Transportation Education Provides a Foundation and a Legacy for Advancing Asset Management

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ABSTRACT

The Transportation Association of Canada Centennial Celebration in 2014 includes a Monograph on the Evolution and Legacy of Transportation Education in Canada. Based on the Monograph the underlying theme of this paper is that transportation education and training is a vital element to creating a base of knowledge and human resource assets.

Transportation education at the University level began even before the advent of the 20th Century, involving primarily railway and surveying. Over the ensuing decades influence of the modes was a factor in highway engineering becoming the core undergraduate course by 1945 after World War II. However, on-the-job training has also, continued to be a vital element.

An era by era progression of education and training, from the formation of the Canadian Good Roads Association in 1914 to the mid 2010's is described in the paper.

Also described are the impacts of the TAC Guides and Manuals, the Scholarship Program and the TAC Foundation, as well as the continuing role of the Education and Human Resources Development Council.

A special feature is a tribute to the "Titans" of transportation education and research.

Future prospects for transportation education and training are explored in the paper, including building on the legacy, the need for innovations, influence of the modes and future delivery methods.

INTRODUCTION

Transportation assets can be physical entities and/or knowledge based. Education and training play a key role in creating and managing these assets.

In accordance with TAC's 2014 Centennial Theme on "Transportation: Past-Present-Future", a project on the Evolution and Legacy of Transportation Education in Canada was carried out as a contribution to the Centennial (1). Sponsors of the project were the Education and Human Resources Development Council of TAC, the TAC Foundation and the Team Canada Alliance for Transportation Teaching. The Monograph resulting from the project provides a resource for this paper. It focusses not only on the evolution and legacy of transportation education and training but also on the skills needed to plan, design, build and manage transportation systems.

The scope and objectives of the paper are:

- An overall review of the evolution of transportation education and training over the past century and the changing influence of the modes
- Discussion of the modern era of transportation education and training, the impacts of TAC Guides and Manuals, the Scholarship Program and the TAC Foundation on advancing human resource and knowledge base of asset management
- Describing the key and continuing role of the Education and Human Resources Development Council
- Giving a tribute to the "Titans" of Transportation Education and Research

- Exploration of prospecs for the future in relation to building on the legacy, the role of innovations, influence of the modes on transportation education and training and future delivery methods

EVOLUTION OF TRANSPORTATION EDUCATION AND TRAINING

Background

The Centennial Celebration of the Transportation Association of Canada 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. 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, extent, 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 the 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.

The Monograph behind this paper focuses 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 a complementary and valuable component of the total picture and should be recognized as such.

The Monograph traces the historical milestones of transportation in Canada because of the influence on transportation education. But it is not 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.

The 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 Year 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.

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. Natives 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 them 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 (2). 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.

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.

The end of World War II in 1945, and beginning of the boom years of road building 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 power point 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.

The many CGRA/RTAC/TAC publications, including manuals and guides, provide an enormous repository of information used in transportation education as subsequently discussed. 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, also subsequently discussed.

BEGINNING ERA (TURN OF THE 20TH CENTURY TO 1914

The Beginning Era in the 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. Advent of the motor car and 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.

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 (3).

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" (3)for growth in population and industry, prosperity, ease of travel to other destinations, marketing agricultural and natural resource products and employment.

Canada's First Roads

Inland waterways were the only practical means of transportation for natives, 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 (4). 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.

While there is a good historical record of early roads (2), it was the advent of the automobile in the early part of the 20th century that spurred efforts to improve roads.

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.

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-faculty/history). The first degree in civil engineering in North America was granted in 1858 at McGill 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 (5). Skill and experience in surveying were absolute necessities.

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.

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.

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" (6).

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.

Table 1 Some Major Requirements of Highway Engineering Education in the Early Years of CGRA

Summarized/Adapted From Ref. (6)

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

GREAT DEPRESSION TO END OF WORLD WAR 11 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.

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.

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

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.

The Trans-Canada Highway 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.

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….." (7). 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 (8).

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 (8).

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.

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, 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.

In the late 1960s planning for a reorganization of CGRA was initiated and the Roads and Transportation Association of Canada (RTAC) was formed in 1971. The Highway Engineering Education Committee was not included in the reorganization.

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 subsequently discussed.

Typical content of an undergraduate Highway Engineering course at a Canadian University during the 1945 to 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" (9). 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

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

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 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. A corresponding increase occurred at the college level.

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 as listed in Ref. (6).

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.

MODERN ERA (MID-1980'S TO MID-2010'S)

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
- A relatively large suite of additionally available optional courses at both the undergraduate and graduate levels
- Advent of a wide range of new and/or enhanced tools (webinars, on-line courses, YouTube, cloud computing, software packages, etc.)
- Continued expansion of transportation faculty, currently numbering about 50 plus, as illustrated by the TCATT membership
- 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
- 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

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 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	Inter. Sec. Design	Cap. & LOS	Transp. Planning	Travel Demand	Geom. Design	Traffic Loads	Rwy. Eng.	Airport Eng.	Pvt. Design	Transp. Econ.	ITS	Sustain. & Eng. Impacts
UBC	√	√	√	√	√	√	√					√		√
UBC OK.	√	√	√	√	√	√	√	√	√			√		√
BCIT	√		√	√	√		√		√	√	√			
U of A	√	√	√	√	√	√	√		√					
U Calg.	√	√	√	√	√	√	√		√	√		√	√	
U Sask.	√	√		√	√		√				√	√	√	
U Man.	√	√	√	√	√	√	√		√		√	√	√	
U Windsor	√		√	√	√	√	√	√			√	√	√	√
U Western														
U Waterloo	√				√	√	√		√	√	√			√
U Toronto	√	√	√	√	√	√		√	√	√		√	√	√
Ryerson	√	√		√	√		√				√			√
RMC				√	√	√		√	√		√			

Institution	Traffic Eng.	Traffic Safety	Inter. Sec. Design	Cap. & LOS	Transp. Planning	Travel Demand	Geom. Design	Traffic Loads	Rwy. Eng.	Airport Eng.	Pvt. Design	Transp. Econ.	ITS	Sustain. & Eng. Impacts
Queen's														
U Ottawa	√			√	√	√	√		√		√			
McMaster	√	√	√	√							√			
Lakehead		√		√		√	√		√		√			
Carleton	√	√	√	√	√	√	√		√	√	√	√		√
U Sherbrooke	√	√	√	√	√		√		√		√			
McGill	√	√	√	√	√	√	√		√					√
U Laval	Transport problems, perspectives and lab studies; urban dynamics; road freight transport													
ETS					√		√		√		√			
Ecole Polyt.	√	√	√	√	√	√	√		√					√
Concordia	√		√	√	√	√	√				√			
UNB	√		√	√		√	√		√	√	√	√		√
U Moncton	√	√	√	√	√	√	√		√		√	√		√
Memorial	√	√	√				√		√		√	√		
Dalhousie	√			√		√				√	√			√

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. Over 20 such texts or manuals listed in Ref. (1) are categorized 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 airport planning and engineering.

Table 4 Representative List of Optional Courses in Transportation Education at Canadian Universities

A. Undergraduate Level

- 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

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 have been broadly categorized in Ref. (1) as Manuals, Handbooks and Guides, Guidelines and Synthesis of Practice and Frameworks and Reports with over 20 examples from the past two decades.

The examples in Ref. (1) 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. However, none have had a more

profound impact in all areas than the Pavement Design and Management Guides. They 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 (10).

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 Committees of TAC (July 26, 1999)[1] the concept of a "TAC Educational Foundation" was proposed.

The concept of a TAC Educational Foundation was subsequently discussed in TAC's Standing Committees in 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 presentation to their meeting on September 29, 1999 in Saint John, New Brunswick. Support in principle was given by the Board, 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.

While much of the focus has been on providing scholarships and expansion of the program, 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 Neil 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

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

Group, 2013 - present. Equally appropriate is recognition of the many donors, public and private organizations and individuals, who have contributed to the program from 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.

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 Ref. (1) leaves out others who are equally deserving. Nevertheless, it was felt important to at least pay tribute to a few, mainly from the latter 50 years simply because information from the first 50 years is limited. Accordingly tributes on 31 example individuals who have made their contributions and are retired or deceased are provided in Ref. (1).

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 provided in Ref. (1).

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 mass on-line 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" (Multiple Open Online Courses) and others.

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 a 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 (11) 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.

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 (11) 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 5 provides examples in the three areas.

Table 5 Areas of education and training with varying effectiveness

Adapted from Ref. 11

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	• 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

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 Transportation Association of Canada 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, as discussed in more detail in Ref. (1).

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 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.

The Education Council's inaugural meeting was held on September 18, 2001 at the Annual Conference in Halifax. Merv Clark became the first Chair of the Council.

Among the first group of Council involvement with courses were those 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.

A very successful workshop was held in September, 2004 at the TAC Conference in Quebec on "Innovation: A Risky Business." The record of the workshop stands as one of the early significant achievements by the Education Council.

The Education Council's major activities for 2005 included 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 well received 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 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. 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.

A name change also occurred to the Education and Human Resources Development Council (EHRDC), as approved by TAC's Board of Directors.

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."

The September 2010 Annual Conference in Halifax included an EHRDC sponsored Workshop, on what new graduates are seeking from employers.

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 EHRDC Workshop on Skill Sets Required by the Transportation Engineer of 2020 provides a focus for a continuing role (11). It had a basic premise that the transportation field is undergoing continuous changes in technology, financing, communications, environmental requirements, climate change adaptions, 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 described in detail in Ref. (11).

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 40 plus colleagues interested in putting together an Alliance was compiled by Jeannette Montufar of the University of Manitoba.

A plan was developed 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.

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. The uptake was over sixty graduate students from twelve universities.

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.

Future Influence of the Modes on Transportation Education and Training

The Monograph (1) 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, as follows:

- Highways: As long as 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 sees 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.

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 (12).

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" (12).

A relevant question concerns the impact on transportation education and any attendant need for incorporating autonomous vehicle technology and use. As this point it is quite an open question but educators should be cognizant of any such need.

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 are 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

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.

Traditionally, and for many years the classroom, the lab and the field have been the primary venues for delivery. However, at this time there is an almost overwhelming array of social media and what might broadly be termed E-learning alternatives to consider. For example, even searching Wikipedia for E-learning reveals not only text on the topic but also a list of some 100 references. 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?

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" (Multiple 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 these are becoming very popular.

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.

The third question falls under the broad form of "E-learning" and includes Webinars, YouTube, Message/Bulletin Boards, Webcams and many others. In fact, the Internet is replete with vast amounts of information on this and social media, including Google and Wikipedia.

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.

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