CHALLENGE OF SUCCESSION PLANNING IN ACHIEVING LONG LIFE PAVEMENTS

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ABSTRACT

Long life pavements and other road infrastructure, by definition, must provide a high level of service over a number of decades. During that time, there will be changes in three critical elements: people, technology and information. In other words, there will be an unavoidable succession, planned or unplanned, of these critical elements. The challenge is to ensure that the road infrastructure, from its inception, achieves its intended function and service over a long span of time through proper succession planning.

This paper builds on an earlier presentation to the Spring, 2002 TAC Workshop on Education and Training by first presenting the management context for succession planning and then illustrating that it involves not only people and technology but also information or data. In formulating and addressing the challenge of succession planning for these three critical elements. The following items are discussed:

- Defining the process of succession planning and the attendant time horizons
- Reasons for succession planning and guidelines for achieving it
- Obstacles and opportunities
- Case example with cost and benefit impacts
- Future prospects

In summary, this paper has as its basic premise that good design, construction and maintenance of long life pavements can be most effectively realized through proper succession planning for the variation of people, technology and information occurring over the time span involved.

INTRODUCTION

Background

The broad issue of transportation education and training and the associated issues of supply and demand have existed for decades. Within the Transportation Association of Canada (TAC), and it's predecessors Roads and Transportation of Canada (RTAC) and Canadian Good Roads Association, these issues have been periodically addressed through committees, studies, and now TAC's new Education Council. A key motivating factor in forming the council is concern over whether the transportation sector is and/or will be adequately served in terms of education and training, supply of skilled people, availability of resources, and future demands and commitment by both the public and private agencies.

Overall, the transportation sector has many dimensions and can be viewed from the point of modal type, public vs. private vs. academic, professionals vs. technologists/technicians vs. operators, function ranging from engineering to financial or accounting to planning to administrative or management, supply sources skill sets needed, breakdown of demand, remuneration levels...and the list goes on.

Obviously, to be meaningful there has to be a clear focus on any study or presentation or document. Examples include an early comprehensive study of Skilled Manpower Requirements, in which RTAC's (at that time) Education Committee was heavily involved and which concluded the following [Haas 1972]

> "...variations in surplus and shortage are cyclic, they can be severe, they occur with measurable frequency and they can be quantitatively and subjectively related to a number of social-economic-technological factors.....Some major reasons for the shortage/surplus cycles are associated with short-term economic policies by senior governments, a low priority assigned to manpower planning and lack of factual data on manpower requirements."

This study identified a number of specific issues and problems, which, unfortunately, still exist today. It also offered a number of policy recommendations, which are similarly still relevant today. It may be noted that the study was financially supported by the forerunner to the current federal department of Human Resources Canada.

Another example is the recent WESTAC document "Moving Forward: A Guide on the Importance of Transportation in Canada" [WESTAC 2001]. This is intended for broad, general interest and awareness as to what the industry means to Canada's socio-economic well being and employment situation. Moreover, it is intended to attract people to the industry.

This paper recognizes the many dimensions of the transportation sector, while the focus remains on the academic perspective. As well, there are several "boundaries" placed on this perspective, as subsequently identified.

Key Issues and Questions

The key issues and questions related to the people side of Canadian pavement engineering sector and the associated education and training needs can be categorized as follows:

1. Supply and demand related: adequacy of supply of trained professionals, sub sector specifics, cyclic nature and cyclic offset of supply and demand, influence of U.S. economy, remuneration and demand, incentives to pursue transportation and succession planning.
2. Education/training/skills related: basic vs. advanced training and education and research support, continuity of training and education, discipline choice or background, specific skill sets (technical and non-technical) needed and faculty resources.

Scope and Objectives

The overall scope of this paper involves a university perspective on what are the education and training needs for skilled people in transportation, and how well we are doing in meeting these needs in achieving long life pavements.

This paper builds on an earlier presentation to the Spring, 2002 TAC Workshop on Education and Training by first presenting the management context for succession planning and then illustrating that it involves not only people but also technology and information or data. In formulating and addressing the challenge of succession planning for these three critical elements. The following items are discussed:

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UNIVERSITIES AS THE UPSTREAM COMPONENT

Supply and Demand Chain

The 1972 study [Haas 1972] noted that the major supply source for skilled professionals in the transport sector and thus pavement sector, was civil engineering graduates. Since that time, the number of graduates has continued to be cyclic and has continued to be out of phase with economic cycles and with the marketplace. Figures 1 and 2 clearly illustrate that the enrolments and production of civil engineers declined by about one third over the past decade. This has occurred during a generally increasing economy, a sharply increasing infrastructure backlog, including roads, and an ageing cohort of professionals in public agencies and industry, and downsizing/ surplussing/ reengineering/ strategic repositioning[1] by transport departments. The

[1] These are all buzz words that have been used to try and soften the reality that layoffs, early retirements and dismissals were involved.

net effect is supply and skills shortages, which already exist in a number of transport sub sectors. Unfortunately, there is no magic tap to be turned on or off in these situations and even more unfortunately the transport sector has not learned from past history. Whether or not we will now enter into a new and more enlightened era of human resource planning, including the critical component of succession planning as subsequently discussed, is at least hopefully a case for optimism.

Figures 1 and 2 clearly illustrate an alarming decline in the production of civil engineers (and the primary supply source for transportation professionals) not only in absolute numbers but also in comparison to computer engineering, mechanical engineering and electrical engineering. It is also noteworthy that in 1972 civil engineering graduates comprised about 21% of the total but now, 30 years later, that has shrunk to about 14% of the total. In fact, the total number of civil engineering graduates has only grown from 889 in 1972 to about 1125 (estimated) in 2002, an increase of only 25%. It is also notable that civil engineering now enjoys close to 100% placement during their undergraduate programs. For example at the University of Waterloo, civil engineering during the past two years has received work term job placements ahead of the other disciplines.

Net Resource

The inflows and outflows that result in the net resource of skilled professionals in the transportation sector can be represented by Figure 3. Since the primary supply source/inflow of civil engineering graduates has been insufficient, it is likely that immigration and graduates of other disciplines have been a primary additional supply source.

The 1972 study [Haas 1972] estimated a net resource of about 3,000 skilled professionals (excluding railways, airlines, pipelines and shipping), with about two thirds being employed by provincial and federal transportation agencies. Engineers generally comprised well over 80% of this resource. While current numbers are not available, it can be very roughly estimated that this would be the order of at least 6,000 to 9,000 with 7,500 as a best guess. Moreover, well over 75% have engineering backgrounds and most of these are civil engineering graduates. It can be inferred, however, that with a shrinking supply source of civil engineers, in relative terms, combined with the previously noted increasing backlog of infrastructure work, an ageing cohort of professionals and recent short sighted policies of sudden downsizing, etc., the transportation sector in Canada is going to face some major problems in the coming decade. This includes lack of succession planning, as subsequently discussed.

Required Skill Sets for Transportation Professionals

It is important to recognize that transportation professionals need to possess a number of skills. Again, the universities are the upstream component in equipping their students with the initial skill sets. Table 1 lists the key non-technical, basic and technical and special skills that professionals require to carry out their work at both the network/system wide level and the project/site specific level. Of course the depth of any individual skill required will vary with a number of factors such as type of transportation network or project, size and complexity, environmental impacts, financing, and others.

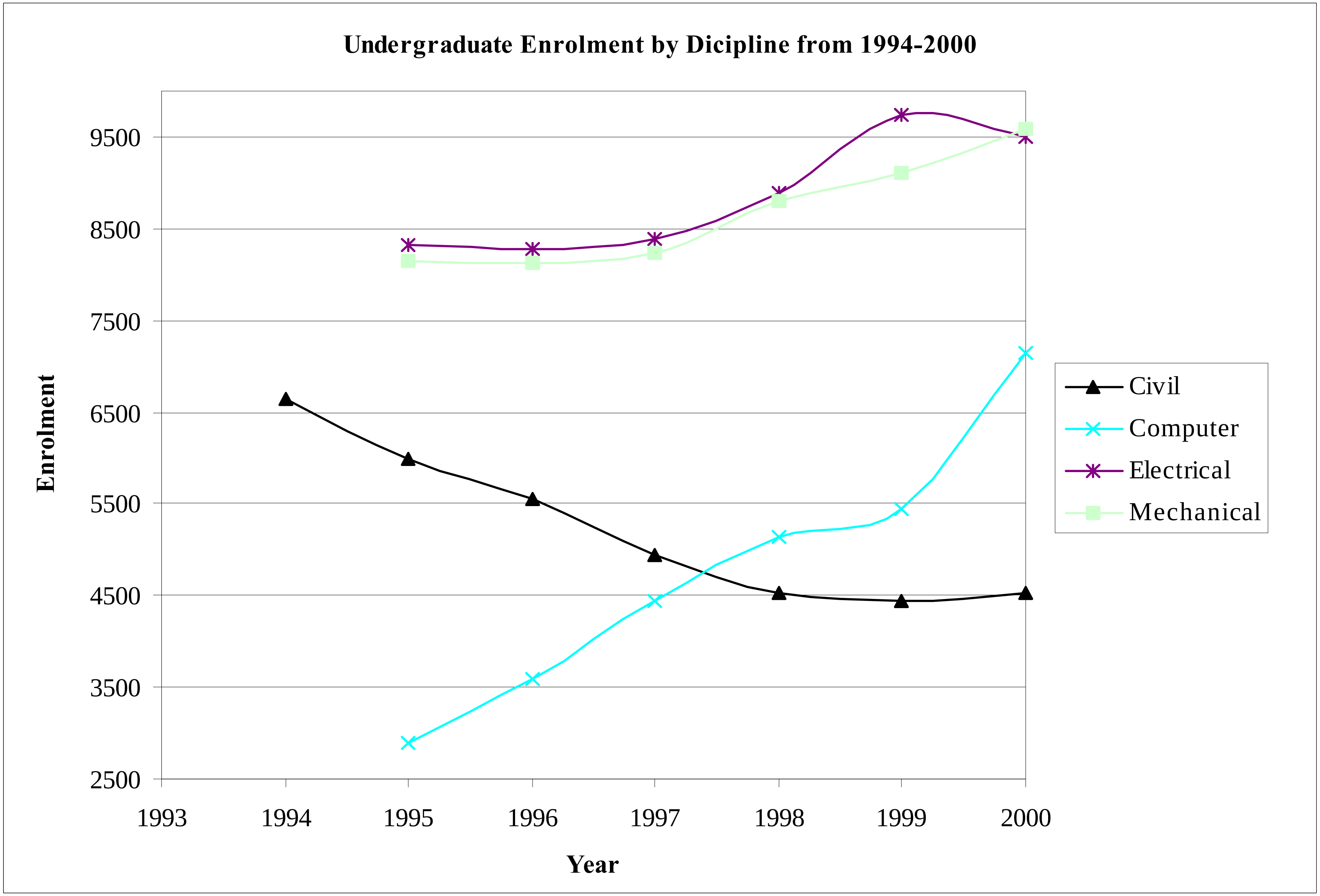

Figure 1 Undergraduate engineering enrolment in Canadian universities [CCPE 2001]

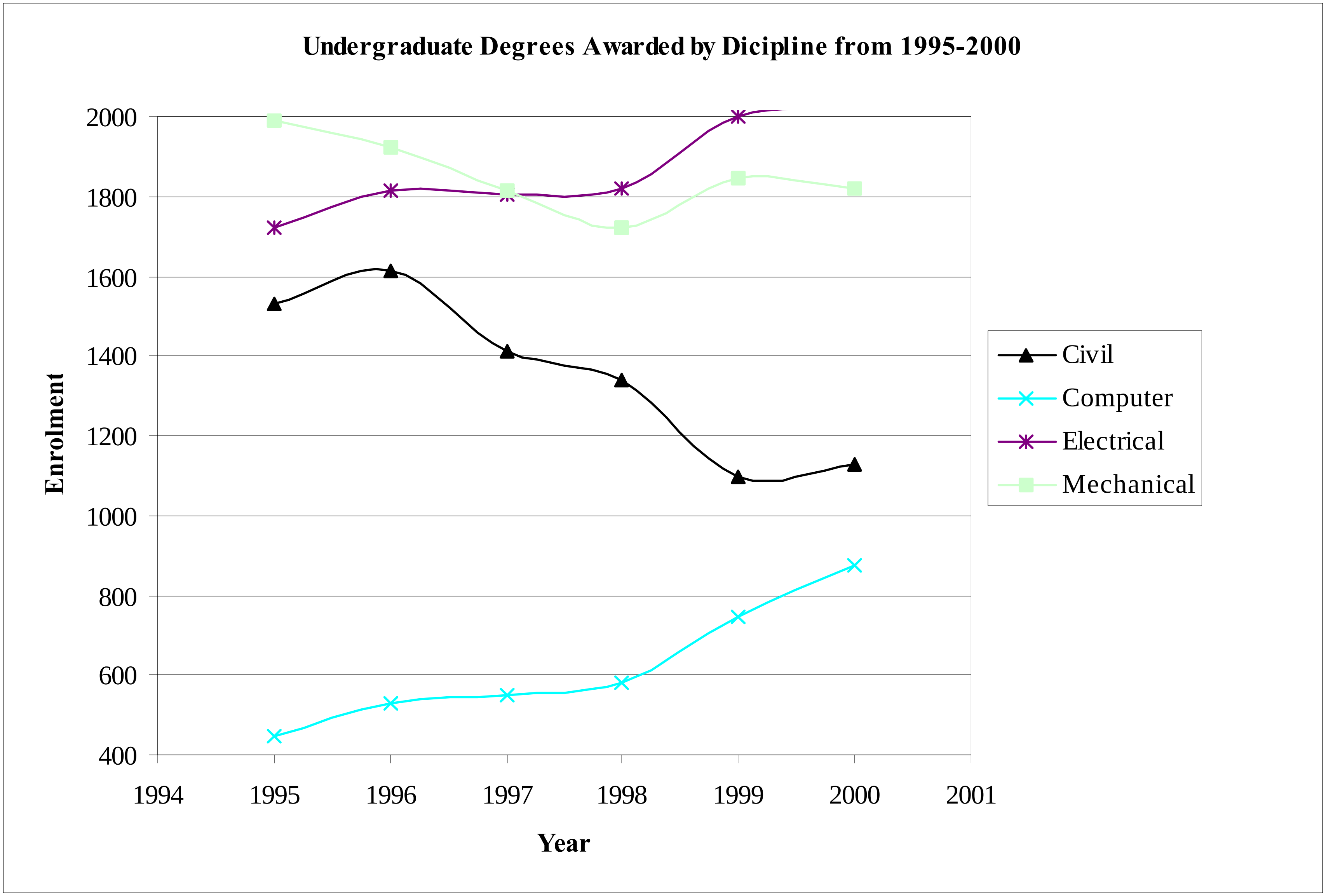

Figure 2 Comparative production of engineering graduates in Canadian Universities [CCPE 2001]

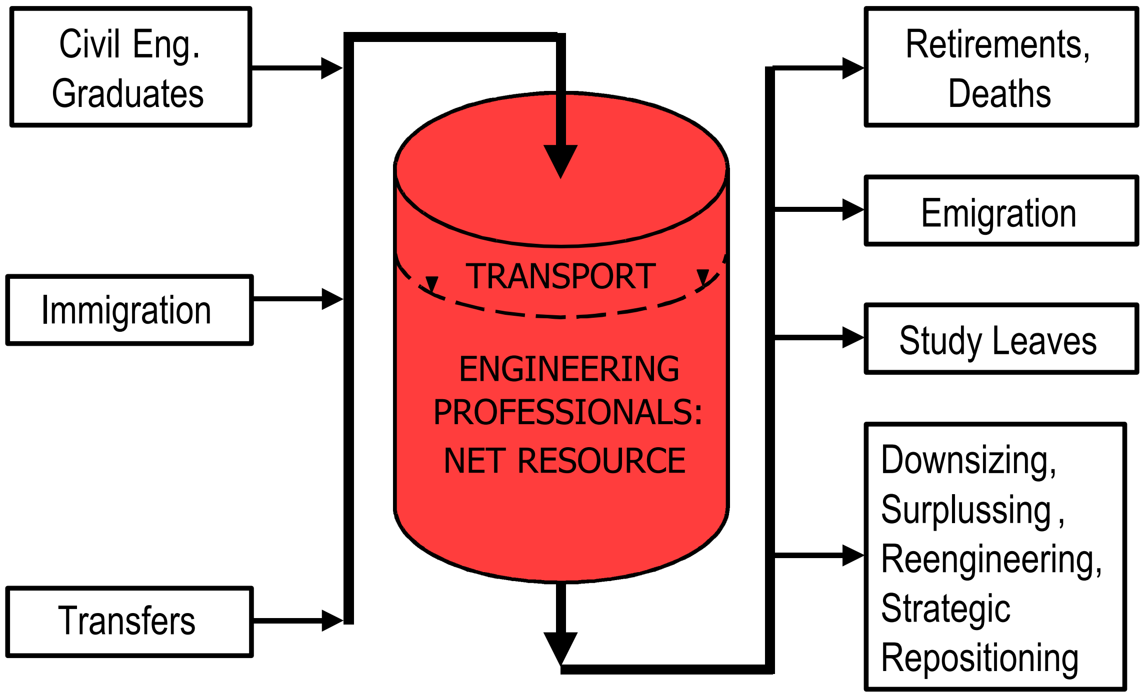

Figure 3 Inflows and Outflows of Skilled Professionals in Transport Sector

Table 1 Required Skills for Transportation Professionals [After Tighe, et al 1997]

		NON-TECHNICAL SKILLS						BASIC SKILLS					TECHNICAL AND SPECIAL SKILLS											
NETWORK/SYSTEM WIDE LEVEL		Financial Planning	Public Policy	Business Admin.	Personnel Manag.	Engineering Law	Public Relations	Computing	Data base design & manag	Statistics	Math Models	Engineering Economics	Geotechnical Geology	Building Materials	Construction Materials	Materials Testing	Field Testing	Traffic Analysis	Pavement Engineering	Bridge Engineering	Structural Engineering	Concrete Design	Construction Manag.	Maint. Engineering
DATA	Locational reference system							X	X				X					X	X	X				
	Facilities Inventory				X			X	X							X	X							
	Field monitoring & other data				X			X	X							X	X							
	Data processing							X	X	X														
	Present status reports							X	X	X														
DEFICIENCY/NEEDS	Min. levels of service		X			X																		
	Max. user costs		X																					
	Max. program costs	X	X	X																				
	Needs now/future							X	X									X	X	X				
	Deter. predictions							X	X	X	X		X		X	X		X	X	X				
ALTERNATIVE STRATEGIES & LIFE CYCYLE COSTING	Maint. & rehab. alternatives												X		X	X		X	X	X	X	X	X	X
	Selection criteria		X																					
	Eng. analy. & perf. predictions							X	X	X	X				X	X		X	X	X	X	X		
	Life cycle costs							X				X							X	X				
	Priority analysis							X			X	X							X	X			X	X
PRIORITIES, PROGRAMS, SCHEDULES	Funding levels			X				X				X							X	X				
	Final capitol program	X	X	X															X	X				
	Final maint. program	X	X	X															X	X				
	Contract schedule	X		X				X															X	
	Maint. Schedule							X																X
	Program monitoring			X	X			X															X	X
	Budget & financial planning	X		X				X															X	X
PROJECT/SITE SPECIFIC LEVEL																								
DATA	Detailed site and other data				X			X	X	X			X											
	Subdivision of project							X	X	X			X											
	Data processing							X	X	X														
DETAILED DESIGN	Specifications									X		X			X	X	X	X	X	X			X	X
	Max. project cost	X	X									X												
	Min. interruptions to service		X				X																	
	Selection criteria		X																					
	Alternatives & Analysis												X		X	X	X	X	X	X	X			
	Life cycle analysis & best alt.							X		X														
CONSTRUCTION	Activities; control, records Built				X	X	X		X	X	X				X	X	X						X	
	to within specifications							X					X	X	X		X						X	
MAINTENANCE	Maint. Activities and records				X				X	X	X													X
	Budget and schedule updates	X		X				X															X	X

STATUS OF TRANSPORTATION EDUCATION IN CANADIAN UNIVERSITIES

The status of transportation education in Canadian universities can be viewed from the following perspectives:

1. The primary supply source of professionals as previously discussed.
2. The faculty in terms of their numbers, courses taught, research interests, and age distribution.
3. Research funding and graduate students.
4. Degree of succession planning.
5. Strengths and weaknesses.

In the following sections the discussion focuses on the last four of these perspectives.

Faculty

The faculty information comes primarily from university web sites and familiarity with many of the individuals and their work. While there are transportation oriented faculty in a variety of such disciplines as law, economics, science, accounting, psychology, mathematics, etc., the emphasis herein is on civil engineering faculty in transportation since this is by far the primary discipline involved.

The university web sites were also the source of identifying transportation courses. Table 2 is a summary of the numbers of transportation professors and the number of transportation courses offered. It must be emphasized that this table is based on the information available and in some cases, a degree of interpretation was applied. Moreover, some universities who should have been included may have been missed and there may well be some errors in the numbers. Nevertheless, they should be reasonably representative of the situation in Canada. Table 2 numbers also include, for several of the universities, professors who are retired but still quite active in research, professional activities and in some cases teaching. On the other hand, the numbers also include some professors who are marginal in terms of having mainly administrative duties, nearing the end of their career and having limited activity, etc.

The Universities that didn't provide information on their faculty were not included in this table.

The average number of transportation courses offered per university is about 4. However, this has to be viewed with caution because some are not offered every year and some only once per year. Thus, a more realistic number would be an average of about 3 to 3.5 transportation courses per university per year. The courses offered for some universities were broken down as either a core or an option course (some universities didn't provide this information so a total is shown instead). It is seen that the maximum core course load is at Ryerson with four core courses but no options. Overall, the universities had an average number of 1.25 core courses and 3.2 option courses.

The total number of faculty in Table 2 is 39. Considering that some universities may have been missed who would have faculty with primary interest in transportation, a reasonable total would be in the order of 40 transportation professors at Canadian Universities. Three of the universities, Calgary, Waterloo and New Brunswick have the highest number of faculty members at 5 each, although this number includes a retired professor for all three universities.

Table 2: Summary of Canadian Universities Offerings and Professors

Canadian University	Number of transportation courses (core/options)	Number of Professors specialized in transportation
UBC	1/2	2
University of Calgary	1/4	5
University of Sask	1/2	2
University of Manitoba	0/5	2
Ryerson University	4/0	2
University of Toronto	2/3	4
University of Waterloo	1/4	5
McMaster University	4	1
Carleton University	1/2	2
Royal Military College	2	2
McGill University	1/5	1
Laval University	3*	3
Concordia University	3	1
Ecole Polytechnique	3	1
UNB	1/6	5
Dalhousie University	1/2	1
	Total	39

*Single number is total number of courses offered.

Table 3: Breakdown of Faculty Interests

Interest Categories	Professors Area of Interest
Pavements	*********
Traffic, Safety, and ITS	****************
Transportation Management, Design, and Economics	****************
Other	************

The average number of transportation faculty at Canadian universities, based on Table 2, is about 2.3. While numbers for other disciplines have not been acquired, this seems substantially lower than the numbers in other areas, particularly environmental and structures and mechanics.

Breakdown into Key Areas

To take a closer look at the faculty and their interests, an approximate grouping was carried out as follows:

1. Pavements

2. Traffic, safety, and ITS
3. Design, management, and economics
4. Other (i.e. trucking, simulation models)

Table 3 is a summary of the breakdown, as shown by the number of *s beside each group. In some cases, a professor's interest was split into two groups. Thus, the total number of *s exceeds the approximately 40 professors involved. Nevertheless, Table 3 provides a good relative picture of interests.

From Table 3 it is seen that the most popular areas of interest are traffic, safety and ITS, and transportation design, management and economics. Pavements seem to be somewhat under represented, although they comprise the largest single area of expenditure and of asset value in transportation.

Age Distribution

The age distribution of professors at Canadian Universities is important in the sense of both the current situation and what is likely to happen over the next decade or two. Not the least of this are the issues of succession planning and the type and degree of research that will be carried out.

Figure 4 is an approximate distribution of ages in terms of career stages. The assignment is somewhat arbitrary in that it relies on personal knowledge and judgement. However, it should be reasonably indicative of the current status.

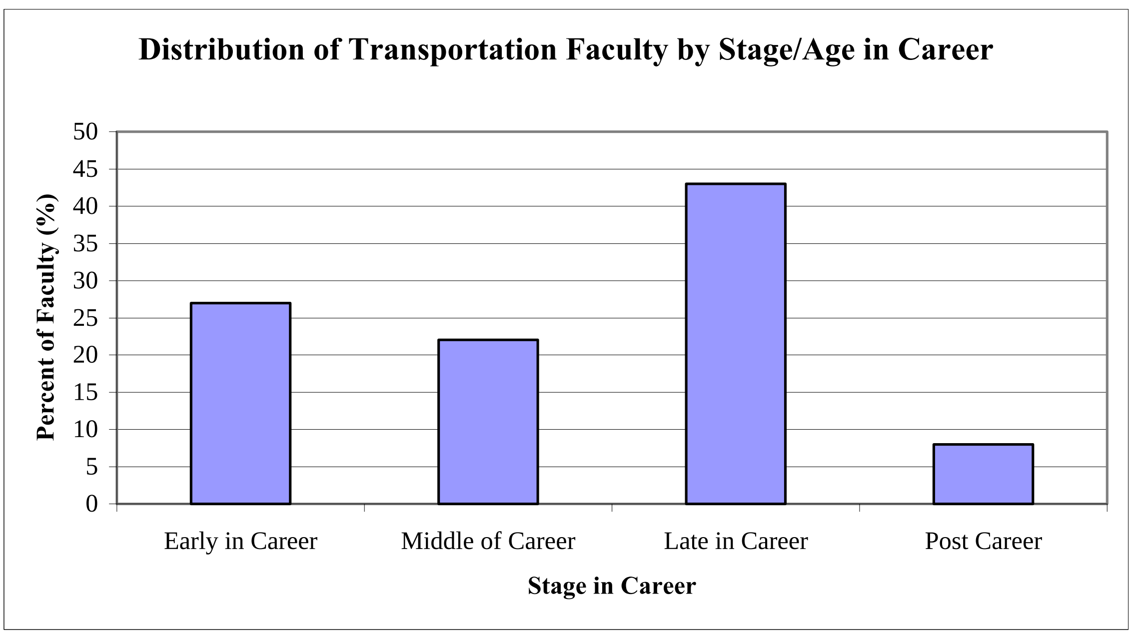

Figure 4 Breakdown of Current University Faculty into the Stages in their Career

Among the immediately apparent aspects of Figure 4 are the following:

1. About half the professors are at a late in career or post career stage. In other words, this late age cohort represents 50% of the resource. The "good news" aspect is the opportunity for renewal; the "bad news" aspect is that a lot of senior experience will be lost in the short term. Moreover, a distorted age distribution, as revealed in Figure 4, is not conducive to orderly succession planning and/or renewal.
2. The mid career cohort in Figure 4, at about 20% of the total, is underrepresented. It means that there will be very few late in career faculty in the next 10 to 20 years; it also indicates there will be a reversal of the existing distribution.
3. The early in career cohort, currently at about 25 to 30%, will offset to some extent the mid career underrepresentation in the next 10 to 15 years.

While Figure 4 conveys some obvious aspects and some inferences, the impact of the distribution on education and training can only be speculative at this time.

Funding for Research and Graduate Students

The level of funding for research has a very important education and training role in terms of producing postgraduates. While this represents a relatively small number in the supply chain, it is a valuable and indeed essential component in terms of advanced training and technological developments.

One of the best indicators of how civil engineering fares is the Natural Sciences and Engineering Research Council's (NSERC) support. The total annual operating grant funding for about 500 civil engineering researchers at Canadian universities is only about $13 million (out of a total of about $275 million for engineering, physical, mathematics and life sciences). In view of the much larger relative position that civil engineering represents in the Canadian economy, this indicates that civil engineering research and the associated faculty, in Canadian universities could be substantially strengthened.

This need is not necessarily the fault of NSERC. The opportunity exists, but major support must also come from provincial, federal and municipal agencies and the private sector. It is remarkable that of the approximately 750 civil engineering professors in Canadian universities, about two thirds, or 500, receive NSERC funding. This in fact represents about 25% of all civil engineering research (Civil Engineering Reallocation Submission to NSERC, Dec. 19, 2001). When other NSERC funding for infrastructure, equipment, partnerships, etc. is added, the total is about 50%. In other words, the private sector and various provincial, federal and municipal agencies only fund about half of civil engineering research. Why have the public and private sectors allowed this to occur; where is the organized demand, and support, from these sectors; is it a lack of awareness and/or apathy; is there a perception that we can just import technology from the U.S. and we don't need home-grown research; is there a perception that there is always an oversupply of skilled professionals available and/or we can rely on immigration?

The answer is that it is likely all of the above!

Related to this of course is the graduate student situation. While scholarships (mainly NSERC) are significant, graduate student funding comes primarily from research grants and contracts of the professors. The data available indicates that the average number per professor at any one time is between about two and four. In turn, this suggests a total graduate student enrolment in civil engineering in Canada of about 1,800 [CCPE 2001].

Succession Planning

Succession planning in the transportation sector, including public and private agencies and the universities, basically does not exist. It has obviously not been considered a priority. Some elaboration and examples will be provided shortly.

First, however, it should be noted that succession planning comprises three main elements: (a) people and their experience and expertise, (b) technology in terms of methods and procedures, codes of practice, software, hardware, facilities, etc., and (c) information and data, particularly in terms of the time dimension. While all three elements are related and important, it is the first element of people succession that is given attention in this paper.

Lack of proper succession planning has been labelled "institutional Alzheimer's" - the corporate memory loss that occurs when key employees leave an organization [Globe and Mail 2002]. The article noted points out that such companies as Clarica Life Insurance, EDS Canada and multinational Proctor and Gamble have a goal to "leverage our substantial investment ... to make the most of the knowledge contained within the firm".

Unfortunately, this has not been the norm. For example, the largest transportation ministry in Canada (Ontario) "surplussed" (to use their terminology) in 1996 all their engineers with less than 5 years seniority and their technologists/technicians with less than 15 years. The loss of investment and the impact for the future of losing a large number of (mostly young) people has to be substantial. Now, however, about 5 years later, the Ministry has a new policy of "Hiring for the Future" which states [MTO 2002]:

> "A strategic approach to ... guarantee long term vitality ... pool of personnel to draw upon for succession planning ... attracting and retaining permanent employment...".

Similar actions have occurred in other transportation ministries in Canada. Needless to say, these are not good examples of continuity succession planning.

The academic sector is certainly not blameless in this regard. Even replacing the approximately 50% of professors who will be retiring in the next 10 to 15 years (see Figure 4) will not be easy. There will be intense pressure (e.g., the nature of an academic institution) to transfer any new appointments to structures, environmental, geotechnical, etc. Unless a strong case can be made internally, which would be enormously helped by outside pressure from the public and private sectors, there is a real danger that transportation faculty, education and training will decline even lower than its current level.

Proper succession planning is critical to the future vitality of the transportation sector. Several key components are involved in succession planning and they include the following:

- Recognising the need and obtaining top level commitment
- Developing a plan which involves timing of replacements, including sufficient training and overlap, provides for contingencies (e.g., sudden resignations) and contains mentoring responsibilities
- Making the necessary investments
- Keeping the plan dynamic by periodic updating and periodic assessment of its effectiveness
- Documenting the plan and procedures, its ongoing activities and accomplishments and the lessons learned.

Generating a "culture" of succession planning in the public and private sectors, and in academia, will be a real challenge indeed. One initiative towards this goal, which is well within the purview of the Transportation Association of Canada, is to produce a "Primer" on the topic, similar in concept to TAC's earlier Primer on Asset Management.

Role of Mentoring in Succession Planning

Succession planning associated with people, information and technology can be facilitated through mentoring. According to Webster’s Dictionary, a mentor is a wise or faithful adviser or monitor [Webster 1984]. These are people with experience and information on a particular subject who are willing to provide advice and support [Williams 2002]. The mentoring relationships are intended to provide networks of knowledge. These networks can facilitate the transfer of information on various aspects of a business or industry. In short, the mentoring relationship helps facilitate quick and easy information and knowledge flow. Previous experience has also demonstrated that a formal mentoring program is an inexpensive way to pass down corporate wisdom and experience while keeping employees satisfied, challenged and most important, loyal [Harding 2003].

It is evident in engineering and particularly in transportation and pavement engineering that senior members in the Canadian transportation sector can play an important role in the transfer of knowledge to ensure long lasting pavements. Both the mentor and protégé can learn from each other. For example, the former CEO of General Electric Co., Jack Welsh pioneered a formal mentoring program. He ordered his top 500 managers to reach down into their ranks and pair them up with younger and even entry level employees. He wanted up-and-comers to teach their elders technical expertise, including computer and internet skills while the senior employees were to pass corporate knowledge on to the younger employees.

Similar examples of this type of successful mentoring have occurred in the transportation and pavement sector. For example, a large Canadian university, which has a strong research record in pavement engineering, has had a very successful senior professor retire recently. This professor was replaced with a young assistant professor. The senior professor has provided extensive guidance and mentoring to the new professor. Together the mentor and protégé have teamed up on several projects. Substantial research funding has been obtained and various reviewers have positively commented on the fact that the proposal is greatly strengthened by the pairing of these researchers. In effect, the succession planning aspect of the work and the transfer of knowledge is viewed as a key strength for the team as there is a mechanism for corporate wisdom and experience. In fact, in the area of transportation where massive reengineering has occurred, as discussed earlier in this paper, mentoring and the succession plan at the university have provided stability to the industry. Overall, the university is one of a few places that have been able to maintain in-house expertise, which can serve as a resource to the pavement community, at large. Both the mentor and protégé benefit by working together.

Economics of Succession Planning

In addition to the transfer of knowledge, succession planning provides tremendous cost savings. As noted earlier, formal mentoring and thus succession planning provide an inexpensive method for passing down corporate knowledge and wisdom by keeping employees satisfied, challenged and most important, loyal. This loyalty translates into employees who are interested in their jobs and who feel they are part of a team where they count. The senior employees are truly interested in their protégé's success and often try to promote and challenge them. It is also a well-established fact in management that if people feel they are part of a team and "valued" by the organization they are less likely to leave the company or field of work.

Employee turnover rates are an excellent measure of cost savings. A privately held U.S. based software company provides tremendous benefits to its employees including use of extensive recreational facilities, day care and medical facilities, etc. In an industry where annual employee turnover rates are 20%, this company has an average turnover rate of 3% per year. Experts at Stanford University have estimated that this dramatic reduction in employee turnover results in conservative savings of 60 to 80 million U.S. dollars per year [CBS 2003]. These savings are simply associated with the retention of corporate knowledge, stability in the workforce, and reduced stress associated with convenience of amenities.

Although it is difficult to completely quantify the cost savings associated with succession planning, it is evident that if employees at all levels in the organization are part of a team they are less likely to leave. Effective organizations are those that capitalize on their resources and transfer knowledge across the organization. In short, succession planning can be a key area of cost savings for the transportation and pavement sector.

Some Bright Lights

While the foregoing sections have identified a significant number of deficiencies and needs, the academic sector does have some bright lights, which include the following:

- A small but highly capable supply stream of civil engineering graduates and post graduates
- A small but high potential cohort of early career transportation professors
- Several chairs and professorships supported by endowments, NSERC and public and private sector funds (examples: The Husky/NSERC chair in Bituminous Materials at Calgary, The McLeod Professorship at Waterloo and the D.C. Campbell Chair at University of New Brunswick)

- The Université de Laval experimental road in Quebec, jointly supported by the Ministère des Transports du Québec, NSERC, The Canada Foundation for Innovation (CFI) and several private sector partners
- The $6 million package for an integrated laboratory and field test facility for pavements and transportation at the University of Waterloo, of which $4.8 million comes from CFI and the Ontario Innovation Trust, and the remainder from the Regional Municipality of Waterloo, McAsphalt Industries Limited and several other public and private sector partners
- Several long standing scholarship programs, including the TAC and the Canadian Institute of Transportation Engineers (CITE)
- The formation of TAC's Education Council
- The entrepreneurial skills and achievements of Canada's transportation sector (consultants, suppliers, manufacturers, contractors) in commercialization of their products and services for foreign markets (examples: International Road Dynamics of Saskatoon and Stantec Consulting Limited's role in the Strategic Highway Research Program).

The foregoing list is by no means complete. But it does illustrate that there are some real positives and it may be an impetus to add to the list with some major new initiatives.

FUTURE PROSPECTS AND OPPORTUNITIES

A best case scenario for the future would be one of co-ordinated, long term planning for transportation education, training and research through a three-way alliance or partnership of public sector, private sector and academia. The worst case scenario would be one of apathy and continuing to muddle along. Realistically, the most likely future prospect is something in between the two extremes. However, there are opportunities, which if realized over the next decade could contribute toward the best case scenario. These opportunities include the following:

1. Establishment of a transportation education foundation, as proposed in the business plan of TAC's Education council.
2. An organized alliance of the public and private sector players to pressure and provide support for an increased level of transportation activities in Canadian universities and to develop a unified strategy for succession planning. This can be accomplished through TAC.
3. Development of a Succession Planning Primer for the Canadian transportation sector.
4. An organized alliance of Canadian transportation professors which seeks to strengthen their role in research, education and training. Some initial steps in this regard, involving the early career professors specializing in pavements, have already occurred and can provide a model for expansion. As well, this should involve a concerted effort to get Canada Research Chairs[2] (CRC's) in transportation.
5. Showcase and/or profile the major achievements of and honours awarded to Canadian academics. This not only creates awareness of transportation but also assists in recruiting new talent.

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[2] The CRC program is a federally funded initiative. 1000 Tier 1 chairs (at $200,000 each per year) and 1000 Tier 2 chairs (at $100,000 each per year) have been designated for Canadian universities. All disciplines are eligible. At this time, it does not appear that any have gone to civil engineering professors who specialize in transportation.

CONCLUSIONS

This paper has focussed on a university perspective of education and training needs but has also addressed complementary issues of supply and demand, current status of the universities in terms of faculty, research funding and succession planning and future opportunities. Major conclusions can be summarized as follows:

1. Universities represent the upstream end of the supply chain for transportation professionals. Most of the supply comes from civil engineering graduates. However, this supply source has declined drastically, by about one third, over the past decade. By comparison, other engineering disciplines have increased their production substantially.
2. The impact of 1. above, combined with an increasing backlog of infrastructure work, an ageing cohort of professionals and short sighted policies of a number of senior government agencies, will almost certainly be major shortfalls in the supply of both numbers of professionals and skills. This is exacerbated by the literally total absence of proper succession planning in not only the public and private sectors but also in the universities.
3. Transportation is far under represented in Canadian universities by any measure, including research funding, proportion of civil faculty, and graduate students. All are between about 4% to 8% of the total in civil engineering.
4. There are some bright lights, however, in transportation and these include a small but highly capable supply stream of civil engineering graduates and post graduates, a cohort of early in their career faculty, albeit small in numbers but with excellent potential, some major new research initiatives at several Canadian universities, several long standing scholarship programs and the formation of TAC's Education Council.
5. Future prospects for improved education, training and research will depend largely on realizing a number of opportunities, including the establishment of a transportation education foundation, organized alliances of public and private sectors to promote and support transportation including a unified strategy for succession planning and showcasing of major achievements to create awareness and recruit new talent.

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