Transportation Association of Canada

The Evolution and Legacy of Transportation Education in Canada:

A monograph in celebration of TAC's centennial





June 2014

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Abstract

The Transportation Association of Canada's centennial celebration in Montreal, September, 2014 showcases many achievements, activities, events, tributes and contributions. A Monograph on *"The Evolution and Legacy of Transportation Education in Canada"* is one such major contribution to both the Centennial and to the overall transportation community.

Transportation education is synonymous with the technical, economic, geographic, political and institutional aspects of the various modes. Prior to 1914, and the beginning of World War I, rail was the dominant mode and instrumental in building a nation. This was reflected in civil engineering curricula at that time and indeed continued to the end of World War II in 1945.

Future influence of the modes of transportation education and training is expected to have an impact on core undergraduate and optional graduate courses, which are relatively incremental, but, technological, communication and teaching and training delivery method advances may well have major impacts.

In summary, transportation education and training has been an evolutionary and vital component of Canadian transportation for more than a century. The legacy for continuing advances is well founded.

Keywords

- Canada
- Construction
- Cultural heritage
- Education
- History
- Planning
- Engineering
- Transport mode
- University

Supplementary Information

None

FOREWORD

Transportation education and training is a subject that is near and dear to those of us who work in the field. But, it is also important to the public who expect providers of transportation service to be properly trained and educated.

Transportation has always been about moving people and goods, but with varying social, political, economic, technical and environmental considerations. The importance of skills in planning, building, operating and maintaining transportation systems has been long recognized.

Early in the twentieth century, at the time of formation of the Canadian Good Roads Association (CGRA) in 1914, training and education were primarily on-the-job based. For long distance travel, rail was dominant at that time, but walking and cycling were the primary modes of transport for the everyday movement of people. Now it is road and air travel which are dominant, and much emphasis is being placed on active transportation modes but railways, pipelines and other modes continue to be a vital part of the safe and efficient movement of goods and people.

The evolution of transportation education, as described in this Monograph has recognized the relative and changing impact of the modes. But it has continued to also recognize that the fundamentals of science and engineering are invariant.

The evolution of transportation education in Canada has seen an extension of rail and highway engineering to traffic, pavement design, freight, air, safety, active transport, transport planning and economics. This has resulted in a growing resource of professionals to provide the training and education and/or become practitioners in public and private agencies. Moreover, this evolution has seen major advances in the state-of-knowledge and the state-of-practice.

In essence, there is a legacy of the outcomes of the training and education and the associated advances. The beneficiaries are not only today's professionals but also the leaders of tomorrow and the public at large.

It is a personal pleasure to write this Foreword as a tribute to all those who made the Monograph possible. This includes the authors Dr. Ralph Haas and Dr. Lynne Cowe Falls, my colleagues in the Team Canada Alliance for Transportation Teaching and the many others in our transportation community.

Jeannette Montufar, PhD, P.Eng., PTOE
Professor, University of Manitoba

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As well, various members of TCATT, the TAC Foundation and the Education and Human Resources Development Council and other individuals in the transportation community, contributed comments and advice all of which is very much appreciated.

French translation of the Monograph has been carried out by Lucie Leblanc, certified translator (OTTIAQ) and Jean-François Gysel, P. Eng. Their efforts and contribution are gratefully acknowledged.

EXECUTIVE SUMMARY

The Transportation Association of Canada's centennial celebration in Montreal, September, 2014 showcases many achievements, activities, events, tributes and contributions. A Monograph on *"The Evolution and Legacy of Transportation Education in Canada"* is one such major contribution to both the Centennial and to the overall transportation community.

Transportation education is synonymous with the technical, economic, geographic, political and institutional aspects of the various modes. Prior to 1914, and the beginning of World War I, rail was the dominant mode and instrumental in building a nation. This was reflected in civil engineering curricula at that time and indeed continued to the end of World War II in 1945.

The First Good Roads Era, from 1914, where the Canadian Good Roads Association (CGRA) was formed, to the Great Depression in 1929 began to see education of highway engineers as a distinct need from only on-the-job training.

The Great Depression to End of World War II Era, 1929 to 1945, lagged in production of graduate engineers but transportation in civil engineering programs continued to feature railway engineering and surveying.

The Boom Years of Road Building Era, 1945 to mid-1960s required substantial numbers of additional engineers and technologists. A highlight of that Era was the first ever gathering of highway engineering professors from across Canada at the Golden Jubilee Convention of CGRA in Montreal, October, 1964.

The Expansion of Transportation Education Era, mid 1960s to mid-1980s continued to have a focus on highway engineering but optional courses in traffic, pavement design, airport engineering and transportation economics became available. As well, there was an associated increase of transportation faculty at Canadian Universities.

The Modern Era, mid-1980s to mid-2010s saw a continuing suite of optional courses at both the undergraduate and graduate levels, and a continued expansion of transportation faculty.

The impact of TAC Guides and Manuals over six decades has been a major contributor to training, education and the state-of-practice. An example is the four Pavement Design and Management Guides of 1965, 1975, 1997 and 2013.

The CGRA Scholarship Program, initiated in 1952, continued to 2002 when the TAC Foundation was formed and assumed responsibility for the program. The impact on education and training of transportation professionals has been enormous, and the Canadian transportation industry and indeed the public have been the beneficiaries.

A tribute to the "*Titans"* of transportation education and research in the Monograph recognizes many prominent educators whose contributions are a lasting legacy.

Prospects for the future are described in the Monograph in terms of building on the legacy of educational achievements and the need for continuing advances through innovations.

The key and continuing role of the Education and Human Resources Development Council is described in the Monograph and includes a focus on skills requirements for transportation professionals.

The Team Canada Alliance for Transportation Teaching (TCATT) initiative to offer a webinar based national course on special topics in transportation engineering represents another key example of building on the legacy.

Future influence of the modes on transportation education and training is expected to have an impact on core undergraduate and optional graduate courses, which are relatively incremental, but, technological, communication and teaching and training delivery method advances may well have major impacts.

In summary, transportation education and training has been an evolutionary and vital component of Canadian transportation for more than a century. The legacy for continuing advances is well founded.

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1. INTRODUCTION

1.1 Background

The Centennial Celebration of the Transportation Association of Canada (TAC) in Montreal, September, 2014 represents a proud moment in Canadian transportation. It was in September, 1914 that the Canadian Good Roads Association (CGRA), the forerunner of TAC, was formed in Montreal[1]. From a modest beginning, largely in response to the growing need and importance of roads to the nation's economy and social well-being, the subsequent century of involvement by the Federal, Provincial, Municipal, Academic and Private Sectors has resulted in a network of roads, rail, air, waterways, pipelines, and other transport facilities which are second to none and indeed represent a legacy of leadership, commitment, innovation and vision.

Evolution in the various transportation modes has had technical, policy, geographic, economic, administrative, institutional, management and educational aspects. In fact, transportation education is in many ways synonymous with the evolution of the transportation modes themselves. Prior to 1914, and the beginning of World War I, rail was not only the primary mode of land transport in Canada but was also instrumental in building a nation. That meant transportation education, in civil engineering curricula, included at least one course in railway engineering, supplemented by extensive training and practice in surveying.

A "speed dial" to 2014 shows that transportation education now has a strong focus on traffic safety, logistics, life cycle economics, planning, management, highways and pavements. While a century of evolution has occurred, the fundamentals underlying today's education are still very much the same as the rigorous base of fundamentals of science, mathematics, physics, materials and dynamics which have always been requisites.

1.2 Scope of the Monograph

The intent of this Monograph is to focus on a century of leadership in and commitment to transportation education in Canada, its role within the broad community of practitioners, the technical, social, economic and institutional dimensions of transportation education and the teaching and learning environment which fosters innovation and an understanding of current and future needs. While on-the-job education and training has always been and continues to be vital, the scope of the Monograph is primarily in the university-based education environment. College-based education in transportation is

[1] Full recognition must be given to the fact that the pioneering organization is the Ontario Good Roads Association, formed in 1894. This was due, originally, to the fact that the railways were dominant in terms of expansion and public funding. Roads and streets were declining in importance, and neglected to the extent of being left largely in the hands of local authorities, so that many became unusable. Since that modest beginning (as recorded in OGRA's archives), OGRA has flourished to become the vibrant organization it is today with widespread support. It is noteworthy that OGRA plays a major role in training and education, starting in 1959 with courses for road superintendents. A suite of current training courses, workshops, seminars and the like can be found on the website (www.OGRA.org).

a complementary and valuable component of the total picture and should be recognized as such, although it is given limited coverage in the Monograph due to resources available for the project.

The audience for the Monograph is intended to be the TAC community at large, including the leaders of today and tomorrow. They will have a description of the key educational and training achievements, the legacy provided and the motivation for continuing advancements.

The Monograph traces the historical milestones of transportation in Canada because of the influence on transportation education. But, it is not intended as just a walk through history. Rather, the journey includes the teaching and learning environment, examples of the pioneers who provided leadership in making transportation education a core component of civil engineering curricula, the effect of advances in transportation research and practice on education *per se* and the substantial increases in the national talent pool of highly qualified professionals. Certainly, the legacy of this journey and all the people and organizations involved, provides a basis for the future of transportation education.

The layout or structure of the Monograph is built around major Eras, from the turn of the twentieth century to 1914 and the Great War as the *"Beginning Era"* followed by the *"First Good Roads Era"* of 1914 to the start of the Great Depression in 1929 and the *"Great Depression to End of WWII Era"* (1929 to 1945) and the "*Boom Years of Road Building Era"* (1945 to mid-1960s). *"Expansion of Transportation Education Era"* (mid-1960s to mid-1980s) is then described followed by the *"Modern Era"* (mid-1980s to mid-2010s). Finally, *"Prospects for the Future"* are explored.

While the century of CGRA/RTAC/TAC existence has seen many marquee/flagship achievements, two stand out in particular with regard to their major impact on transportation training and education over the past six or more decades and the latter three eras. These are the impact of guides, manuals and various TAC publications, and the impact of the scholarship program and the TAC Foundation. Both are included in the Monograph as special features; as well a special feature is a tribute to the *"Titans"* of transportation education and research.

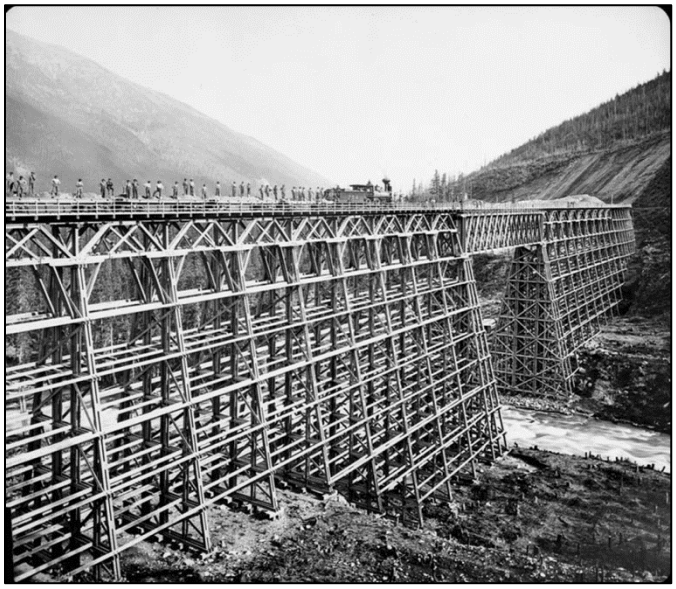
1.3 Transportation Modes and Milestones with an Impact on Education

The history of Canada was shaped in large part by the challenges of connecting a sparsely populated, geographically diverse nation by various modes of transportation. Aboriginal peoples travelled by water and on foot over trails, early European settlers travelled on inland waterways by boat and by sleigh in winter, coastal boats connected the outports of Newfoundland and the coast of British Columbia, while the Europeans also brought the wheel, and made wagons. Building roads to use these wagons was a formidable task.

That is why no mode had a more profound effect in connecting a young nation from the Atlantic to the Pacific coast than rail. Short stretches began in the mid-1800s, and by the time of Confederation in 1867, considerable investment in rail had occurred. This was to the detriment of investment in roads [Guillet 1966]. Nevertheless, by the turn of the twentieth century Canada had an extensive system of regional rail networks and the Transcontinental Railroad which connected the nation.

The first Canadian Pacific Railway through train from the Atlantic to the Pacific at Port Arthur, June 30, 1886

Regarding transportation education, the dominance of rail was a driving force in being the mode which was covered in the early civil engineering programs of the late 1800s to the mid-1900s. Otherwise, on-the-job apprentice-type training, including surveying, was the primary method of education in transportation. Bridge design and construction skills were also a key part of education and training in this period.



Wooden railway bridge over Mountain Creek, British Columbia, circa 1880-1890

The end of World War II in 1945, and beginning of the boom years of road building (see Section 5) saw the core transportation course in most university civil engineering programs become highway engineering. That continued to the expansion of transportation education in about the mid-1960s where the core course in most programs became transportation engineering. While highway engineering is still a major part of these courses, some coverage is also given to air, rail, traffic, freight and other components.

The post-World War II decades also saw the advent of optional undergraduate and graduate courses in civil engineering programs, including traffic engineering, pavement design, transportation planning, urban transit, air transportation and others.

While transportation modes have certainly had an impact on transportation education, the methods of delivery have also evolved from chalkboard, to visual aids such as transparencies and PowerPoint slides, to web-based courses and webinars for specific one-off topics or entire courses. An illustration of the latter is TCATT's (Team Canada Alliance for Transportation Teaching) national graduate course on Special Topics in Transportation Engineering, started in 2011, with an annual uptake of about 60 students from across Canada. In fact, TCATT was the recipient of TAC's Educational Achievement Award for this initiative in 2012.

The many CGRA/RTAC/TAC publications, including manuals and guides, provide an enormous repository of information used in transportation education (see Section 8). As well, the scholarship program and the TAC Foundation have had a profound impact on education and training and on the nation's resource of skilled professionals (see Section 9).

2. BEGINNING ERA (TURN OF THE 20TH CENTURY TO 1914)

The Beginning Era for this Monograph has been arbitrarily defined as from the turn of the twentieth century to 1914 and start of World War I. In fact, though, the rail era began several decades before that and had a substantial influence as the nation's primary mode of transportation. The advent of the motor car and a major push by cyclists, a key mode of personal transportation at the time, for decent pathways were also influential factors leading up to the formation of CGRA in 1914.

Of course World War I, starting in 1914, caused a major drain on the nation's economy. The recruitment of soldiers and commitment to the war effort relied very much on the network of railways. Engineering expertise and experience from the rail sector, involving design, bridges, surveying, construction and materials was a valuable asset to Canada's contribution to the war effort, as well as to the fledgling road sector in the Beginning Era and for subsequent decades.

Because of the importance of the rail sector, not only to the nation as a whole but also its role in the creation of road engineering competencies, it is useful to summarize some of the key historical milestones.

2.1 The Rail Sector in Canada: An Important Legacy

Canada's geographic and climatic diversity, and extent as a sparsely populated country, made the long trips by wagon, foot, coach and inland waterways particularly arduous. The railway building boom began in the mid-nineteenth century and despite the effects on connecting regions, towns and cities, the early years were also characterized by chronic financial problems, unrealistic hopes and far too many charters [Archives Canada 2002].

Nevertheless, railways were essential to unifying the young Dominion of Canada, geographically and politically. Sir John A. Macdonald's "national dream" is a key historical example where the Canadian Pacific Railway from coast to coast was a promise of Confederation. A railway line through a town or region was like a "golden touch" [Archives Canada 2002] for growth in population and industry, prosperity, ease of travel to other destinations, marketing agricultural and natural resource products and employment.

Hon. Donald A. Smith driving the last spike to complete the Canadian Pacific Railway. November 7, 1885; Craigallachie, B.C

2.2 Canada's First Roads

Inland waterways were the only practical means of transportation for aboriginal peoples, early explorers and settlers up to the nineteenth century. Early roads were built to accommodate horse-drawn carriages and wagons, other than those built of military necessity [Canadian Encyclopedia]. Consisting mainly of cleared paths or planked (termed "corduroy") roads they complemented water transport and helped to open up new areas to settlement. However, travel by roads was difficult at best because of weather, poor drainage and foundation support and lack of maintenance.

Highway 6 Winnipeg to Souris ca1922

While there is a good historical record of early roads [Guillet 1966], it was the advent of the automobile in the early part of the twentieth century that spurred efforts to improve roads. For example, there were 50,000 vehicles registered in Canada at the outbreak of World War I, and by 1915 Ontario had completed a concrete highway from Toronto to Hamilton. In 1914, Quebec created the first provincial Department of Highways.

Thomas Wilby and F.V. Haney make the first cross-Canada trip by car, travelling from Halifax to Victoria in 52 days in a Canadian-built Reo. The trip was intended to publicize the need for an "All-Red Route," or highway, which would run through southern Canada from the Atlantic to the Pacific, 1912

Transportation Education and Training in the Beginning Era

Training in transportation at the turn of the nineteenth century was very much on the job based rather than any courses at universities. The engineers who had any formal training worked on railways and came primarily from Scotland and England. Road location and construction employed mainly those who were recruited either locally or had some experience on railway design, construction and bridges.

Survey Party, Alberta Land Surveyors

The oldest English-speaking university in Canada, the University of New Brunswick (UNB), founded in 1785, appears to have the proud history of offering the first courses in engineering in 1854. These were Railway Engineering and Surveying, and reflected the influence of the railway builders who were very active in the Atlantic Region at that time.

But McGill University instituted a course in Road and Railway Engineering at a similar time (1857), as described in their archival document on the "History of the Faculty of Engineering" (www.mcgill.ca/engineering/about/history/1811-1899). The first degree in civil engineering in North America was granted in 1858 at McGill University and many more milestone events are provided in this archival document.

One of the first direct transportation related courses in Western Canada was railway engineering at the University of Alberta's new civil and municipal engineering program established in 1907. The program also offered surveying courses and field work in both the first and second years [Ford 1988]. Skill and experience in surveying were absolute necessities.

University of Alberta Civil Engineering Class, 1910
University of Alberta founding President, Henry Marshall Tory (centre), with a civil engineering class and professor William Muir Edwards, at far right

The University of Manitoba in Winnipeg and the University of Saskatchewan in Saskatoon also had courses in railway engineering and surveying in their civil engineering programs at that time.

Other examples exist in the archives of the University of British Columbia and the University of Toronto.

Courses in highway engineering did not generally appear in civil engineering programs until “The Boom Years of Road Building,” as subsequently described.

3. FIRST GOOD ROADS ERA (1914 TO THE GREAT DEPRESSION IN 1929)

While the formation of the Canadian Good Roads Association (CGRA) in 1914 coincided with the outbreak of World War I, the need and demand for better roads had been building for over a decade or more. CGRA provided a well-timed focus for governments to begin upgrading their policies, plans and technologies toward new and expanded networks of roads and bridges.

Conference Programme from the first Canadian Good Roads Association Conference, 1914

However, the war did have an immediate effect on transportation education and projects in that the few experienced road builders along with other soldiers were conscripted for the war front in Europe. On the plus side, those that returned brought their expanded experience with them. For example, Brigadier General C. H. Mitchell, a civil engineer, became Dean of Engineering at the University of Toronto, and in 1920 he gave a keynote address to the CGRA Annual Congress in Winnipeg titled "The Education of the Highway Engineer" [Mitchell 1920].

Table 1 provides a listing of the major requirements of such education, extracted from his address, which illustrate a profound vision and foresight still largely relevant today.

**Charles Hamilton Mitchell
Third Dean of Engineering,
University of Toronto, 1919-1941**

General Mitchell stated that while "…..the colleges and universities must give the fundamental education…..further or later education must progress in successive stages in the field, on the actual construction…..in the engineering or administrative offices of the Highway Departments…..of the country."

Table 1 – Some Major Requirements of Highway Engineering Education in the Early Years of CGRA Summarized/Adapted From [Mitchell 1920]

A.	Fundamentals: Core engineering courses in Mathematics, Physics, Electricity and Magnetism
B.	Basics of Applied Requirements: Land surveys and topography; cross-sections and computation of quantities; grades and drainages; steel and concrete bridges and culverts; meteorology and climatic effects; properties of materials
C.	Specialized Requirements: Paving materials, properties, construction and maintenance; knowledge of mechanical, electrical and chemical work; knowledge of mechanical and electrical equipment used in the construction of roads; knowledge of the principles of motor transport
D.	Particular Emerging Requirements: Strategic planning of routes; aesthetics of street arrangements, boulevards and parkways; administrative abilities and vision, judgement and tact; Capability of dealing with legislators and the public as well as contractors and workers

4. GREAT DEPRESSION TO END OF WORLD WAR II ERA (1929 TO 1945)

This Era was in effect also a depression on road construction. The road building that did occur was largely a "make work" type and mainly on tertiary roads with only a gravel surface. Engineering education, including railway engineering and surveying, continued at most universities which offered programs in civil engineering. However, enrolments were low for economic reasons and recruitment for the military in World War II drew those who were eligible for university entrance.

Federal Government Relief Project, 1933; Road construction, Kimberly-Wasa, B.C.

The net result was a lag in university production of graduate engineers. The positions available in highway agencies and municipalities were filled by on-the-job trained personnel. Returning soldiers in 1945 and in the next few years filled a pent up demand which responded with a road building boom, as discussed in the next section.

Mackenzie King drives a Bennett Buggy in Sturgeon Valley, Saskatchewan. Bennett Buggies were cars pulled by horses used by farmers not able to buy gas during the Depression

5. THE BOOM YEARS OF ROAD BUILDING ERA (1945 TO MID-1960S)

The end of World War II in 1945 was also the beginning of a boom in highway construction. Networks were expanded and extensive programs of paving were underway.

The road building boom across provinces, cities and towns is reflected in expanded CGRA activities and programs, with a launch of the Scholarship Program in 1952 being particularly noteworthy (see also Section 9).

Canadian Good Roads Association logo, 1952

The Trans-Canada Highway (TCH) was a major initiative of that Era, starting with the Trans-Canada Highway Act in December 1949; and was officially opened on September 3, 1962 by Prime Minister John Diefenbaker at Rogers Pass. In fact, the TCH, plus other road and street expenditures amounted to over $1.2 billion annually by the mid-1960s [CGRA 1964].

Prime Minister John Diefenbaker opens the Trans-Canada Highway, September 3, 1962

The boom in highway construction required substantial numbers of additional engineers and technologists. Most of the engineering schools in Canada had highway engineering courses in their core undergraduate civil engineering programs by 1950. A CGRA survey in early 1966 "…..indicated that there was an apparent deficiency of 1,100 graduate engineers in the highway industry….." [CGRA 1966].

Yet, in late 1967 the situation began to change rapidly as the construction boom was over, the nation began to enter an economic downturn and very few new graduates were being absorbed into the highway industry [Haas 1967].

A major reason for similar boom-bust cycles in highway engineering manpower, from an employee's to an employer's market was shown to be the 5-year offsets between peaks of graduate supply and bottoming out of demand [Haas 1967].

A first ever gathering of highway engineering professors from across Canada occurred at the Golden Jubilee Convention of the Canadian Good Roads Association in Montreal, October, 1964. This was a milestone event, sponsored by CGRA with the Technical Director at that time, Dr. Gordon Campbell, as a driving force. Representatives from 19 universities offering highway engineering were invited to attend. Organizer and Chairman of this "Highway Engineering Education Conference" was Professor Albert Stevens of the University of New Brunswick, and the recorder, the "rookie" at his first CGRA Conference, was Ralph Haas then at Carleton University.

1964 CGRA Conference Program

Not only was this Conference part of the celebration of CGRA's Golden Jubilee, but it was a milestone event in its contribution to highway engineering education and research. Moreover, it provided much of the foundation for future interchanges, growth, progress and advancement in transportation education.

The Record of the Conference, which is available in the CGRA's 1964 Conference Proceedings, was intended to achieve the following:

> "The purpose of the Conference was to bring about an exchange of information on course content and a discussion of mutual problems of teaching methods at the universities…..also to bring about a more effective liaison among the teaching staff and to inform the representatives attending…..what functions are being performed…..by provincial highway departments, the Canadian Good Roads Association, and other allied national associations."

The status of Transportation Education in Canada, 50 years later at the Centennial Celebration of TAC in 2014, is a legacy of that initiative in Montreal in 1964.

In a forward-looking move, the 1964 conference attendees passed a motion, unanimously, put forward by Dean Meyerhof of the Technical University of Nova Scotia for CGRA to create a Highway Engineering Education Committee. The new Committee became a reality at the 1966 Annual Convention, with Professor Albert Stevens of the University of New Brunswick as Chairman and Professor H. M. Edwards

of Queen's University as Vice-Chairman. A Subcommittee on the Supply and Demand for Transportation Engineers in Canada reported its findings to the 1967 Annual Conference [Haas 1967].

In the late 1960s, planning for a reorganization of CGRA was initiated and the Roads and Transportation Association of Canada (RTAC) was formed in 1970. The Highway Engineering Education Committee was not included in the reorganization.

A new logo for RTAC was designed to express the broad scope of the association. It was adopted at the Halifax conference in 1973 as the association entered its 60th year. According to the November 1973 issue of *Road and Wheel* , "It consists of four intersecting circles within a square, representing the interdependence of road, rail, air and water transport, as brought together under the RTAC programs … The enduring roads interest of the association is also represented by the 'RTAC/ARTC' lettering."

RTAC Logo, 1973

A revitalization of the role of transportation education in TAC subsequently occurred with formation of the Education Council in 2002, which then became the Education and Human Resources Development Council (EHRDC) in 2008. The Council has had a major impact on transportation education, as discussed further in Section 7.

Typical content of an undergraduate Highway Engineering course at a Canadian University during the 1945to mid-1960s is provided in Table 2. It should be noted that a number of influential textbooks began to appear in this era, including the classic "*Highway Engineering*" [Oglesby and Hewes 1954]. In fact this textbook was used extensively in the basic undergraduate course in both Canada and the United States.

Table 2 – Typical Content of an Undergraduate Highway Engineering Course during the Boom Years of Road Building Era (1945 to mid-1960s)

1. Introduction: Importance and History of Highway Transportation
2. Highway Planning, Economics and Finance
3. Highway Surveying
4. Highway Design and Vehicle/Driver Factors: Traffic Engineering Fundamentals
5. Highway Drainage and Construction
6. Highway Structures: Subgrades, Subbase and Base; Bituminous and Portland Cement Concrete Pavements
7. Highway Operations and Maintenance

6. EXPANSION OF TRANSPORTATION EDUCATION ERA (MID-1960S TO MID-1980S)

Transportation education in this era continued to have a focus on highway engineering and planning, but optional courses such as traffic engineering, transportation economics, pavement design and airport engineering began to be available. Some of these courses were at the undergraduate level and/or at the graduate level with more advanced content.

One reason for this increased availability of courses was an associated increase of transportation faculty at Canadian universities. A review of the first conference on Highway Engineering Education in 1964 (see Section 5) indicates a complement of only about 15 professors in the area at that time. However, the 1970s and 1980s saw new hirings and this has continued to the present time (see Section 7 for an estimate of current faculty numbers). A corresponding increase occurred at the college level, but details are not included in the Monograph. Certainly college level transportation engineering education justifies a study on its own.

The mid-1960s to mid-1980s era also saw a corresponding growth in training programs by associations, such as the Ontario Good Roads Association, and the various industry-supported programs.

The core transportation course(s) in universities during this era still involved to a large degree prescribed textbooks, such as [Morlok, 1978; Hutchinson 1974; Hennes and Ekse 1969; Oglesby and Hicks 1982; Hay 1977]. However, new and/or updated books were becoming available for option courses, such as Traffic Engineering and Transportation Planning (see Section 7.2). In addition, the development of course notes by instructors started to appear, such as Transportation Engineering at the University of Waterloo, originally prepared by Professor Bruce Hutchinson in the early 1980s.

The advent of cooperative education programs in engineering, started by the University of Waterloo in the early 1960s, and subsequently expanding to other universities across Canada, had a substantial impact on transportation training. Work term students were, and continue to be, employed by highway and transportation departments, municipalities, contractors, consultants, suppliers and others.

7. MODERN ERA (MID-1980S TO MID-2010S)

The Modern Era of Transportation Education and Training is characterized by the following:

- Continuation of at least one and in some programs two undergraduate core courses in transportation engineering (see Section 7.1)
- A relatively large suite of additionally available optional courses at both the undergraduate and graduate levels (see the list in Section 7.2)
- Advent of a wide range of new and/or enhanced tools (webinars, on-line courses, YouTube, cloud computing, software packages, etc. – See Section 11.9 on Future Delivery Methods)
- Continued expansion of transportation faculty, currently numbering about 50 plus, as illustrated by the TCATT membership (see Section 11.5)
- Formation of the TAC Foundation in 2002, as a successor to the Scholarship Program, and its profound effect on increasing the available scholarships and the resource of transportation professionals (see Section 9)
- Formation of the Education and Human Resources Development Council in 2002, and similarly its focus on advancing the human resource aspects of transportation education and careers (see Section 11.4)

7.1 Major Components of the Core Undergraduate Course in Transportation

A request to the members of TCATT, as well as web site information from various Canadian universities made it possible to develop a representative table of common topics in the core/basic undergraduate course in transportation engineering, as shown in Table 3. The topics are generic in title, with variations in specific institutions. As well, each topic, again depending on the institution, may contain a number of sub-headings and more or less emphasis.

Table 3 indicates, with a check mark, whether or not that topic is included in university "X's" core course in transportation engineering. Filling in these check marks was carried out mainly from web sites, and involves a fair degree of subjectivity. The Writers assume full responsibility for any errors or omissions. However, the table does illustrate overall a wide spectrum of transportation topics across Canadian universities, which is further enhanced by the availability of option courses (see Section 7.2).

The institutions listed (28 in total) are those with Civil Engineering departments who offer degree programs, according to the Canadian Society for Civil Engineering's web site.

Table 3 Canadian Civil Engineering Departments and Common Topics in Core Undergraduate Transportation Engineering Courses

Institution	Traffic Eng.	Traffic Safety	Intersection Section Design	Cap. & LOS	Transp. Planning	Travel Demand	Geometric Design	Traffic Loads	Rwy. Eng.	Airport Eng.	Pavement Design	Transp. Econ.	ITS	Sustain. & Eng. Impacts
University of British Columbia	√	√	√	√	√	√	√					√		√
University of British Columbia Okanagan	√	√	√	√	√	√	√	√	√			√		√
British Columbia Institute of Technology	√		√	√	√		√		√	√	√			
University of Alberta	√	√	√	√	√	√	√		√					
University of Calgary	√	√	√	√	√	√	√		√	√		√	√	
University of Saskatchewan	√	√		√	√		√				√	√	√	
University of Manitoba	√	√	√	√	√	√	√		√		√	√	√	
University of Windsor	√		√	√	√	√	√	√			√	√	√	√
University of Western Ontario														
University of Waterloo	√				√	√	√		√	√	√			√
University of Toronto	√	√	√	√	√	√		√	√	√		√	√	√
Ryerson University	√	√		√	√		√				√			√
Royal Military College				√	√	√		√	√		√			

Institution	Traffic Eng.	Traffic Safety	Intersection Section Design	Cap. & LOS	Transp. Planning	Travel Demand	Geometric Design	Traffic Loads	Rwy. Eng.	Airport Eng.	Pavement Design	Transp. Econ.	ITS	Sustain. & Eng. Impacts
Queen's University														
University of Ottawa	√			√	√	√	√		√		√			
McMaster University	√	√	√	√							√			
Lakehead University		√		√		√	√		√		√			
Carleton University	√	√	√	√	√	√	√		√	√	√	√		√
University of Sherbrooke	√	√	√	√	√		√		√		√			
McGill University	√	√	√	√	√	√	√		√					√
University Laval	Transport problems, perspectives and lab studies; urban dynamics; road freight transport													
ETS					√		√		√		√			
Ecole Polyt.	√	√	√	√	√	√	√		√					√
Concordia University	√		√	√	√	√	√				√			
University of New Brunswick	√		√	√		√	√		√	√	√	√		√
University of Moncton	√	√	√	√	√	√	√		√		√	√		√
Memorial University	√	√	√				√		√		√	√		
Dalhousie University	√			√		√				√	√			√

7.2 Optional Courses in Transportation at Canadian Universities

The Modern Era's availability of a large suite of optional courses is due in part to an overall increasing demand, a growth in undergraduate and graduate enrolments and an increased number of faculty members to teach the courses. Table 4 provides a representative list which is essentially a generic synthesis of specific course offerings across the spectrum of universities. As well, some courses are offered more frequently than others, depending on the institution, number of instructors and enrolment.

Very few of the courses listed in Table 4, similar to the core course(s) have mandatory texts. Rather, they list reference texts or manuals. A listing in Table 5 is categorized generally as (a) transportation engineering and planning, highway engineering and ITS (b) traffic engineering, operations, simulation, modelling and safety (c) pavement design and management, materials (d) public transit and (e) airport planning and engineering.

Table 4 – Representative List of Optional Courses in Transportation Education at Canadian Universities[2,3]

A. Undergraduate Level[4]

- Transportation Engineering
- Pavement Design
- Traffic Engineering
- Transportation Planning
- Public Transit Operations
- Intelligent Transportation Systems

B. Graduate Level

- Traffic Operations and Control
- Road Traffic Safety
- Transportation Demand Modelling and Management
- Traffic Flow Modelling
- Pavement Management Systems
- Traffic Simulation Modelling
- Airport Planning and Engineering
- Freight Transportation

[2] The names/titles for the courses listed are representative in that the exact title may be slightly different in various institutions

[3] The listing is not all inclusive; it may well have inadvertently missed some courses.

[4] Some programs make these courses also available to graduate students.

Table 5 – Representative List of Some Common Texts and Manuals for Option Courses in Transportation

A. Transportation Engineering and Planning, Highway Engineering and ITS

- Mannering, Kilareski and Washburn, "*Principles of Highway Engineering and Traffic Analysis*," Fourth Edition, Wiley 2009
- Khisty, J. and K. Lall, "*Transportation Engineering: An Introduction*," 3rd Edition, Prentice Hall, 2002
- ITE, "*Transportation Planning Handbook*," 3rd Edition, 2009
- TAC, "*Geometric Design Guide for Canadian Roads*," 1999
- AASHTO, "*A Policy on Geometric Design of Highways and Streets*," 2011
- Meyer, M.D. and E.J. Miller, "*Urban Transportation Planning: A Decision-Oriented Approach*," 2nd Edition, McGraw Hill, 2001
- Banks, James H., "*Introduction to Transportation Engineering*," 2nd Edition, McGraw Hill, 2002

B. Traffic Engineering, Operations, Simulation, Modelling and Safety

- ITE, "*Traffic Engineering Handbook*," 6th Edition, 2009
- TAC, "*Manual of Uniform Traffic Control Devices for Canada*," 5th Edition, 2014
- McShane, William R. and Roger Roess, "*Traffic Engineering*," 4th Edition, Prentice Hall, 2010
- Adolf D. May, "*Traffic Flow Fundamentals*," Prentice Hall, 1990

C. Pavement Design and Management, Materials

- TAC, "*Pavement Asset Design and Management Guide*," 2013
- Rajib B. Mallick and Tahar El-Korchi, "*Pavement Engineering: Principles and Practice*," CRC Press, 2013
- Guy Doré and Hannele K. Zubeck, "*Cold Regions Pavement Engineering*," ASCE Press, 2009
- Haas, Ralph, W. Ronald Hudson and John Zaniewski, "*Modern Pavement Management*," Krieger, 1994
- Papagiannakis, A.T. and E.A. Masad, "*Pavement Design and Materials*," Wiley, 2008

D. Public Transit

- Vuchic, V. "Urban Transit: Operations, Planning and Economics," Wiley, 2005
- Black, William H., "Sustainable Transportation," Guilford Press, 2010
- Bruun, Eric Christian, "Better Public Transit Systems, Routledge," 2013

E. Airport Planning and Engineering

- Ashford, Norman J. and Paul H. Wright, "Airport Engineering," 3rd Edition, Wiley, 1992
- Richard De Neufville and Amedeo Odoni, "Airport Systems – Planning, Design and Management," McGraw-Hill, 2003
- Robert Horonjeff, Francis McKelvey and Richard D. Horonjeff, "Planning and Design of Airports," 4th Edition, McGraw-Hill, 1993

8. IMPACT OF TAC GUIDES AND MANUALS ON TRAINING AND EDUCATION

TAC guides and manuals, and various other publications over the past six decades have had a major impact on transportation education and training, as well as on the state of practice. They can be broadly categorized, with examples from the past two decades, as follows:

- **Manuals and Guides**
  - Manual of Uniform Traffic Control Devices for Canada
  - Drainage Manual
  - Geometric Design Guide for Canadian Roads
  - Guide to Bridge Hydraulics
  - Guide to Bridge Management
  - Environmental Management Systems User Guide for Transportation Practitioners
  - National Guide to Erosion and Sediment Control on Roadways Projects
  - Salt Management Guide
  - The Canadian Guide to In-Service Road Safety Reviews
  - Guide for the Design of Roadway Lighting
  - Pavement Asset Design and Management Guides (1965, 1977, 1997, and 2013)
- **Guidelines, Syntheses of Practice and Handbooks**
  - Guidelines and Best Practices for Road Features Inventories
  - Canadian Road Safety Engineering Handbook
  - Highway Finance Theory and Practice: Synthesis
  - Synthesis of Practices for Implementing Public-Private-Partnerships in Transportation Related Projects
  - Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions
  - Guidelines for the Construction and Operation of Winter Roads
  - Synthesis of Quality Management Practices for Canadian Flexible Pavement Materials and Construction
  - Bikeway Traffic Control Guidelines for Canada
- **Frameworks and Reports**
  - Framework for the Application of Intelligent Transportation Systems (ITS) for Traffic Management
  - Measuring and Reporting Highway Asset Value, Condition and Performance
  - Performance Measures for Highway Road Networks
  - Active Transportation – Making it Work in Canadian Communities

The foregoing examples, plus many other reports, conference proceedings and others have been used to varying degrees for training, education, information for practitioners and in some cases adoption to practice or policy by agencies. The Pavement Design and Management Guides are just one example of the success of TAC publications, and will be highlighted in this section. The Pavement and Design

Management Guides have been used as texts in undergraduate courses in civil engineering programs, and as references in graduate level courses, over the past five decades. In essence, they constitute an evolution and legacy themselves, as described in [Haas 2011]. A summary of that evolution and legacy is presented in the following.

The pioneering work began in the late 1950s with formation of a Pavement Design and Evaluation Committee in CGRA. Based on nationwide investigations of pavement sections, and an extraordinary level of commitment by the committee members and their organizations, "*A Guide to the Structural Design of Flexible and Rigid Pavements in Canada*" was published in 1965. This early work was the foundation for subsequent advances in developing and implementing pavement management systems across Canada.

The First Guide (1965)

In 1971 a successor, the Pavement Management Committee was formed under the Roads and Transportation Association of Canada, itself a successor to CGRA. The new Committee, under the leadership of G. Robert Tessier of the ministère des Transports du Québec, undertook a major initiative to develop a pavement management guide with financial support from Transport Canada.

The result, again based on an extraordinary level of effort by committee members and their organizations, was the 1977 "*Pavement Management Guide*," published by RTAC, and the "*Guide de gestion routière*" published by the Association québécoise du transport et des routes (AQTR). This was the first book ever published on the subject, worldwide.

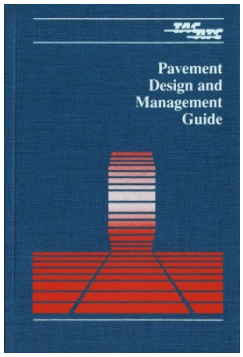
A major impact of the 1977 Guide was the impetus it gave to the development and implementation of operational pavement management systems (PMS) by the provinces and territories, federal agencies and municipalities, starting in the late 1970s and continuing through the subsequent decades. It also proved to be an impetus for implementation of PMS in other countries (e.g. The guide was translated into Portuguese in Brazil), as well the impetus for establishment of consultancies in the area.

The Second Guide (1977)

The Pavements Standing Committee under TAC, which succeeded RTAC in 1991, saw a need to update the 1977 Guide, with the following objectives:

- Provide an up-to-date comprehensive consolidation of pavement design and management knowledge for a new generation of users.
- Promote good pavement design and management practice among the provincial, federal and municipal owners of pavements.
- Incorporate new technology within a systematic, organized management framework.

A Project Steering Committee was formed under the leadership of Tom Kazmierowski of the Ministry of Transportation, Ontario (MTO). A contract was awarded in 1993 to the University of Waterloo and a national project team was formed. The result was the 1997 "*Pavement Design and Management Guide*." It again proved to be a flagship publication for TAC and it has received extensive use including as a valuable education tool at the university and college levels.

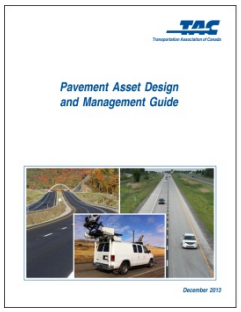


Tom Kazmierowski
(Chair) MTO

Ralph Haas
(Editor)

The Third Guide (1997)

A need for updating became apparent in 2000. Through the cooperative efforts of TAC's Standing Committees on Pavements and on Soils and Materials, a pooled fund project was initiated with the objective to ".....update the 1997 Guide.....supplemented with new information while highlighting Canadian practices and recommending best practices." A contract was awarded to the University of Waterloo, a Project Steering Committee under the leadership of Marta Juhasz of Alberta Transportation was formed and a national team to carry out the work was put together.

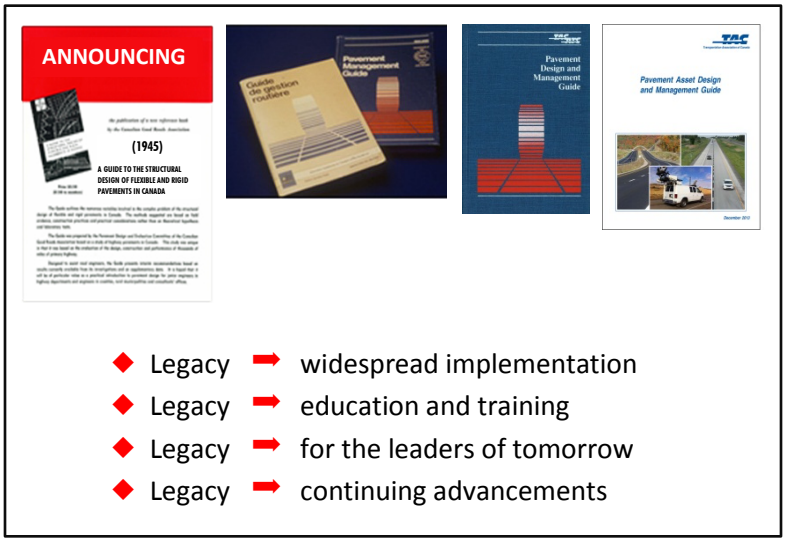


Marta Juhasz (Chair)
Alberta Transportation

Susan Tighe
(Editor)

The Fourth Guide (2013)

So what is the legacy from these Guides? Broadly, a legacy consists of something of value which has been created for today and tomorrow. It can include codes of practice, investments and assets, mentoring and/or training of new leaders, business models, guides, new knowledge and technologies, a basis for ongoing sustainability of assets and practices, and others. In essence, the legacy of the Guides can be summarized as ranging from widespread implementation to education and training to use by the leaders of tomorrow to a culture of continuing advancements.



Legacy of the Guides

9. IMPACT OF THE SCHOLARSHIP PROGRAM AND THE TAC FOUNDATION ON TRAINING AND EDUCATION

The CGRA Scholarship program was initiated in 1952 largely to encourage postgraduate studies in highway engineering. At that time there were no such studies offered by Canadian universities. The first two recipients of these scholarships, valued at $2,000 each, were Jacques Barrière in 1952 and Gordon Campbell in 1954.

By 1969, 86 scholarships had been awarded, with a total value of $179,000, and 20 universities in Canada were offering postgraduate studies in the area. As stated by the Hon. Dave Boldt, President of CGRA at that time, ".....an increasing number of young Canadian highway engineers receive their advanced education in Canada."

The program continued to support 5 or 6 postgraduate scholarships per year, funded primarily by industry, through the 1970s, 1980s and into the 1990s. While this was a significant contribution to the resource base of skilled transportation professionals, in a submission to the Strategic Planning Committee of TAC (July 26, 1999)[5] the following was stated:

> "TAC's Scholarship Program has been in existence for nearly 50 years. Over 200 individuals have been CGRA/RTAC/TAC Scholars. Most have gone on to distinguished transportation careers (a number of examples were provided)..... The Scholarship Program has been an unqualified success story in attracting future leaders to the transportation industry. It has been a highly cost-effective investment and represents TAC's longest standing initiative as well as a demonstrable legacy of excellence."

The submission went on to state that despite these successes the Program has operated on limited year to year funding, and because of widespread concern that our transportation industry would soon be facing shortages of skilled professionals, the concept of a "TAC Educational Foundation" was proposed. It was noted that the concept was actually initiated in 1998 by the Scholarship Committee and the Succession Planning Subcommittee.

The objectives and rationale for the Foundation, as well as Key Issues and Next Steps were detailed in the submission, with a conclusion as follows:

> "In essence, a TAC Educational Foundation has the potential to generate a quantum advance in the quality and competitiveness of Canadian transportation by making it an attractive career choice for talented young professionals".

The concept of a TAC Educational Foundation was subsequently discussed in TAC's Standing Committees on Pavements and on Soils and Materials, and then presented to TAC's Chief Engineers Council. All showed strong support, and an invitation was received from the TAC Board of Directors to make a

[5] R. Haas personal files contain documentation on this and the subsequent formation of the TAC Foundation.

presentation to their meeting on September 29, 1999 in Saint John, New Brunswick. This was in the form of a presentation by Ralph Haas, Lynne Cowe Falls and Susan Tighe, with the result being support in principle by the Board.

Accordingly, a draft business plan was prepared for the Board of Directors on January 2, 2001 by Ralph Haas, then Chair of the Scholarship Committee, and Lynne Cowe Falls, then Vice-Chair of the Scholarship Committee. Several versions ensued and a final business plan for a "TAC Education Foundation" was submitted to the Board on August 20, 2002.

The Foundation was subsequently granted charitable status in 2003, and an inaugural Board of Directors was appointed with Michel Gravel as Acting Chair at the first meeting on November 12, 2003. Brian Henderson was appointed as Executive Director. Mr. Gravel continued in his role until the Foundation Board at its January 24, 2004 meeting unanimously elected Neil Irwin as the first President.

Since the Scholarship Committee had reported to the TAC Board of Directors for many years, and subsequently to the Executive Director, the TAC Board passed a motion at its January 2004 meeting approving a transfer to the Foundation.

The year 2004 saw considerable progress in organization and promotional development of the Foundation and the launch of an appeal campaign for donors. The "message" behind the appeal can be summarized as follows:

- Provide scholarships, including expansion of the existing program
- Establish internships to attract students to transportation
- Support academic chairs in educational institutions and
- Support transportation research

While much of the focus has been on the first item, the overall success of the Foundation in only one decade of existence has been nothing short of astounding.

It is appropriate at this point to recognize the enormous contributions of the Foundation's Board and Executive Director, including the following successors to Neal Irwin (Managing Director of the IBI Group): Gary Mack, President, Infrastructure Systems Ltd., 2007 to 2009; Ian Williams, Chief Executive Officer, McCormick Rankin 2009 to 2011; Tim Holyoke, Manager, Exp Services Inc., 2012 to 2013; Carl Clayton, Senior VP Transportation, Stantec Group, 2013 - present. Equally appropriate is recognition of the many donors, public and private organizations and individuals, who have contributed to the program to the original $25,000 which funded 6 scholarships to the current annual funding of $200,000 and more than 45 graduate and undergraduate scholarships.

With this substantive increase in scholarships over the past decade, the Scholarship Committee, consisting entirely of volunteers the same as the Directors, has faced a major task of assessing more than 100 applications each year. While it is not possible to acknowledge all these people, leadership of the Committee has been an essential element, and the following Chairs deserve recognition and

appreciation: Lynne Cowe Falls, University of Calgary, 2003-2006, Susan Tighe, University of Waterloo, 2006-2009, Robyn MacGregor, EBA Consultants, Calgary, 2009-2011, Jeannette Montufar, University of Manitoba, 2011 to 2013 and Eric Hildebrand, University of New Brunswick, 2013 - present.

In summary, the TAC Scholarship Program and the TAC Foundation have had an enormous impact on the education and training of transportation professionals in Canada. Public authorities, private organizations such as consultancies, contractors and suppliers, associations and academia have many on their staffs from early-in-career engineers to mid-level managers to senior executives who were scholarship recipients. They and the Canadian transportation industry overall are the beneficiaries. As well, the Canadian public benefits from the resource of skilled professionals in designing, building and managing our transportation infrastructure.

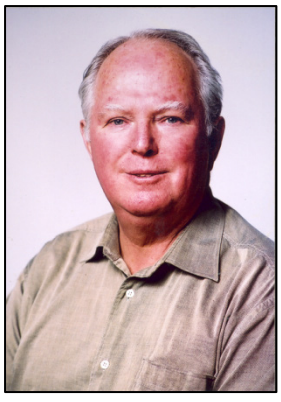
10. A TRIBUTE TO THE "TITANS" OF TRANSPORTATION EDUCATION AND RESEARCH

The 100 years of TAC's history have seen many prominent and dedicated educators playing major roles in not only CGRA/RTAC/TAC itself but also in creating a resource of skilled professionals and contributing through their research key advances in the technology. Their legacy is reflected to a large degree in the fact that transportation education and research in Canada today stands second to none.

Recognition of all the individuals and their contributions is not possible, and even the naming of example "*Titans*" in the following will very likely leave out others who are equally deserving. Nevertheless, it is important for this Monograph to at least pay tribute to a few, mainly from the latter 50 years simply because information from the first 50 years is limited. The following tributes focus on individuals who have made their contributions and are retired or deceased.

There are currently active educators and researchers, however, who are already accomplished and widely recognized, and/or who are early in their careers and have the potential to become the titans of tomorrow. Many of these are members of the TCATT Group, and a list is subsequently provided in Section 11.5. An additional list of academic staff not listed with TCATT is also subsequently provided in Section 11.5.

The following is a west to east sweep across Canada, rather than a chronological or alphabetical order, of titans of our industry. As well, it gives their primary focus as planning, design, safety, traffic, materials, economics, construction, pavements and/or geotechnique.

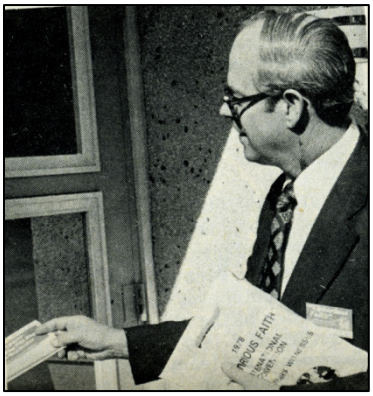


Dr. Francis P.D. Navin

Professor Francis Navin was and has been for many years a key player in highway safety, geometric design and transportation planning at UBC. He was also an active member of TAC, the Transportation Research Board (TRB) and various international organizations. He is currently an Emeritus Professor of Civil Engineering at the University of British Columbia.

Dr. R.M. Hardy

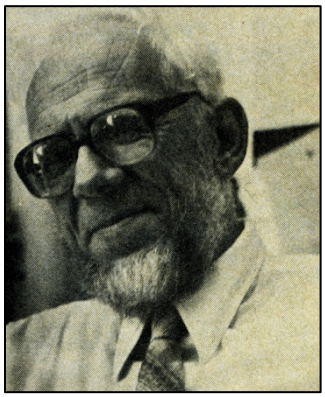
Dr. R. M. Hardy, who served as Dean of Engineering at the University of Alberta in the 1940s and 1950s, was a well-known educator and practitioner in the field of soil mechanics. He was a driving force behind establishment of CGRA's Scholarship Program in the early 1950s.



Dr. Kenneth O. Anderson

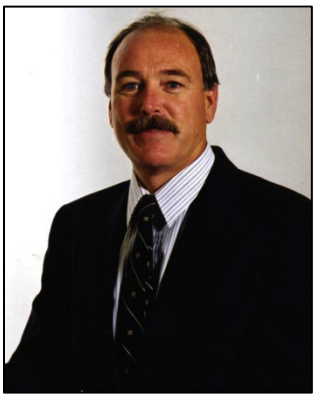
Professor K.O. (Ken) Anderson, who started as a faculty member in Civil Engineering at the University of Alberta in 1957 became well known for his contributions to highway materials and pavement design. He was a prominent member of various CGRA/RTAC/TAC Committees for many years.

Similarly, Professors John Bakker and Stan Teply in traffic, planning and construction were prominent members of the University of Alberta's transportation faculty from the 1960s.



Dr. John Bakker

Dr. Stan Teply



Dr. John Morrall

Dr. John Morrall, who had a long and distinguished career over four decades as a member of the Transportation Group at the University of Calgary, is well known in Canada, the U.S. and abroad for his many contributions to highway design, planning and safety. Dr. Morrall remains active on major highway and bridge projects in Canada and abroad.

The University of Saskatchewan's Dr. Art Bergan, pavements and traffic, who founded International Road Dynamics and Dr. Gordon Sparks, economics, transport infrastructure, who founded Vemax Ltd., have made over four decades of contributions to transportation education and research.

Dr. Art Bergan

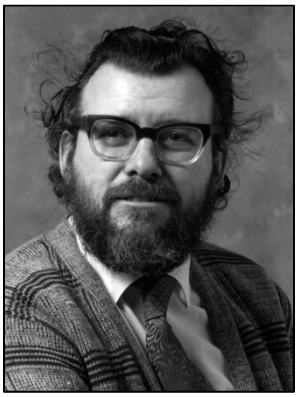
Dr. Gordon Sparks

Professor Al Clayton of the University of Manitoba, a major player in the areas of traffic and freight transportation over the last four decades, had contemporaries Professors Al Solomon in transportation planning and Allen Lansdown in transportation structures for a major part of that time.

Dr. Al Clayton

Photo not available

Dr. Al Solomon

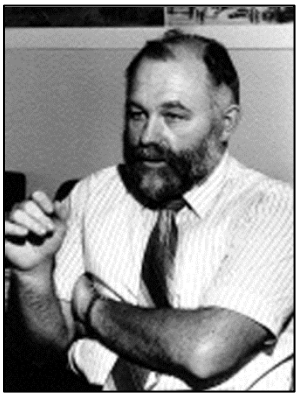


Dr. Allen Lansdown

Dr. Norman McLeod

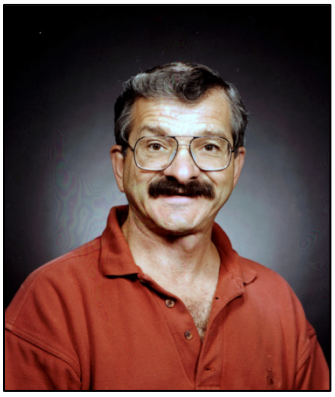
Dr. Norman McLeod, an engineer and scientist in the field of asphalt technology and pavement design from the 1940s to 2000, had a lifelong commitment to education and research. This included 18 years as an Adjunct Professor at the University of Waterloo. Dr. McLeod's contributions were recognized by being awarded the Order of Canada and named a Fellow of the Royal Society of Canada.

The University of Waterloo's Transport Group, formed in the 1960s, was active for the ensuing decades with leadership from Professor Bruce Hutchinson (economics, planning), John Shortreed (planning, economics), Sam Yagar (traffic), Ralph Haas (pavements, infrastructure), Wally McLaughlin (traffic, construction), Hendrick Edens (planning, traffic) and Richard Cockfield (design, construction).



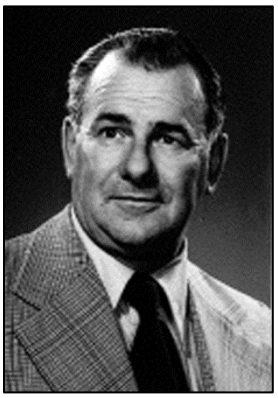
Dr. Bruce Hutchinson

Dr. John Shortreed



Dr. Sam Yagar

Dr. Ralph Haas



Dr. Wally McLaughlin

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not
available

Dr. Hendrick Edens

Dr. Richard Cockfield

The University of Toronto's transportation group of professors was similarly active from the 1960s and during the ensuing decades. Leadership came from Professors Richard Soberman (planning, economics), Ezra Hauer (traffic, safety) and G. Steuart (traffic, design).

Dr. Richard Soberman

Dr. Ezra Hauer

Dr. G. Steuart

Dr. H. M. (Bert) Edwards

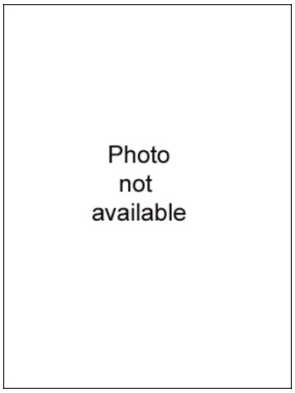
Queen's University's Professor Bert Edwards, from the 1950s and through the next four decades was a "*Titan*" in Canadian transportation, particularly in the traffic and highway design area. As a major player in many CGRA/RTAC/TAC activities he is only one of three academics, the others being Albert Stevens of UNB and Ralph Haas of Waterloo, elected as Honorary Life Members of the organization.

Dr. Gordon Campbell

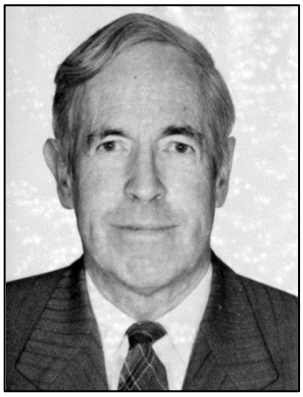
Dr. Gordon Campbell, Technical Director of CGRA, was committed to transportation education and the advancement of technologies. He was not only a driving force behind the 1964 Highway Engineering Education Conference at the Golden Jubilee of CGRA (see Section 5), but also directly involved in various projects such as the pioneering "*Guide to Pavement Design"* [CGRA 1965].

École Polytechnique de Montréal included Professors Josef Hode Keyser, materials and geotechnique, and Professor Jean Granger, traffic and design, as prominent players in transportation education over several decades starting in the 1960s.

Dr. Josef Hode Keyser



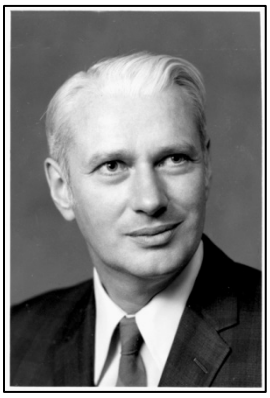
Dr. Jean Granger



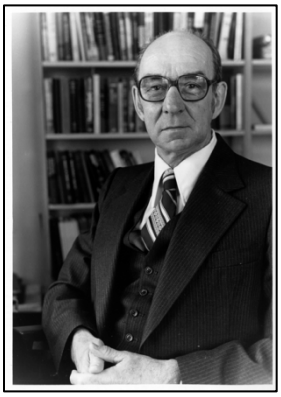
Dr. G. G. Meyerhof

Professor G. G. Meyerhof, Dean of the Nova Scotia Technical College, later to become the Technical University of Nova Scotia was a prominent individual at the 1964 Highway Engineering Education Conference. He was also one of Canada's most eminent geotechnical engineers at that time, and for several ensuing decades.

The University of New Brunswick (see Section 2.2), originally with railway engineering in its curriculum, instituted Highway Engineering in 1950. Key players in that initiative, and in subsequent decades, were Professors Albert Stevens and Howard McFarlane. They were joined in the 1960s by Professor Frank Wilson, who later also became Dean, and by Professor Michael Ircha who specialized in coastal transport.

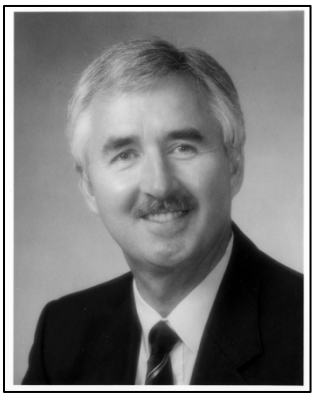


Dr. Albert Stevens



Dr. Howard McFarlane

Dr. Frank Wilson



Dr. Michael Ircha

11. PROSPECTS FOR THE FUTURE

Future prospects come with the expectation that there will be advances in transportation education and training and that these will build on the legacy. By definition this involves considerable speculation, hopefully with a solid rationale, on potential changes in the transportation modes and the associated influence on education and training. The continuing role of the EHRDC, the delivery methods such as massive online courses, webinars and the like, and the need for innovations on future advancements are addressed.

The following sections first consider building on the legacy, the time horizons involved, the dependency of future prospects on areas of education and training with varying effectiveness and the role of innovations in future prospects for advancement. A key and continuing role of the EHRDC in realizing the future skills requirements for transportation engineers, as well as their overall role in encouraging/promoting/facilitating transportation education and training is then addressed. The TCATT initiative is summarized with emphasis on the potential for future graduate, undergraduate and professional transportation education. Finally, some speculations are provided on the relative future influence of the modes on transportation education and training and on the "model" core undergraduate transportation course in civil engineering programs, and the possible delivery methods varying from traditional classroom settings to webinars, Facebook, "MOOCS" (Massive Open Online Courses) and others.

11.1 Building on the Legacy and Over What Time Horizons

Building on the legacy of educational achievements and advances in technologies, environmental stewardship, social and financial responsibility and good management is critical to continuing advances. Innovation is a key part of these advances being substantial. However, the question is one of identifying the ones that stand out as being unique, creative and truly innovative.

Another question involves the likely changes and influence of the various transportation modes and their impact on education. For example, rail travel had a profound influence on transportation education in the Eras leading up to the Boom Years of Road Building. Currently, air travel, highway travel and urban transit have major influence and this is reflected in various basic undergraduate plus optional and graduate courses at Canadian universities.

Before addressing these questions, an underlying consideration is that of identifying what comprises the future in terms of time horizons. It has been suggested [EHRDC 2009] that these can be broken down as follows:

- Short term, 10 to 30 years (eg., secondary and tertiary roads, regional air routes, local transit operations)

- Medium term, 30 to 70 years (eg., primary highways, high speed rail, major international air corridors)
- Long term, 70 to 100+ years (eg., bridges, subways, urban light rail)

Regarding transportation, it was also suggested that over the short to long term there would continue to be a general need for transporting people and goods, although to what extent, what type of goods, what modes and other factors might undergo considerable variation.

11.2 Dependency of Future Prospects on Areas of Varying Effectiveness

The effectiveness of education and training in transportation is vital to realizing future prospects. It was suggested in [EHRDC 2009] that this comprises areas of lasting effectiveness over the foreseeable future, areas that need strengthening and areas that represent a major challenge. Assuming that the fundamentals of science, mathematics, humanities and social sciences and economics have been adequately addressed, Table 6 provides examples in the three areas.

Table 6 – Areas of Education and Training with Varying Effectiveness

Adapted from [EHRDC 2009]

Areas with Lasting Effectiveness	Areas Which Need Strengthening	Areas Representing a Major Challenge
• Planning and design of experiments (experimental and analytical) • Probability and statistics • Risk and reliability • Performance analysis and modeling • Integration of management, design, operations and other processes	• Accounting and business practices • Communication (verbal and written) • Legal considerations and issues • Knowledge management • Integrative thinking	• Creativity and innovation • Judgment and integrity • Interpersonal skills • Handling information overload • Dealing with “flavour of the month” technologies • Research is more than searching the web

11.3 Innovation is Essential to Progress and Future Prospects for Advancement

Transportation education, training, research, management, technology development and a myriad of associated activities need to be forward looking. This implies innovation as an essential ingredient, which was succinctly captured in a TAC Workshop, Quebec City, September, 2004:

> *"…..have to build, renew, maintain and manage a transport infrastructure which can support economic development…..preserve our quality of life…..requires search for new and better technologies and processes…..can be realized in part by creative individuals and innovation."*

The foregoing excerpt specifically identifies creative individuals, notwithstanding that organizations, resources, a "climate" of encouragement and various driving forces are also major ingredients. In fact, the driving forces behind innovations in transportation in general, come from such sources as individuals themselves, economic/cost-efficiency concerns, environmental issues, science and engineering problems, resource issues, knowledge needs, security issues, social/political concerns and public-private-partnership (P3) initiatives. Figure 1 is a schematic portrayal of these driving forces [Haas 2010].

Figure 1 – Driving Forces Behind Innovations in Transportation Engineering

After [Haas 2010]

Given that transportation has to be forward looking, that there are key driving forces behind the innovations needed and that creative individuals are an essential element, the obvious question is what are the motivating factors? Figure 2 lists some of these factors as well as possible road blocks as identified on the right side of the diagram.

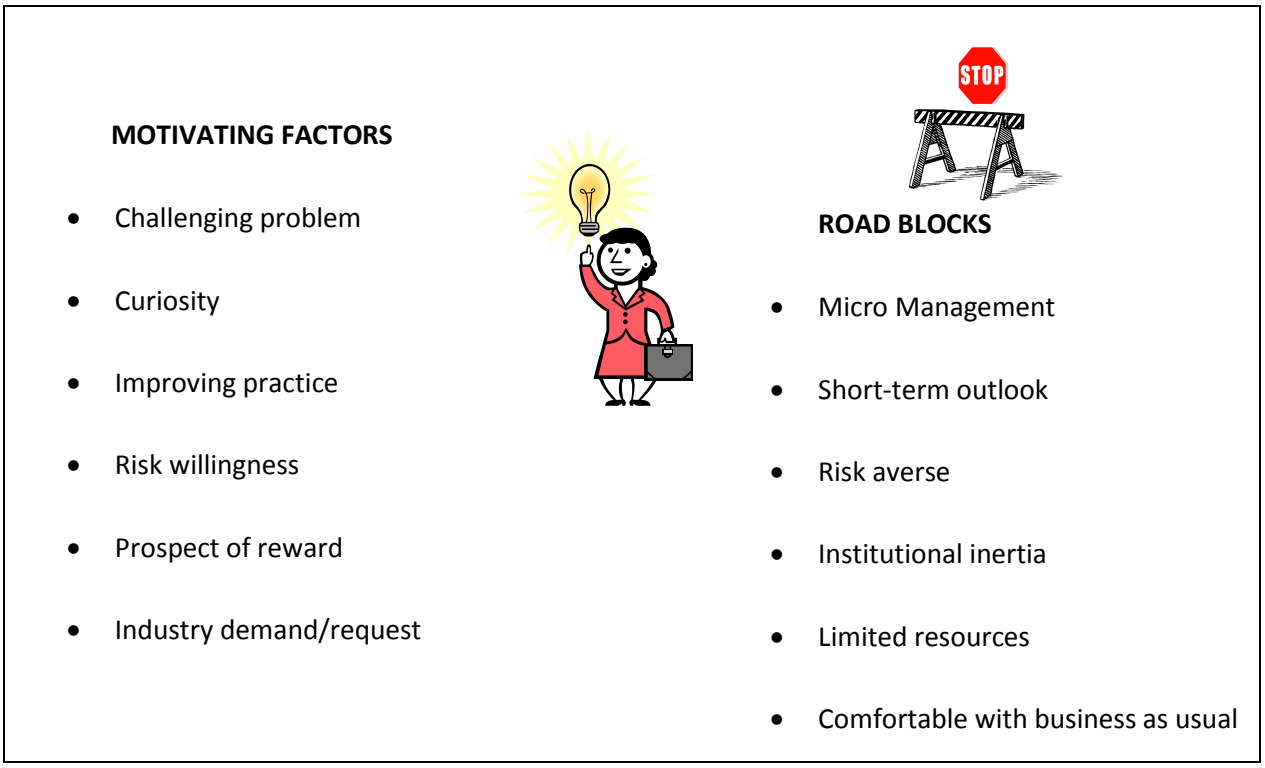


Figure 2 – Motivation for Innovation and Road Blocks

After [Haas 2010]

11.4 The Key and Continuing Role of the EHRDC

The Education and Human Resources Development Council (EHRDC) was originally formed as the Education Council in 2002 as part of a TAC reorganization described in the Board's Business Plan of April 2, 2001.

The Business Plan established four major thrust areas: Chief Engineers Council, Urban Transportation Council, Sponsored Projects and an Education Council to "guide the development of TAC's education and outreach products and services."

The EC, originally, and then the EHRDC have had a major impact on education and training, as summarized in the following background and examples of major achievements.

As a first step in forming the new Council, a Task Force on Education was established in May, 2001 comprised of TAC Board Members Tom Beckett of Newfoundland and Labrador, Lynne Cowe Falls of Stantec, Ralph Haas of the University of Waterloo and Michel Gravel, Executive Director of TAC. An Action Plan was developed in July 2001, and Merv Clark with EBA Consultants was invited to join the

Task Force. The Education Council's inaugural meeting was held on September 18, 2001 at the Annual Conference in Halifax to plan its structure and activities. Merv Clark was asked to become the first Chair of the Council.

A comprehensive draft Business Plan for the Education Council was then developed in late 2001 and the Council met at the TAC spring meetings in Ottawa on May 9, 2002. The Business Plan was a main agenda item, and additional members joining the Council were Joe Lam of ITS Canada, Heather Crewe of the Ontario Good Roads Association, who became Vice-Chair, and Guy Doré of Université Laval. By July, 2002, Luc Couture of AQTR, Tim Hawnt of Alberta Transportation, Peter Vician of the Government of the Northwest Territories and James Thomson of the City of Winnipeg had also become members.

Among the first group of Council involvement were courses on road salt management, urban geometric design, road safety audit, and rural geometric design. An Education and Training Workshop Report sponsored by the Council in April, 2002 became available in late 2002.

The Education Council's first report to TAC's Board of Directors in September, 2002 highlighted its mandate in facilitating educational and training needs, developing outreach programs for transportation professionals, addressing educational and training issues in the federal, provincial, large to small municipalities and private sectors, coordination with the TAC Foundation, addressing the issue of continuing education credits, and establishing a National Education and Training Coalition.

A meeting of the Coalition on February 23, 2003 discussed the need to raise public awareness of transportation, identified the coalition partners from across Canada, established a set of guiding principles for the coalition and an action plan. The Education Council also provided sponsoring Council assistance to TAC's education program manager in 2003 and 2004 regarding courses previously noted and new ones coming on stream.

A new Chair of the Education Council, Heather Crewe of OGRA, was named in 2004. One of her first responsibilities was to Chair a very successful workshop in September, 2004 at the TAC Conference in Quebec on "Innovation: A Risky Business?" A keynote presentation came from Dr. Carolyn Hansson, Vice President, Research at the University of Waterloo on "Innovations Gone Awry." Other presentations were by Ralph Haas on the "Human Aspect of Innovations" and by Ralph Haas, Susan Tighe and Lynne Cowe Falls on "Leading Edge Innovations in Road and Transportation Technology." The record of the workshop stands as one of the early significant achievements by the Education Council.

Another contribution on behalf of the Education Council was an article in TAC News (Volume 30, Fall 2004) by Ralph Haas on "Proper Succession Planning: A Must for Canadian Transportation." As well, an initiative on Student Paper Competitions, to start in 2005, was spearheaded by Lynne Cowe Falls.

The Education Council's major activities for 2005 included an updating of the Business Plan and Council structure and organizing Workshop Sessions on (a) Successfully "Selling" the Transportation Sector to Youth, (b) Linking People to Opportunity, (c) Equipping Transportation Sector Employees, and (d) Preparation for the Workplace – Training and Education of Potential/New Workers. As well, a very

successful Student Poster Session was inaugurated at the 2005 Annual Conference in Calgary. The Education Council also initiated a project on "Sustainable Knowledge Management for Transportation Agencies."

The Education Council's major thrusts in 2006 included a Skills Sets Requirements Task Force and a Student Outreach Task Force, plus continuation of the Student Poster Session and Student Paper Awards Programs. A new chair, Tim Hawnt, was named to succeed Heather Crewe and Catherine Berthod of the ministère des Transports du Québec was named as Vice-Chair. Because Council membership only comprised 11 seats compared to other Councils such as Chief Engineers, a movement was initiated to expand council membership and explore additional initiatives.

A highlight of the TAC Annual Conference in Saskatoon in October, 2007 was a Workshop on "Critical Issues Facing Transportation Professionals," jointly sponsored by the Education Council and Chief Engineers Council. As well, work began in 2007 on Terms of Reference for a TAC Educational Achievement Award, which was inaugurated in 2008 and has demonstrated in subsequent years this became a very successful initiative. Another Education Council product in summer, 2007 was preparation of "Guidelines for Designing and Delivering Courses."

New Terms of Reference for the Education Council were drafted in early 2008 including a focus on recruitment and retention of professional and technical staff, skills shortages in the transportation sector, skills development and training, encouraging students to pursue careers in transportation, and to promote an awareness of transportation to Canada's economy and society. It was also proposed that the Council's membership be expanded from 11 to 30 and that there should be a name change. This did occur with it becoming the Education and Human Resources Development Council (EHRDC), as approved by TAC's Board of Directors.

Carl Clayton of Stantec was named as Chair of the EHRDC and Élaine Lapointe of the New Brunswick Department of Transportation was named as Vice Chair. Among the first initiatives of the EHRDC was to form a Student Outreach Standing Committee, a Knowledge Management Task Force and a Labour and Skills Shortages Working Group. A very successful workshop on Retention and Recruitment Practices at the 2009 Annual Conference in Vancouver was carried out and Terms of Reference for a Primer on Knowledge Management were developed. The Educational Achievement Award went to Manitoba Infrastructure and Transportation for its program "Build Manitoba with Us – Building the Infrastructure to a Sustainable Workforce."

Élaine Lapointe succeeded Carl Clayton as Chair of the EHRDC in 2010 and Kerry Buckley of Transport Canada was named Vice-Chair. A consultant was selected to prepare the Knowledge Management Primer and the resulting product was in the form of a Framework and an interactive web-based tool. The September 2010 Annual Conference in Halifax included an EHRDC sponsored Workshop, on what new graduates are seeking from employers. Cindy Lucas, responsible for organizing the Workshop, reported that it had been a success with an attendance of about 50 people.

The EHRDC Spring Meeting in Ottawa, April 16, 2011 focussed on continuing work by the Skills Development and Awareness Committee, the Student Outreach Committee, the Educational Achievement Award Review Panel, and the Knowledge Management Committee. The latter Committee hosted a Panel Session and Workshop at the September 2011 Annual Conference of TAC in Edmonton, with about 30-35 people in attendance.

A "Chronology/Highlights of the Formation and Achievements of the Education and Human Resources Development Council", dated September 1, 2011, was prepared by Lynne Cowe Falls and Ralph Haas for the September 10 annual meeting of the Council.

Kerry Buckley became the new Chair of EHRDC after the September, 2011 meeting and Cindy Lucas of the Ministry of Transportation Ontario became Vice-Chair. A key outcome of the meeting was agreement for a targeted focus in 2012 by the Knowledge Management Committee on Succession Planning, by the Skills Development and Awareness Committee on Career Development and by the Student Outreach Committee on Retention.

A key activity for the Council in 2012 was planning for the Lion's Den Workshop at the Annual Conference in Fredericton in September, with leadership by Cindy Lucas. This turned out to be a highly successful event with standing room only attendance.

The Educational Achievement Award winning nomination in 2012 was the Team Canada Alliance for Transportation Teaching (TCATT) for their national graduate course on transportation engineering, first offered in January 2012.

The Award was accepted by Professor Jeannette Montufar of the University of Manitoba. The EHRDC also committed in 2012 to participate in TAC's Centennial Celebrations in Montreal in September, 2014. Ralph Haas and Lynne Cowe Falls, members of the Centennial Oversight Committee, report periodically on progress and activities.

The EHRDC carried out a survey in 2012 on Human Resource Issues faced by public and private sector organizations. The results proved to be limited.

An initial proposal to the EHRDC on Initiatives contributing to the TAC Centennial Celebration of 2014 was prepared in September, 2012. Of the two major initiatives, the one on "The Evolution and Legacy of Transportation Education in Canada" became a pooled fund project in 2013 and is the subject of this Monograph.

The EHRDC Workshop on Skill Sets Required by the Transportation Engineer of 2020 provides a focus for a continuing role [EHRDC 2009]. It had a basic premise that the transportation field is undergoing continuous changes in technology, financing, communications, environmental requirements, climate change adaptations, administrative and governance structures, information, globalization, market characteristics, human resources, management tools and the need for sustainability in all its forms. Having transportation engineers with the appropriate skill sets is fundamental to meeting the challenge of change, as suggested in Tables 7 to 9.

While the focus is on the transportation engineer of 2020, whether from the public, private or academic sector, there is an implicit long term or time invariant aspect to the skills requirements. In other words, they apply to the transportation engineer of today, in 2020 and beyond.

Table 7 – Skills Requirements for the 2020 Entry Level Transportation Engineer

After [EHRDC 2009]

Skill Sets	Critical	Necessary	Useful
Technical			
• Graduation from an accredited engineering program and/or professional registration	*****	*****	
• Continued education (voluntary and mandated where applicable)		*****	
• Risk assessment			*****
Non-technical			
• Business			*****
• Economics			*****
• Communication (written and verbal)		*****	
• Management (project, system, etc.)			*****
Adaptation			
• Climate change		*****	*****
• New technologies		*****	*****
• Globalization			*****
• Social/political change			*****
Sustainability			
• Infrastructure		*****	*****
• Resources			*****
• Energy			*****
• Innovation		*****	*****
People			
• Expectations			*****
• Interactions/interpersonal		*****	
• Teamwork		*****	
• Ethics and integrity	*****		
Services Provision[6]			
• Water and/or other services	*****	*****	
• Waste and/or other services	*****	*****	
• Transportation and/or other services	*****	*****	
• Habitat	*****	*****	

[6] Notes: This is sector and specialization dependent

Table 8 – Skills Requirements for the 2020 Mid Career Level Transportation Engineer

After [EHRDC 2009]

Skill Sets	Critical	Necessary	Useful
Technical			
• Graduation from an accredited engineering program and/or professional registration	*****	*****	
• Continued education (voluntary and mandated where applicable)		*****	
• Risk assessment		*****	
Non-technical		*****	
• Business		*****	
• Economics		*****	
• Communication (written and verbal)	*****	*****	
• Management (project, system, etc.)		*****	
Adaptation			
• Climate change		*****	
• New technologies		*****	
• Globalization		*****	
• Social/political change		*****	*****
Sustainability			
• Infrastructure		*****	
• Resources		*****	
• Energy		*****	*****
• Innovation		*****	
People			
• Expectations		*****	
• Interactions/interpersonal		*****	
• Teamwork	*****	*****	
• Ethics and integrity	*****		
Services Provision[7]			
• Water and/or other services	*****	*****	
• Waste and/or other services	*****	*****	
• Transportation and/or other services	*****	*****	
• Habitat	*****	*****	

[7] Notes: This is sector and specialization dependent

Table 9 – Skills Requirements for the 2020 Senior Level Transportation Engineer

After [EHRDC 2009]

Skill Sets	Critical	Necessary	Useful
Technical			
• Graduation from an accredited engineering program and/or professional registration	*****	*****	
• Continued education (voluntary and mandated where applicable)	*****	*****	
• Risk assessment	*****	*****	
Non-technical			
• Business	*****	*****	
• Economics	*****	*****	
• Communication (written and verbal)	*****		
• Management (project, system, etc.)	*****		
Adaptation			
• Climate change		*****	
• New technologies		*****	
• Globalization	*****	*****	
• Social/political change	*****	*****	
Sustainability			
• Infrastructure		*****	
• Resources	*****	*****	
• Energy		*****	
• Innovation		*****	
People			
• Expectations	*****	*****	
• Interactions/interpersonal		*****	
• Teamwork	*****	*****	
• Ethics and integrity	*****		
Services Provision[8]			
• Water and/or other services		*****	*****
• Waste and/or other services		*****	*****
• Transportation and/or other services		*****	*****
• Habitat		*****	*****

[8] Notes: This is sector and specialization dependent

11.5 The TCATT Initiative

The origin of the Team Canada Alliance for Transportation Teaching goes back to a number of discussions starting in 2009 among university faculty who teach transportation engineering. A list of colleagues interested in putting together an Alliance was compiled by Jeannette Montufar of the University of Manitoba and an informal meeting was held at TRB in January, 2011[9]. Several ideas were generated on how the Alliance could function on topics of mutual interest, ranging from research funding to collaborative initiatives.

The latter resulted in a plan to offer a Webinar based national graduate course on "Special Topics in Transportation Engineering," A unique aspect was the mobilization of a pool of expertise from across Canada, which would not be available in any single university.

Dr. Jeannette Montufar

The organization, preparation and presentations of the first course in the winter of 2012 was carried out by 14 professors and involved 4 modules with 12 lectures over a period of 4 months, with Jeannette Montufar as "Team Captain." Support by the Canadian Institute of Transportation Engineers was invaluable.

Table 10 provides a list of the modules, lecture topics and the professor responsible. Each lecture was 2 hours in length, with additional hours of work or assignments the responsibility of each student's advisor. The uptake was over sixty graduate students from twelve universities.

[9] The list comprises over 40 professors from across Canada, a cohort which illustrates the strength and extent of today's transportation education and research.

Table 10 – Lecture Topics for the Winter 2012 First Graduate Course on Special Topics in Transportation Engineering

LECTURE TOPICS
This course is divided into 4 modules. Each lecture is 2 hours in length, for a total of 28 hours of class. Additional hours of work may be assigned by the student's advisor, in form of a project or special reports on each lecture.

MODULE 1 – TRANSPORTATION PLANNING
1. Integrated transportation land-use modeling – Dr. Z. Patterson
2. Active traffic and demand management – Dr. T. Qiu
3. Discrete choice models for travel behavior analysis – Dr. N. Eluru
4. Modelling travelers' choices for informed decision making and planning – Dr. K. Habib
5. Airport planning and operations – Dr. A. de Barros

MODULE 2 – ROAD SAFETY ENGINEERING
1. Road safety analysis: data collection, methods and countermeasure design – Dr. L. Miranda
2. Identification and improvement of hazardous road locations – Dr. E. Hildebrand
3. Surrogate measures of road safety – Dr. N. Saunier

MODULE 3 – COMMERCIAL VEHICLE OPERATIONS
1. ITS applications in public transportation – Dr. B. Hellinga
2. Truck microsimulation modelling and applications in truck only highway lanes – Dr. M. Roorda
3. Accommodating trucks in road design and operations – Dr. J. Montufar

MODULE 4 – MISCELLANEOUS TOPICS
1. Transportation and air quality – Dr. M. Hatzopoulou
2. Mechanistic road modeling and materials testing for road design and performance prediction – Dr. C. Berthelot
3. Traffic monitoring and estimation – Dr. J. Regehr

This pioneering and highly successful initiative was repeated in the winter 2013 term. It illustrates the potential of similar initiatives in transportation education even at the undergraduate level. Certainly the use of webinars in specialty topics, by public and private agencies, is widespread as information and training tools.

The "*Titans*" identified in Section 10 will be succeeded by a new and/or emerging cohort in the next decades. Many are already identified in the TCATT "membership," which is actually an informal group of professors with no fixed organizational structure. Nevertheless this group is representative of the existing talent across Canadian universities. Table 11 provides a current list of the group. Table 12 provides a list of additional transportation faculty which are not in the Table 11 list. The Writers have taken the liberty of compiling this additional list and take full responsibility for any errors or omissions.

It should also be noted that there are faculty in schools and departments other than civil engineering who focus on transportation (eg., geography, economics, law, mechanical and electrical engineering, environmental studies, etc.). It was not possible within the scope and resources for this Monograph to compile a list of these still additional faculty.

Table 11 – List of TCATT Professors as of 2013

Name	University
Abd El Halim Omar Abd El Halim	Carleton University
Ahmed El Geneidy	McGill University
Ahmed Shalaby	University of Manitoba
Alan Clayton	University of Manitoba
Alex de Barros	University of Calgary
Amy Kim	University of Alberta
Ata Khan	Carleton University
Bhagwant Persaud	Ryerson University
Bruce Hellinga	University of Waterloo
Catherine Morency	École Polytechnique de Montréal
Chris Lee	University of Windsor
Ciprian Alecsandru	Concordia University
Curtis Berthelot	University of Saskatchewan
Eric Hildebrand	University of New Brunswick
Eric Miller	University of Toronto
Frank Saccomanno	University of Waterloo
Gord Lovegrove	University of British Columbia, Okanagan
Guy Doré	Laval University
Hanna Maoh	University of Windsor
Jeannette Montufar	University of Manitoba
Jeff Casello	University of Waterloo
Jinhua Zhao	University of British Columbia
Jonathan Regehr	University of Manitoba
Joseph Chow	Ryerson University
Juan Pernia	Lakehead University
Karim El-Basouny	University of Alberta
Karim Ismail	Carleton University
Khandker Nurul Habib	University of Toronto
Lina Katan	University of Calgary
Liping Fu	University of Waterloo
Luis Amador	Concordia University
Luis Miranda Moreno	McGill University

Lynne Cowe Falls	University of Calgary
Marianne Hatzopoulou	McGill University
Martin Trépanier	École Polytechnique de Montréal
Matthew Roorda	University of Toronto
Ming Zhong	University of New Brunswick
Murtaza Haider	McGill University
Naveen Eluru	McGill University
Nicolas Saunier	École Polytechnique de Montréal
Peter Park	University of Saskatchewan
Ralph Haas	University of Waterloo
Said Easa	Ryerson University
Susan Tighe	University of Waterloo
Tarek Sayed	University of British Columbia
Tony Qiu	University of Alberta
William Anderson	University of Windsor
Xiaolei Guo	University of Windsor
Yasser Hassan	Carleton University
Zachary Patterson	Concordia University

Table 12 – Additional List of Civil Engineering Based Faculty Members in Transportation

Name	**University**
Fiona Crofton	University of British Columbia
Chan Wirasinghe, Doug Hunt, Ludo Zanzotto	University of Calgary
Alireza Bayat	University of Alberta
Dieter Stolle	McMaster University
Baher Abdulhai, Amer Shalaby	University of Toronto
Donaldson MacLeod (Adjunct)	University of Ottawa
J. A. Stewart	Royal Military College
Saeed Mirza	McGill University
Robert Chapleau	École Polytechnique de Montréal
Alan Carter	École de technologie supériere
Nouman Ali, Chris Barnes (Adjunct)	Dalhousie University

11.6 Future Influence of the Modes on Transportation Education and Training

The Monograph has illustrated that in the early part of the last century to at least the Great Depression to End of World War II Era (1929 to 1945) the rail mode was dominant and this was reflected in that rail also dominated transportation education and training. However, in the subsequent eras, to the present, highways have dominated and again this is reflected in that mode being dominant in the core undergraduate courses at Canadian universities and colleges.

Considering all the major modes, however, some speculation can be made on their influence in the core undergraduate course[10], as follows:

- Highways: While the need to transport people and goods exists, it is likely that highway engineering will continue to play a major role.
- Urban Transit: This mode will continue to grow in importance (eg., light rail, subways, express bus lanes, etc.) but will likely be covered mostly in optional undergraduate or graduate courses.
- Rail: Intercity rail, including traffic, safety, technologies, etc. will continue in importance as a primary mode but will also be covered mostly in optional courses, although some core undergraduate courses have a key section or module on this mode.
- Trucks and Freight: While not a specific mode, per se, and possible to incorporate in highways, the continuing and growing importance of freight transportation (traffic, technologies, economics, safety, etc.) may well see more optional courses in the area.
- Air: National and worldwide growth in air travel and freight (eg., perishable goods, manufactured items, couriers, etc.) will also likely see more optional courses in the area, although again some core undergraduate courses have a key section or module.
- Coastal and Inland Waterways: This is a vital and important mode to Canada but education and training tends to be specialized with little coverage in core undergraduate courses.
- Pipelines: These are similarly vital and important to Canada but again education and training see little coverage in mainstream core undergraduate courses but centres or clusters of courses exist (eg., University of Calgary).
- Bicycle Paths and Pedestrian Walkways: Likelihood that these will be covered mostly in design and training guides, notwithstanding their importance in both urban and rural areas.

In summary, while highways, rail and air will likely continue to have a major focus at the undergraduate program level, there is considerable scope to more and enhanced education and training in the other modes, particularly urban transit.

[10] Civil engineering programs at Canadian Universities normally have one, and in some cases two, core undergraduate course in transportation, usually in the third year.

11.7 Potential Future Impact of Autonomous Vehicle Transportation

A new wave of technological advances in automotive and communications technology involves what can be termed the "Connected Vehicle." This autonomous vehicle concept has the potential to reduce congestion, improve the efficiency of our road networks, improve safety and allow vehicle users/occupants to be disengaged from the driving process [Godsmark and Kenney 2013].

It is suggested that these technologies will eventually change how we use road space, the size and weight or configuration of vehicles, how roads and intersections are designed and how public transport functions. This will require the need to address how policies, regulations and standards, environmental/climate conditions and indeed various social and economic considerations can accommodate what has been called an "impending revolution on our roads" [Godsmark and Kenney 2013].

A relevant question concerns the impact on transportation education and any attendant need for incorporating autonomous vehicle technology and use. At this point it is quite an open question but educators should be cognizant of any such need. Certainly this is an area that might be addressed in the future by TCATT members.

11.8 Toward A "Model" Future Core Undergraduate Course in Transportation

It is not likely that there will be any substantive change in the core undergraduate course(s) in civil engineering programs at Canadian universities over at least the next decade. A basic reason is that they have been part of the periodic assessment by the Canadian Engineering Accreditation Board (CEAB).

Another reason is that all programs face continuing pressure of not overloading existing courses, but also incorporating new knowledge and methods. For example, Table 3 contains fourteen specific topics, notwithstanding that these vary in depth and coverage depending on the institution. If all were included in any core transportation course it would be overloaded, and/or the coverage would have to be superficial.

Nevertheless, the following modifications and/or initiatives are worth considering for a future "model" course:

- Evaluating the 14 topics in Table 3 as to their relevance and priority
- Working toward a better balance among modes
- Incorporating changing perspectives on environmental stewardship in planning, design and operations
- More emphasis on traffic/demand/flow/capacity interactions with modal infrastructure
- Exploration of a web based core course similar to the TCATT graduate course, if CEAB requirements can be satisfied

- An EHRDC sponsored project to develop a "model" outline for a core course in transportation engineering, based on but not exclusively the Table 3 topics, with elaboration on sub-topics
- Guidelines on how a core course in transportation engineering can provide the basis for advanced education
- Development of an Addendum or Special Section for use by any core transportation course instructor on the key technical, economic, social, political and environmental issues facing the various modes

11.9 Future Delivery Methods for Transportation Education and Training

The objective of education and training in any area is for the recipients/students/audience to learn and develop skills. While this section of the Monograph is focussed on the "delivery" side, the total objective needs to always be kept in mind.

Traditionally, and for many years the classroom, the lab and the field have been the primary venues for delivery. However, at the time of writing this Monograph there is an almost overwhelming array of electronic media and what might broadly be termed E-learning alternatives to consider. So the following questions are relevant:

1. Is the blackboard and chalk only an artifact of history; similarly the overhead projector and transparencies and/or the whiteboard and coloured pens and/or the computer with PowerPoint slides?
2. Is the traditional classroom setting still relevant?
3. Of the many types of media available which are most suited to the academic, corporate and professional worlds; what are their key features as well as advantages and disadvantages?

Addressing these questions in any depth would require much more space than in this entire Monograph. So the following simply attempts to provide some opinions and a basis for more thorough discussion in such forums as TAC's Education and Human Resources Development Council (EHRDC)[11].

First, the blackboard isn't dead yet and will likely be used into the foreseeable future especially in small and not highly organized settings, as will the whiteboard. The computer and slides will undoubtedly continue to find use in workshop, conference/seminar sessions and the like, and in fact this is essentially the presentation/communication method used in many webinars.

The second question is more difficult because investments in classrooms are expensive, especially if there is long term uncertainty. A key issue is the growing presence of "MOOCs" (Massive Open Online Courses), where many thousands can register free on a web-based course developed by experts from prestigious universities. Apparently in some of the science areas and, for example, in electrical engineering, these are becoming very popular.

[11] The EHRDC in fact held a lengthy discussion in its Sept. 25, 2013 annual meeting on communication trends and technical training using Facebook, Twitter, Blogs, Message/Bulletin Boards, Podcasts, YouTube, Webinars and other media.

So, what is the cost recovery in MOOCs? Without providing specific examples, again apparently, the market is in lower level institutions where the developer "franchises" it for degree granting purposes. Students then take the course online, and attend tutorials by professors in the institution in "inverted classrooms." These professors then set and grade exams in the same way as a lecture-based course. The argument is that this is no different than using a textbook, notwithstanding reports that the original course developers can acquire very large "royalty revenues" and charges that the professors conducting the tutorials became glorified teaching assistants.

Perhaps transportation education and training is not at that stage yet. However, considering the popularity and growth of MOOCs in other areas, they should not be discounted.

It should be noted that there are counter streams to MOOCs, offered by private organizations with lectures available via YouTube. They are called DOCCs (Distributed Open Collaborative Courses). They do not use a centralized syllabus but focus on distributed expertise among participants as a learning activity. Again, transportation education and training may not be at the stage yet to take advances of DOCCs, but they should not be discounted.

The third question falls under the broad form of "E-learning" and includes webinars, YouTube, message/bulletin boards and many others. In fact, the Internet is replete with vast amounts of information.

At this time, webinars seem to be a preferred medium for much of the educational and training world in the academic, public and private sectors, which is certainly the situation for transportation education and training. Relevant advantages and disadvantages include the following:

1. Advantages of Webinars and other E-learning Methods
    - Capability of educating/training/informing large number of participants (students, employees, customers) from off-site locations
    - Cost reductions, often quite substantial, compared to face-to-face seminars, meetings, and the like
    - Participants ability to further skills at minimal cost through practice with tools provided
    - Capability of good interactions between participants and instructors
    - Capability of many part time and remote location students to pursue degrees
2. Disadvantages of Webinars and other E-learning Methods
    - Potential of over-use (eg., saturation)
    - Danger of participants attitude becoming lackadaisical or disengaged from learning because medium is not face to face
    - Potential of bias toward more knowledgeable participants
    - Lack of immediate feedback from instructors on participant confusion or need to change pace
    - Participant distractions from whatever source, such as colleagues, not apparent to the instructor

The foregoing discussion has not addressed the potential role of media in transportation education and training, partially because the role is limited at this time. But in a fast changing world that potential role should not be discounted. Moreover, those responsible for education and training, whether in academia, or in public or private agencies, need to be aware of the various delivery methods as well as their advantages and limitations to advance the state of transportation knowledge and practice as efficiently and in the most cost-effective way as possible.

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