A Process Management Approach to Fund Safety Projects in Alberta

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Abstract

Within a roadway agency, a capital plan usually includes traditional programs such as pavement rehabilitation, roadway capital improvement, new capital projects and other ancillary features. With declining annual budgets in a context of increasing needs for various programs, new safety programs are usually difficult to accommodate. Decision makers must be presented with a strong business case to decide to incorporate new programs in the capital plan.

The science of roadway safety has gained increased recognition over the last 15 years. During this period, Transportation Association of Canada (TAC) and other agencies have developed various safety engineering guidelines such as road safety audit, in-service road safety review and 3R/4R guidelines. Also, the explicit evaluation of safety considerations in selecting geometric parameters is encouraged throughout the current TAC Geometric Design Guide for Canadian Roads. However, funding of road safety projects has not met with the same degree of success. In a process management context, development of road safety standards and guidelines is only one of the key activities. Other activities, such as policy development, planning, program development, education, research and training must all take place as well in order to successfully deliver road safety programs. The goal of this process management approach is to secure on-going annual funding for safety projects throughout the highway network in an equitable and cost effective way. The ultimate objective is to achieve a reduction in collision rates and average collision severities resulting in a significant decrease in societal costs for collisions. This will reduce pressure on the province's health care and emergency services. These highway improvements will continue to provide enhanced safety for the general public as long as the infrastructure element is in service.

This paper describes a process management approach that has been used effectively to implement various road safety projects and programs over the last 15 years in Alberta, Canada. Road safety projects such as 3R/4R improvements, shoulder rumble strips, railway crossing improvement, safety rest areas, traffic operation safety improvements and other safety projects are now incorporated into Alberta Infrastructure and Transportation's normal planning and programming process. This paper provides details on how these programs and projects were developed from conception to implementation stage despite institutional barriers and challenges.

1. Edmonton, Calgary and all other municipalities are assumed to contribute one third each towards the total municipal transportation expenditure. The $960 million per annum estimate is based on current figures for Calgary and Edmonton.

1.0 Background

Alberta Infrastructure and Transportation currently has jurisdiction over a provincial network of highways that extends throughout the province with the exception of the National Parks. The network consists of 28,662 km of total highway length. This comprises 2,087 km of divided highway (mostly four lane) and 26,575 km (**1**) of undivided highway (mostly two lane). The provincial network is 97% rural and 3% urban and carries the majority of longer distance trips within and through the province. For example: international, national, intra-regional and special use roads (to serve tourists, natural resource access, agricultural and industrial) are part of the provincial network. Generally roadways serving a local and/or municipal function are under municipal jurisdiction. Therefore, the majority of roadways within cities, towns and other municipalities are under municipal jurisdiction.
Provincial highways are generally providing a high degree of mobility at posted speeds of 100 km/h to 110 km/h while municipal roads are providing a higher degree of access at a typically lower posted speed of between 50 km/h and 80 km/h.

Alberta Infrastructure and Transportation (AIT) typically spends about $385 million per annum on highway construction and $173 million per annum (**2**) on highway maintenance. Alberta municipalities (including cities, towns and other urban and rural municipalities) collectively spend approximately $960 million annually[1] on all of their roadway construction and maintenance programs. Based on Alberta's current population, the annual per capita spending on all roadways in the province is approximately $500. The per capita spending on all roadways in Canada is approximately $430 (**3**). Therefore the per capita level of spending on Alberta roads exceeds the national average.

Collision rates for Alberta and other provinces of Canada are compiled annually. To obtain a simplified collision cost for Alberta, a unit value is given for each collision type as follows: Fatal collision: $1,345,068, Injury collision: $100,000 and Property Damage Only Collision: $12,000 (**4**). The typical number of crashes per year (using a baseline of 1996 to 2001) of each type reported in Alberta is as follows: 387 (Fatals), 2936 (Injuries) and 81180 (Property Damage Only) (**5**). Using these figures the annual collision cost for Alberta is approximately $1,788 million and based on the provincial population in 2001 (3,034,485), the per capita collision cost was $634. Using the same methodology and unit costs, the per capita collision cost for all of Canada in 2001 (population of 30,893,788) was $384 (**6**).

Based on this brief review, it is apparent that Alberta's per capita collision cost is significantly higher than the national average while the level of spending on Alberta's roads exceeds the national average. This could be partly due to the relatively 'new' nature of the Alberta network which requires a big capital investment each year compared to other provincial networks. It may also be partly due to Albertans driving a little more than the average Canadian each year. Current data shows that the average number of annual vehicle-kilometres driven per capita in Alberta is approximately 27% higher than that of Canada (**7**).

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The on going collision experience in Alberta raises the question about the cost-effectiveness of roadway investments currently being made in this province especially in regard to safety. This paper illustrates a process management approach to funding of Road Safety Initiatives in Alberta which is primarily geared to achieving the goal of maximizing the safety-cost-effectiveness of all highway investments.

2.0 Current Programs

AIT's current programs consist of a variety of categories covering all of the basic needs of a highway network that is aging as well as expanding. This includes the following umbrella categories: highway construction, highway rehabilitation, bridge rehabilitation, highway maintenance, motor vehicle operations management, driver programs (licensing, education etc) and grants to municipalities. Within these programs there is funding provided for safety initiatives such as highway lighting, traffic signals, rest areas, rumble strips, intersection improvements, pedestrian crossings, warning signs, pavement markings, railway crossing improvements, intelligent transportation initiatives etc. The level of funding provided for safety initiatives currently is somewhat changeable from year to year depending on other programming constraints. Furthermore, the distribution of funding among various safety initiatives, such as Rest Areas versus Highway Lighting, is often done on a subjective basis rather than being based on a rating system.
For candidate projects within the highway construction and highway rehabilitation programs, projects are currently rated against each other using a Comparative Rating System (CRS). This system considers safety performance, highway functionality, highway continuity, timing pressures due to technical needs (such as pavement distress or bridge condition etc) and other performance measures. Although safety is included in the CRS, many other considerations may override safety in the determination of ranking. The ranking is a technical tool for the programming process however there are many other inputs that affect the program also.

3.0 Consideration of Safety within Projects

Once projects are selected for the program, the preliminary engineering and detailed design processes get underway. While there are certain expectations for the level of expenditure on projects based on the type of work and the size of the project, there is also significant opportunity to enhance the safety of a highway through major improvements at the time of construction and/or rehabilitation. To minimize the occurrence of major scope changes at the detailed design stage (which is typically late in the programming process), the department has implemented a preliminary engineering process for roadways and bridges. This process includes preparation of reports for Geometric Assessment, Safety Assessment, Bridge Assessment etc as required. This process allows senior management and others in the department to take a first look at the nature of all projects and to come to a consensus on the type of work and the magnitude of the project to be undertaken. The main purpose of preliminary engineering activities is to proactively identify safety and other improvements so that the scope of work is determined accurately in advance of programming or at an early stage in the programming process. Prior to the advent of preliminary engineering the department frequently experienced difficulties trying to implement major safety improvements at a late stage due to timing pressures.

Preliminary engineering decisions are made based on the technical parameters of the project, the current operational experience (including safety), the service classification, traffic data, and technical information on adjacent projects as well as other programming inputs. Ideally, choices regarding major capital investments, for example whether or not to grade-widen, are made at the preliminary engineering stage. In some cases a preliminary engineering exercise may prompt a planning study if it is agreed that larger issues or a larger scope needs to be examined.

The department uses a Net Present Value Life Cycle Costing approach to compare various alternatives under consideration within projects. This methodology is documented in the department's Benefit Cost Analysis manual. All available capital, maintenance, road-user and residual costs (asset values) are considered. Expected collision costs (based on a combination of past experience and future predictions of collision rates), collision severities and frequencies are tabulated for each alternative under consideration. The collision cost is a component of the road-user costs. Other components include vehicle operation costs based on vehicle fleet composition, speed, distance, curvature, gradient, surface type and type of operation (free flow or otherwise).

On project analysis, all proposed improvements are compared to the "base" alternative. The base alternative is normally the lowest capital cost alternative that will satisfy the department's basic needs for the project. All costs and benefits for future years are discounted back to the current year at a discount rate of 4%. To be considered cost effective any alternative has to have an Internal Rate of Return of 4% at year 20 or the end of the life of the improvement (whichever is shorter). Also, when comparing alternatives, the higher Rate of Return will be a more desirable alternative (if all other factors are equal). In some cases the magnitude of the capital investment may be much greater for one alternative than for another (even though they have a similar Rate of Return). In these cases other economic indicators such as the "Payback Period", "Residual Value" or "Benefit / Cost Ratio" may also be considered in selecting the preferred option. Also, where there is a need to distinguish between options, safety benefits are sometimes given a "weighting" such as 2:1 when compared to non-safety benefits.

4.0 Consideration of safety in determination of program sizes

When determining the size of the various program categories within the transportation budget, a subjective evaluation of needs is undertaken. There is no engineering or analytical method applied to this process however there is an opportunity for proponents of any particular initiative to lobby for their project or program. This is normally done using the economic analysis tools available and/or through arguments regarding the need to "preserve the infrastructure" or "enhance safety".

5.0 A process to evaluate stand-alone safety improvements against each other

To facilitate the development of a comprehensive set of safety initiatives that are balanced as well as cost-effective, the department has adopted a Process Management approach. This is shown in Figure 1. This involved identifying a Top-Ten (initially) of safety initiatives using stakeholder input and then monitoring and documenting the various stages of development that have been undertaken to date with each initiative. The Inputs, Outputs and Outcomes from all initiatives are identified and quantified based on known data as well as "evidence-based" predictions of collision reduction effectiveness. The Outcomes for safety initiatives are expressed in net impact on annual number of fatal, injury and property damage collisions. This is also expressed in dollars.

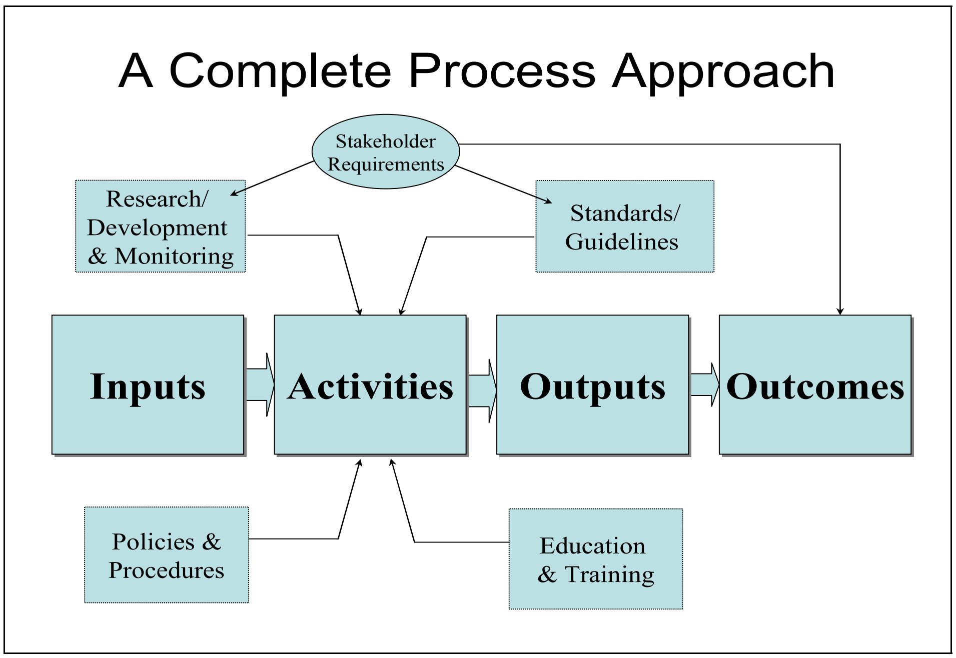

Figure 1 – A Complete Process Approach

A Process Management system requires the following elements for each initiative: Research & Development, Standards/ Guidelines, Policy & Procedures, Education & Training, Evaluation / Monitoring and Program (Implementation). Figure 2 shows this matrix for a selected number of safety initiatives that were investigated this year. Some initiatives have been fully developed to date while there are others that are at various stages of development. Also, there are many conceivable safety initiatives that have not been considered using the Process Management approach to date, for example Roadside Barrier improvements etc.

Innovative Proposals	Research/ Development	Standards/ Guidelines	Policy & Procedures	Education/ Training	Evaluation/ Monitoring	Existing Program
Centerline Rumble Strips	YES	YES	YES	YES	YES	YES
Shoulder Rumble Strips	YES	YES	YES	YES	YES	YES
Modern Roundabouts	YES	NO	NO	NO	NO	NO
Signal Improvement	YES	YES	YES	YES	NO	YES
Interchanges	YES	YES	YES	YES	NO	NO
Enhanced Pavement Markings	YES	YES	NO	N/A	NO	NO
Enhanced Warning Signs	YES	YES	NO	N/A	NO	NO
Roadway Lighting	NO	YES	NO	N/A	NO	NO
Safety Rest Areas	YES	YES	YES	YES	NO	NO
In-Vehicle Technology	YES	YES	YES	YES	NO	NO
All-Weather Resource Roads	NO	YES	NO	NO	NO	NO

Figure 2 – Safety Initiative Development

The department's Benefit Cost Analysis guidelines provide the economic tools to evaluate proposed improvements. Safety improvements may be evaluated and compared to each other based on their safety impact (cost-effectiveness) or their total economic impact on society (total societal cost-effectiveness). The latter method is a more balanced approach which is more consistent with the department's general philosophy of inclusion of all considerations in engineering decisions.

Some safety "improvements" may have a negative impact on road user costs. An example is the introduction of a lower posted speed limit over a segment of highway. Although this may reduce the severity and rate of collisions, it may also increase vehicle operating costs (fuel consumption and wear and tear), as well as driver and passenger time over the segment.

Other safety improvements such as the conversion of a signalised at-grade intersection to an interchange may have significant non-safety benefits such as reduced delay. Where traffic volumes are intermediate or high, the road user savings resulting from horizontal alignment improvements may dwarf any predicted safety benefits. It is clear from our experience that the inclusion of all benefits and costs will generally provide a more reliable result.

When comparing stand-alone safety initiatives that may be applied selectively or comprehensively throughout the highway network it is useful to develop formulae to compute the cost effectiveness based on a limited number of readily available parameters. These parameters generally include traffic volume, speed and collision experience. In this way a generic safety cost-effectiveness rating can be developed for each type of safety improvement, for example shoulder rumble strips or enhanced pavement markings. When recommending these types of improvements, more accurate cost-effectiveness indicators can be calculated based on the project specific parameters. This allows the most cost-effective initiatives as well as the most cost-effective locations to be given the highest priority for funding.

6.0 The most cost-effective safety initiatives (identified for the McDermid Report and Transport Canada's VISION 2010)

In 2005 Alberta Infrastructure and Transportation compiled information on a list of innovative safety initiatives for highway infrastructure that are intended to reduce the number and severity of collisions on Alberta's roads and streets. This work has been undertaken in response to the McDermid report entitled "Saving Lives on Alberta's Roads – Report and Recommendations for a Traffic Collision Fatality and Injury Reduction Strategy, June 2004" by Don McDermid. This report recommends that Alberta establish specific targets consistent with Transport Canada's Road Safety Vision 2010 (**8**) and report regularly on progress in achieving those targets. It also recommends establishing a sustainable source of ongoing funding for road safety initiatives in the province.

Specific targets have been developed for Alberta and these include a 30% reduction in fatalities and a 30% reduction in serious injury collisions by 2010 (compared to a baseline of 1996 – 2001). There are also a series of 16 sub-targets related to high risk behaviours, environments and/or drivers including the following: unbelted, speeding, intersection related, commercial vehicles, young drivers, rural highways, vulnerable road users and drinking drivers. The Alberta targets are a reduction of 116 fatalities and 880 serious injuries annually by 2010 (**4**). Many different initiatives involving enforcement, education and infrastructure etc, are under consideration to assist in achieving these targets. The initiatives discussed here are infrastructure based only.

Using the process management approach mentioned above, a number of high potential initiatives were identified as shown in Figure 3. The benefits in terms of safety impacts were estimated based on the current collision experience as well as "evidence-based" research on collision reduction. Many of these initiatives could be implemented with a large investment (giving a large coverage) or a smaller investment. The cost-effectiveness generally varies with the magnitude i.e. smaller magnitude has a higher cost-effectiveness etc. The magnitude of the recommended initiatives was selected based on practical limitations as well as cost-effectiveness i.e. generally all initiatives have a life cycle benefit/ cost ratio of at least two. Figure 4 provides an illustration of this for the recommended initiatives. This information is based on a five year improvement program however many of the benefits continue beyond five years (depending on the estimated life of the improvement).

Safety Initiatives to Achieve Targets

1. Rumble Strips on Shoulders to prevent Run-off-Road crashes
2. Rumble Strips on Centreline to prevent Left-of-Centre crashes
3. Improvements to Intersections – includes upgrades, roundabouts, signal improvements and grade-separations
4. Enhanced Pavement Markings
5. Enhanced Conspicuity of Warning Signs
6. Continuous Roadway Lighting between Cities and Suburbs
7. Upgrade Pedestrian Crossing Controls
8. Increased Safety Rest Areas
9. Provision of Safer Resource Roads
10. Intelligent Transportation Systems
11. In-Vehicle Technology (Advocacy only)

Figure 3 – Safety Initiatives to achieve McDermid targets.

5 Year Program Cost Effectiveness

#	Type of Collision	Potential % Reduction*	Total Cost (millions)	Projected Benefit (millions)	B/C Ratio (Life Cycle)
1	Run-off-Road	40%	$ 11.3	$ 360.0	49 (12)
2	Left of Centre	40%	$ 4.5	$ 35.5	6 (12)
3	Intersection	Variable	$ 140.0	$ 71.25	2 (20)
4	ROR/ LOC	5%	$ 33.9	$ 87.3	2.6 (4)
5	Warning	2%	$ 9.0	$ 37.2	6.6 (8)
6	Night time	25%	$ 18.76	$ 10.5	1.31 (20)
7	Pedestrian	10%	$ 10.0	$ 159.5	16 (4)
8	Fatigue	5%	$ 61.0	$ 61.0	2 (20)
9	Resource	N/A	N/A	N/A	N/A
10	All	3%	$ 105.0	$ 639.0	6.1 (10)
11	All	N/A	N/A	N/A	N/A
		Total	$ 393.5	$ 1461.3	Variable

**Potential % Reduction with related type of collision where the treatment is applied*

Figure 4 – Cost Effectiveness of Safety Initiatives

The projected annual crash reduction resulting from the various initiatives (if fully implemented) is shown in Figure 5.

Projected Annual Crash Reduction

#	Proposed Initiative	Fatals	Serious Injuries
1	Shoulder Rumble Strips	26	23
2	Centreline Rumble Strips	4	3
3	Intersections	7	60
4	Enhanced Pavement Lines	12	6
5	Enhanced Warning Signs	3	3
6	Lighting Commuter Hwys	1	1
7	Pedestrian Crossings	4	37
8	Safety Rest Areas	5	15
9.	Safer Resource Roads	N/A	N/A
10.	Intelligent Transportation	3	27
11.	In-Vehicle Technology	N/A	N/A
	TOTALS	65	175

Figure 5 – Projected Reduction in Collisions

The impact of these initiatives on the McDermid targets is shown in Figure 6.

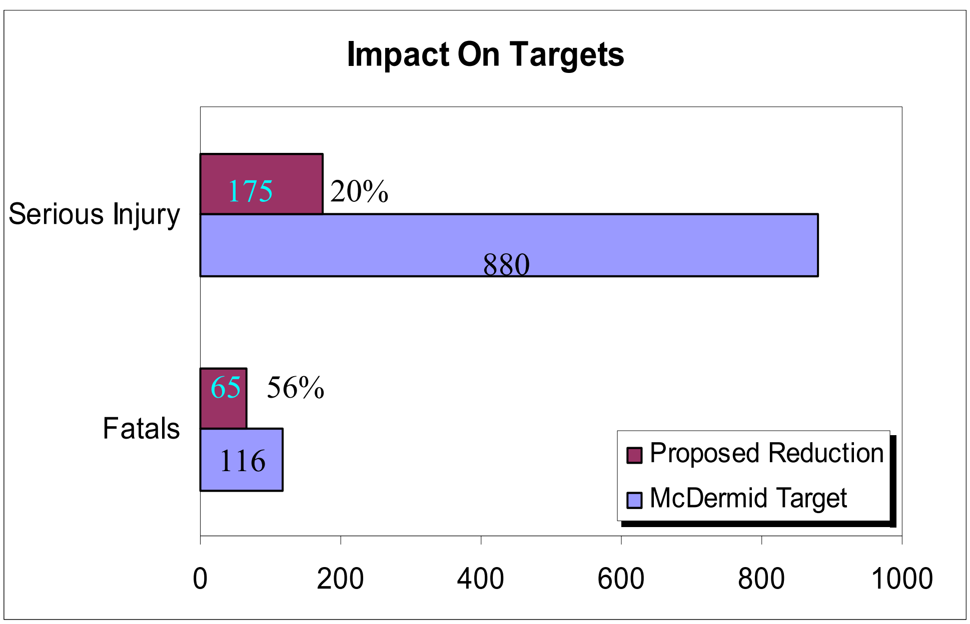

Figure 6 – Impact of safety initiatives on McDermid targets.

7.0 Conclusion.

There is a desire to fully implement a process management approach to fund safety projects in Alberta. While this is considered feasible for stand alone safety improvements, there is also a desire to fully integrate safety considerations into all program development processes. This is challenging as many programs are “driven” by other needs, such as the Pavement Rehabilitation Program and the Bridge Rehabilitation Program. In the case of the Pavement Rehabilitation Program, there is a perceived need to advance projects to preserve the existing structure. This may be based on a number of different performance criteria but roughness is generally the trigger. Consequently, programming decisions in pavement rehabilitation are generally independent of safety performance issues. Often there are other technical or safety needs on existing paved highways that should be considered together with pavement issues in development of the Pavement Rehabilitation Program. Currently the department is working on new systems to allow more issues (including safety) to be considered together with traditional issues in the program development process.

The department’s best go-forward plan on implementing a process management approach for funding road safety projects involves two steps as follows:

Step 1: Complete all of the activities required to support all stand-alone safety initiatives including Research & Development, Standards & Guidelines, Policy & Procedures, Education & Training, Evaluation & Monitoring and securing annual program funding.

Step 2: Using information and knowledge learned from step 1, integrate safety considerations together with all other considerations on an equitable basis in the development of all future department programs. The integration of various considerations to achieve a balanced program can best be achieved by using economics as the common basis.

Alberta Infrastructure and Transportation has used the process management approach effectively to implement various road safety projects and programs over the last 15 years. Road safety projects such as 3R/4R improvements, shoulder rumble strips, railway crossing improvement, safety rest areas, traffic operation safety improvements and other safety projects are now incorporated into Alberta Infrastructure and Transportation’s normal planning and programming process. AIT continues to adopt this approach to secure on-going annual funding for new safety projects throughout the highway network in an equitable and cost-effective manner.

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