the U.K. Institution of Electrical Engineers. He is a member of the Association of Professional Engineers of British Columbia and a Chartered Engineer in the United Kingdom. He has been a member of the British National Committee for CIGRE (*Conseil International des Grands Réseaux Électriques*) and was a regular Canadian member of its study committee on telecontrol.

Dr. Wedepohl's submission was received in October 1999.

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### **Lawrence David Wickwire**

Mr. Wickwire was Nova Scotia-born, in August 1907, at Milford in Hants County. He graduated from the Nova Scotia Technical College in 1933 with a degree in electrical engineering. His brief career resumé follows:

"Became chief engineer, Bowater Mersey Paper Company Ltd., Brooklyn, N.S.. Later, chief engineer of the Paper Division, Price Brothers Company in Kenogami, Québec, and manager of their Riverbend Mill in Alma, Québec. Moved to Grand Falls, Newfoundland, in 1965 as resident general manager of the Price (Nfld.) Pulp and Paper Company Ltd. Became a director and vice-president of the Company until retirement in 1968. Then a period with the United Nations International Development Organization (UNIDO) in New Guinea and papermill start-up projects in South Africa and Iraq.

"President of the Association of Professional Engineers of Nova Scotia in 1958.

Practised engineering in various provinces and countries throughout the world. Member of the Engineering Institute of Canada, Sigma Chi Fraternity and Serving Brother of the St. John Ambulance Association. Enlisted in the RCAF in 1939, took aeronautical engineering course, served in Canada and overseas, discharged in 1946 as a wing commander... Retired to West Vancouver, B.C.... Member of the Circumnavigators Club. Presented with pilot's wings in 1999 for service as a test pilot during WW II."

Mr. Wickware became a member of EIC in 1949. His submission was received in April 2000.

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### **In Summary...**

The 'sample' discussed in this Paper is minuscule in terms of the number of engineers working in Canada during the second half of the 20<sup>th</sup> century. It is even minuscule in terms of the membership of the Engineering Institute of Canada at that time. Most of the careers reported are for *civil* engineers, leaving the mechanicals, electricals, chemicals and others even less effectively represented. Almost all of the submissions were from industry people, with a few from government and one from academia. Only a few responded to the 'most satisfaction' question, but most appeared satisfied with their choice of career. Not surprisingly, since the LMO membership around the time of the Millennium included none, there were no submissions from women engineers.

Nevertheless, the purpose of this Paper is to draw attention to the *kinds* of careers that *some* Canadian engineers had and, in this way, to try to draw a number of lessons from them. All the respondents appeared to find much to interest them during their working years. Their work options varied. Many travelled a great deal, and some worked abroad. They learned to deal with the unforeseen, with problems and with unusual situations, and worked beyond the disciplines of their formal education.

Nowadays, in 2004, engineering might be defined differently from 50 - or even 20 - years ago, thanks to technological advances, including the computer. However it may be defined, it still involves the exercise of ingenuity - and enterprise.

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