road improvement program

20 years of improving communities in British Columbia | **1990 – 2010**

ICBC

building trust. driving confidence.

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Message from the President

2010 marks a significant milestone — the 20th anniversary of our Road Improvement Program. When ICBC first started investing in road infrastructure to improve road safety in British Columbia, no one could have envisioned the remarkable success the program has achieved to date.

By devoting dedicated funding to improving the safety of roads and intersections, the Road Improvement Program has become a vital element in improving traffic safety in communities across the province. Road safety engineering measures, funded by ICBC, have proven to be effective in saving lives and reducing injuries at high-crash locations and helping keep auto insurance rates low and stable.

Over the past 20 years the dedicated and hardworking team of road safety experts have built a program that not only makes our roads safer but have also established committed partnerships with B.C. communities based on a strong foundation and the mutual interest of reducing crashes.

The Road Improvement Program is also working with our community partners to ensure that safety is explicitly considered in the design and construction of new roads. The road safety audit's motto, "Prevention is better than cure," is one of the keys to safer roads and lower insurance rates.

Engineering solutions will remain a key strategy in making B.C. roads as safe as possible. Infrastructure improvements will work in synergy with ICBC's road safety programs targeting drivers and vehicles. In addition, thanks to our strong partnerships with local governments, the Ministry of Transportation and Infrastructure, and other road authorities every resident and visitor will benefit from safer roads.

Congratulations to the Road Improvement Program team on this significant milestone.

Jon Schubert, CMA
President and Chief Executive Officer

Acknowledgements

The ICBC Road Improvement Program would like to thank our partners for their participation over the past 20 years.

Government of Canada
Ministry of Transportation and Infrastructure
TransLink
BC Ferries
District of 100 Mile House
City of Abbotsford
Village of Alert Bay
Village of Anmore
City of Armstrong
Bowen Island Municipality
City of Burnaby
Village of Burns Lake
Village of Cache Creek
City of Campbell River
City of Castlegar
District of Central Saanich
Village of Chase
District of Chetwynd
City of Chilliwack
Village of Clinton
City of Colwood
Town of Comox
City of Coquitlam
City of Courtenay
Cowichan Valley Regional District
City of Cranbook
Town of Creston
City of Dawson Creek
Dease Lake
Corporation of Delta
City of Duncan
City of Enderby
Township of Esquimalt
City of Fernie
Town of Fort Nelson
District of Fort St. James
City of Fort St. John
Four Mile Lake
Village of Fraser Lake
Village of Fruitvale
Town of Gibsons
Village of Gold River
City of Grand Forks
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Town of Lake Cowichan
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Township of Langley
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District of North Cowichan
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District of Oak Bay
Village of Old Masset
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Village of Pemberton
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City of Pitt Meadows
City of Port Alberni
Village of Port Alice
Village of Port Clements
City of Port Coquitlam
District of Port Edward
District of Port Hardy
Town of Port McNeill
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City of Powell River
City of Prince George
City of Prince Rupert
Town of Qualicum Beach
Village of Queen Charlotte
City of Quesnel
Village of Radium Hot Springs
City of Revelstoke
City of Richmond
City of Rossland
District of Saanich
Village Salmo
City of Salmon Arm
Village of Sayward
District of Sechelt
District of Sicamous
Village of Skidegate
Village of Slocan
Town of Smithers
Township of Spallumcheen
District of Sparwood
District of Sooke
District of Squamish
District of Summerland
District of Stewart
City of Surrey
Village of Tahsis
District of Taylor
Village of Telkwa
City of Terrace
District of Tofino
City of Trail
District of Ucluelet
Village of Valemount
City of Vancouver
District of Vanderhoof
City of Vernon
City of Victoria
Town of View Royal
District of Wells
District of West Kelowna
District of West Vancouver
City of White Rock
City of Williams Lake

Acknowledgements

John Pump
Manager
Road Improvement Program

I would like to take this opportunity to thank the many people involved with the Road Improvement Program for their support, contributions, and on-going dedication and hard work toward making the roads of B.C. safer.

The completion of this publication was made possible with the talents of our publishing department, the generous donation of the unique cover materials by 3M Canada, and the photography by Geoffrey Ho.

A special thank you to the RIP Team of road safety engineers, who work with our many partners solving road safety problems across British Columbia.

David Dean, P.Eng., joined the Program in 2003. He is responsible for the North/Central Interior and Southern Interior Regions.

Dr. Paul de Leur, P.Eng., joined the Program in 1998. He is responsible for the Provincial program with the Ministry of Transportation and Infrastructure.

David Hill, P.Eng., joined the Program in 2000. He is responsible for the Fraser Valley Region.

Geoffrey Ho, P.Eng., joined the Program in 1999. He is responsible for the Road Safety Audit Program.

Alison Wong, P.Eng., joined the Program in 1998. She is responsible for the Lower Mainland Region.

Julian Rozental, P.Eng., joined the Program in 2000. He is responsible for the Vancouver Island Region and the Modern Roundabout Program.

Where do we go from here?

Nicolas Jimenez
Director of Road Safety

In 2010, the United Nations General Assembly proclaimed 2011 to 2020 as the Decade of Action for Road Safety to encourage global effort to reverse the increasing global trend in road traffic deaths and injuries. This important declaration recognizes the alarming human and economic consequences of traffic crashes around the world.

In B.C., we're not insulated from these global trends or impacts. Traffic casualties in our province are significant and often tragic — some 400 British Columbians die and more than 70,000 are injured each year on our roads. It's why ICBC committed itself many years ago to respond to this enormous challenge. For almost 30 years, ICBC has been at the forefront in developing road safety programs to address road related risks. Working with many others in B.C. (including police, the provincial government, communities, individuals), together we've helped save numerous lives and prevent untold injuries, which has at the same time allowed us to maintain affordable, universal auto insurance.

ICBC embraces a "systems approach" to road safety, one that accounts for the needs, mistakes and vulnerabilities of road users. A key pillar of this strategy is our "roads" portfolio. For over 20 years, ICBC's Road Improvement Program has partnered with the provincial and municipal road authorities to build safer roads and fix high-crash-locations. In all, we've invested about $100 million to make our communities safer.

Looking ahead to the Program's next decade, much will change in B.C. when it comes to driving, including:

- population growth and densification of urban areas
- emergence of vehicle technologies (crash avoidance, telematics, safety features)
- increased use of data and analytics to change driver behaviour
- major infrastructure investments such as the Gateway Program
- growth of sophisticated policing tools and strategies
- continued evolution of legislative approaches to addressing road risks.

All will change how drivers, roads and vehicles interact with one another, meaning we have to adapt our strategies too. We cannot rest on 20 years of success in the Road Improvement Program (or our entire road safety program for that matter). Instead, we will challenge ourselves to find new approaches that evolve our understanding of road technologies and countermeasures. And we will look for creative ways to integrate this work with other road safety initiatives, including driver-based awareness and enforcement programs and safer vehicle initiatives. The task ahead is significant, but the consequences of inaction are too great to do anything less than give our best effort.

Prince Michael
INTERNATIONAL
ROAD SAFETY AWARDS

Milestones of the Road Improvement Program

1990 – The Road Improvement Program (RIP) was formally established by ICBC. Mavis Johnson was in charge of getting the program up and running.

1992 – The first road safety improvements were funded by ICBC at the intersection of Holdom Avenue and Broadway in Burnaby. The total investment was $80,000, and involved the funding for a new traffic signal.

1994 – ICBC in association with the City of Vancouver and Hamilton Associates received the Technical Achievement Award for the Knight Street Corridor Project from the Institute of Transportation Engineers Vancouver Section.

1995 – The total budget for the Road Improvement Program exceeded $1 million.

1996 – ICBC received the Edmund R. Ricker Traffic Safety Award from the Institute of Transportation Engineers for providing funding to road authorities to study traffic safety, install preventative devices, and improve roadways.

1997 – The first evaluation of the program was conducted using projects funded between 1993 and 1995, the evaluation estimated that the program achieved a benefit to cost ratio of 6.8 to 1, i.e. for every dollar invested ICBC received $6.8 return due to a decrease in crashes.

1998 – The Stop Sign In-fill (SSIF) Program was established to fund the conversion from uncontrolled residential intersections to two-way Stop controlled intersections in an alternating pattern in residential neighbourhoods. The SSIP reduced on average approximately 50 per cent of crashes in the neighbourhoods.

1998/9 – The core of the RIP Team of road safety engineers was formed. As the program and the number of partners grew over the years, it was recognized that more road safety engineering expertise was needed to service the program. Road safety engineers were brought into the RIP to service specific areas of the program.

1999 – The Sign Upgrade Program was established to fund the upgrading of regulatory and warning signs from engineering-grade to highly reflective grade sheeting that is approximately 10 times brighter. This program targeted nighttime crashes, because nighttime crash rates are typically more than three times higher than the daytime crash rate.

2000 – The first modern roundabout funded by ICBC was built in the Town of Ladysmith at the intersection of First Avenue and Symonds Street.

2001 – Started the Traffic Signal Upgrade Program in conjunction with the BC Power Smart Program. Typically a three-way partnership between BC Hydro, a Road Authority, and ICBC cost shared in upgrading traffic signals with 300mm LED displays. The upgrade provides better reliability and conspicuity for the traffic signal and consumes less power.

2002 – ICBC received the Prince Michael International Road Safety Award.

2004 – With technical assistance from the Road Improvement Program, the Ministry of Transportation and Infrastructure implemented a Policy to conduct Road Safety Audits for Ministry projects. This policy is the first of its kind in Canada.

2006 – The Enhanced Curve Delineation Program began. It provides funding to install reflective markers along tight horizontal curves throughout the province.

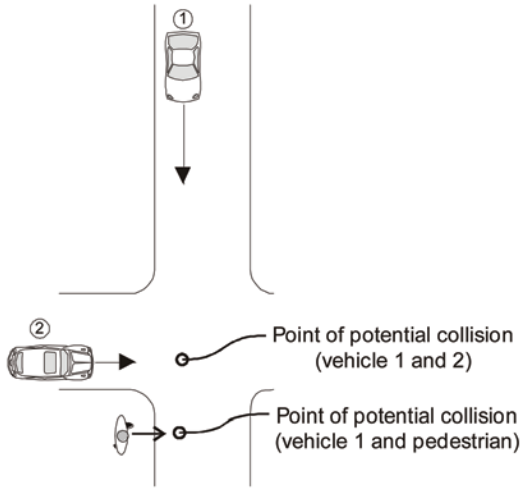
2007 – With technical assistance from the Road Improvement Program, the Ministry of Transportation and Infrastructure implemented a Policy for the implementation of modern roundabouts for Ministry projects.

The First 10 Years:
A Decade of Progress

Geoffrey Ho, P.Eng., Road Safety Engineer
Road Improvement Program

The first 10 years of the Road Improvement Program were focused on developing components of the Program that would eventually form the backbone of today's success.

The Program started as a series of cooperative projects between ICBC, the University of British Columbia (UBC) and interested municipalities. Peter Cooper, who was ICBC's Manager of Traffic Safety Research Department at the time, commissioned Drs. Frank Navin and Gerry Brown of UBC to develop a field-based observation diagnostic tool to identify safety problems at intersections, called the traffic conflict technique.



Concept of a Traffic Conflict

Subsequently, two engineering consulting firms were trained by UBC to conduct the traffic conflict technique. ICBC offered the services of the trained consultants to interested municipalities at 50 percent of cost to conduct diagnostic studies.

Over time, ICBC recognized the need to make limited funds available to assist in mitigating safety problems identified by the diagnostic studies. This proposal was supported by Executives and the Board, and the Road Improvement Program formally emerged in 1990 and Mavis Johnson was given the task of managing the Program under Road Safety Strategic Initiatives. Under the thoughtful guidance of Mavis Johnson, the Program underwent significant expansion in terms of the number of studies, the amount invested in road improvements, and the coverage of the Province in the 1990s.

From a few interested municipalities in Metro Vancouver and on Vancouver Island, the Road Improvement Program started a partnership with the Ministry of Transportation and Highways to invest in rural communities by the mid-1990s. During this time, the Program relied on the technical expertise of the two engineering consultants Delcan Corporation and Hamilton Associates, and in turn the engineers of these firms gained valuable experience in road safety engineering that was also applied to their day-to-day work.

By the late 1990s it became obvious that the administrative and technical requirement of the Road Improvement Program had grown significantly and was in need of help. Mavis Johnson began assembling the RIP Team to take on various responsibilities within the Program. Many of the members who are still with the RIP Team today joined the Program during this time.

The 1990s saw a tremendous amount in growth in the safety awareness of the B.C. engineering community. Funding for research at UBC help provide a stream of young and eager engineers well-trained in road safety engineering. Ideas to improve road safety were explored and exchanged between ICBC and the partners. Significant improvements were made to locations with chronic safety problems. British Columbia and ICBC were the talk of the country at any given engineering conference, with practitioners from other provinces envious of the contribution the Road Improvement Program had made.

84th Avenue and 168th Street, Surrey
New traffic signal, and left turn lanes

The Second 10 Years: A Decade of Investing in Communities

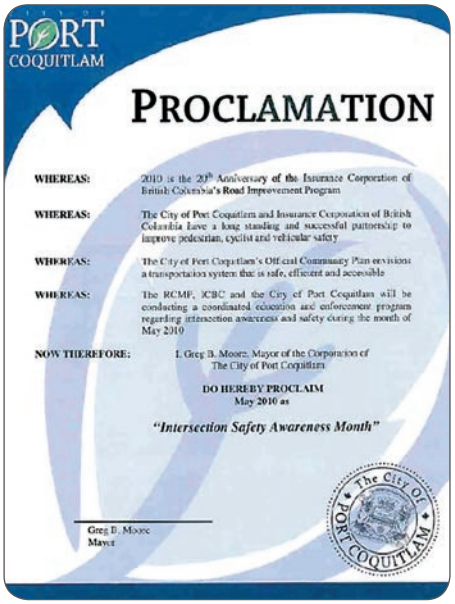
John Pump, Manager
Road Improvement Program

While the first 10 years of the Road Improvement Program focused on defining and establishing various aspects of the program, the second 10 years shifted its focus on building partnerships and investing in British Columbia communities using the strong foundation built in the first 10 years.

The funding for the Program stabilized during the past 10 years and enables ICBC to provide sustainable funding. At the same time, the program expanded the resources available to the various regions by expanding the RIP Team. Each ICBC region has a designated road safety engineer serving its specific needs. The road safety engineers also work with other ICBC departments on road safety matters, attend local road safety committee meetings and provide valuable technical guidance. At the same time, the road safety engineers work closely with the municipal partners on identifying and funding projects that best serve the local community's needs. This has enabled the RIP to solidify its position with its local partners, and many municipalities also rely upon the guidance and funding provided by ICBC on improving their infrastructure.

Another important initiative was establishing a long-standing partnership with the Ministry of Transportation and Infrastructure. In many instances, particularly in smaller municipalities, the more prominent safety issues occur along the provincial highways. Through this partnership with the Ministry, the RIP is able to facilitate commitments from the Ministry and the local governments towards addressing road safety issues and providing funding for improvements.

Many of the Program's partners have expressed appreciation towards ICBC's commitment to improving road safety in their municipalities. For example, the City of Port Coquitlam proclaimed May 2010 as "Intersection Safety Awareness Month" in recognition of the outstanding contribution of ICBC to the City.


PORT COQUITLAM

PROCLAMATION

WHEREAS: 2010 is the 20th Anniversary of the Insurance Corporation of British Columbia's Road Improvement Program

WHEREAS: The City of Port Coquitlam and Insurance Corporation of British Columbia have a long standing and successful partnership to improve pedestrian, cyclist and vehicular safety

WHEREAS: The City of Port Coquitlam's Official Community Plan envisions a transportation system that is safe, efficient and accessible

WHEREAS: The RCMP, ICBC and the City of Port Coquitlam will be conducting a coordinated education and enforcement program regarding intersection awareness and safety during the month of May 2010

NOW THEREFORE: I, Greg B. Moore, Mayor of the Corporation of The City of Port Coquitlam

DO HEREBY PROCLAIM May 2010 as

"Intersection Safety Awareness Month"

Greg B. Moore
Mayor

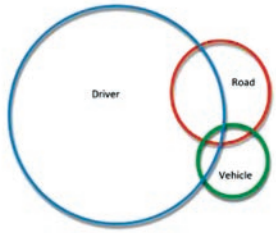
The City of Port Coquitlam

The Importance of Engineering in Improving Road Safety

Paul de Leur, Ph.D., P.Eng., Road Safety Engineer
Road Improvement Program

The Road in Road Safety

The fundamental components related to crash causation, namely the driver, the vehicle and the road, and the interaction of these components is the basis for all road safety programs and initiatives. Many researchers have studied and quantified the relative contributions from the three components, which conclude that the driver is the dominant factor in crash causation, as illustrated in the figure below, and the corresponding estimates of contributions.



Component	Contribution
Driver Only:	67%
Road Only:	3%
Vehicle Only:	3%
Driver + Road:	23%
Driver + Vehicle:	3%
Driver + Road + Vehicle:	2%
TOTAL Driver:	95%
TOTAL Road:	28%
TOTAL Vehicle:	8%

Contributing Factors to Crashes

Although the driver is clearly the culprit in the mechanisms that lead to crash occurrence, the road is also an important component, contributing at least in part, to one in four crashes. Since roads are designed and created by engineers, they must accept the burden and responsibility of a less than desirable level of crash contribution. However, this scenario creates a challenge and opportunity for the engineering discipline to explicitly address the issue of road safety.

Engineering for Road Safety

Traditionally, road safety has been incorporated into the design process by following road design standards, where road safety needs are **implicitly** considered. However, safety issues can arise even if a road design project has strict adherence to the applicable design standards.

- **Desirable versus minimum standards:** Design standards are typically limit standards, where designers must meet a minimum design value. Often, this minimum standard is far from ideal to achieve desirable levels of safety for a road design.
- **Combination of standards:** Some individual design standards may appear to provide an adequate level of design, but the combination of design standards may introduce safety concerns, especially when the minimum standards are combined.
- **Age of the standards:** Over time, components of the road system will change and it is quite common for design standards to lag behind the latest research that relates road safety performance with specific design features.

The traditional road design process has created the opportunity for roadways to be designed and built, which may not be optimal from a road safety perspective, recognizing that there are objectives other than safety, that a road authority must balance in the road design process, such as mobility, environmental constraints, economic development and so on. Fortunately, in the past 20 years, the discipline of Road Safety Engineering has emerged and is infiltrating the road design process, such that safety performance is becoming more of an **explicit** consideration.

An explicit safety evaluation facilitates the quantification of the safety impacts associated with roadway engineering. Quantifying safety impacts supports the road design process by allowing decision makers the opportunity to analyze safety benefits in relation to the project cost. This "trade-off" analysis allows for the justification and rationalization of infrastructure investment.

Recent developments in the area of road safety engineering are emerging that can facilitate the explicit consideration and quantification of the safety impacts of road design decisions. This includes the use of crash prediction models (CPMs) and crash modification factors (CMFs), which were used in the assessment of the safety performance of the Sea to Sky Highway Improvement Project. Engineering judgment will still be required in the design process, but it is believed that these new techniques will complement traditional design approaches. Furthermore, the ability to quantify the safety impacts of design decisions is viewed as superior to the subjective nature of the traditional approaches.

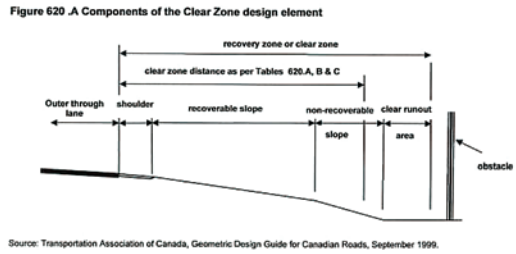
Sea to Sky Highway Improvement Project

Engineering Improved Road Safety

As discussed, the road safety engineering discipline is encouraged by the advancement into the road design process and hopes that road safety will improve as safety engineers make an impact in the design process. However, the amount of new road construction in relation to the amount of existing road is very small. As such, it is imperative that road safety engineers also focus on existing roadways, which is generally the focus of ICBC's Road Improvement Program.

Engineers are typically considered to be evidenced/numbers based individuals, who often rely on empirical research to support decision-making. This is no different for the Road Safety Engineers working in support of ICBC's Road Improvement Program. The RIP engineers make use of information that describes the potential for crash reduction associated with the various road-engineering improvements that can be made to existing roadways by partnering road authorities.

Road safety engineering interventions can be very effective in reducing crashes and in fact, can compensate for driver mistakes, such as the concept of "designing forgiving roadways". This is where a road is designed to allow for some level of driver error, such as the clear zone design, where a roadside is designed to be safe (i.e., traversable and clear of any roadside hazards) in the event that a diver makes a mistake and enters the roadside.



Forgiving Roadway: Clear Zone Design

Many road safety-engineering measures are likely to be 'invisible' to most drivers, such as a roadway crown or cross-fall, designed to allow for proper road drainage or the super-elevation designed in horizontal curves on a high-speed facility, to allow for improved vehicle control. Other road safety engineering interventions are much more obvious to the road user such as geometric design, improvement to the roadway cross-sectional elements (lane width, shoulder width, etc.), traffic control, barrier systems, delineation, signing, among others.

Crash and Speed warning system

Although these roadway safety devices seem simple, there are constant improvements, utilizing new technology, such as the use of high conspicuity LED chevron signs that can be placed in areas where visibility can be reduced to help motorists navigate safely. Or the crash prone location signing with a speed warning system designed to interact with the driver to notify them when there speed is excessive.

LED chevron signs lit during fog

Summary

Road safety engineering is critically important in the overall management of road safety. The road component and thus, the engineering element, is a contributing factor in at least one in four crashes. The explicit consideration of safety requirements within the road engineering and design process has been improving and in time, will prove to be an effective and proactive process to improve safety. Similarly, the importance of road safety engineering for existing roads in operation cannot be understated. Significant safety benefits can be realized when engineering interventions are effectively targeted at existing road safety problems. Engineering efforts in support of both proactive and reactive initiatives undertaken within ICBC's Road Improvement Program has, and will continue to produce an improved level of safety on the roadways within British Columbia.

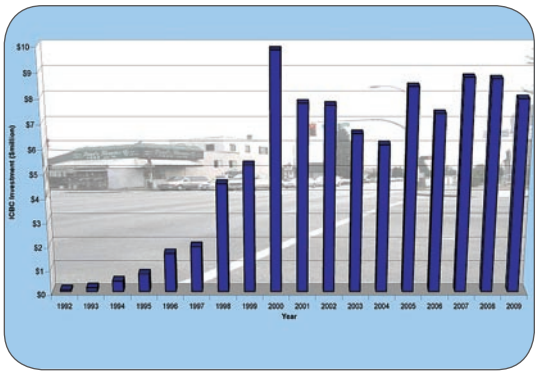
Investment and Achievements

Geoffrey Ho, P.Eng., Road Safety Engineer
Road Improvement Program

Over the past 20 years, ICBC has invested about $100 million in road improvements to reduce the frequency and severity of crashes that occur on the B.C. road network. The program began with an $80,000 investment at the intersection of Holdom Avenue and Broadway in Burnaby in 1992. The annual amount of investment reached its peak in year 2000 with approximately $10 million invested. In recent years, between 2005 and 2009, the level of investment by ICBC has stabilized at about $8 million per year.

More importantly, over the past 20 years, the amount of funding that was leveraged by ICBC funding for road safety improvements grew significantly over this period.

The investment criteria for ICBC also changed over the past two decades. For the first 11 years of the program, the amount of ICBC investment was calculated based on a return on investment of 2 to1 over two years. Between 2002 and 2004, the investment criteria were changed to a return of 3 to 1 over two years. In 2005 the investment criteria was changed again to an internal rate of return of 50 per cent over the service life of the improvement. The service life ranges between two years and 10 years. The latest investment criteria continue to be used to the present, and are reflective of ICBC investing in larger regional projects to become more synchronized with the shift in strategic changes in capital investment by our partners in the region.



ICBC investment:1992 to 2009

The effectiveness of the Road Improvement Program has been evaluated on a regular basis using state-of-the-art evaluation techniques. The program was evaluated in 1997, 1998, 1999, 2001, 2006 and 2009. The results found consistently positive returns on investment in road improvements, and confirmed that safer road infrastructure is an excellent investment for ICBC. Benefit to cost ratios of between 4.4 to 1 and 8 to 1 were found in the evaluations, demonstrating that the program continues to be highly effective and investing in road improvement provides a sustainable way of managing road safety.

A Successful Partnership:
Working Together with the Ministry of Transportation and Infrastructure

Dirk Nyland, P.Eng., Chief Engineer
Ministry of Transportation and Infrastructure

A Model Road Safety Partner

The Ministry of Transportation and Infrastructure and ICBC have demonstrated a model partnership in improving road safety through the Road Improvement Program. Since 1995, this formal partnership has evolved from the Road Sense Program in which ICBC contributed to low-cost highly effective safety projects to the more diverse and larger scale projects under the Road Improvement Program. The mutual goal to make roads safer has most importantly benefited the road users in terms of injury prevention in addition to reducing societal costs.

Since 2000, over 600 highway safety improvement projects were completed in funding partnership with ICBC. Contributions were made to road safety projects that ranged from replacing existing signs with higher grade reflective sheeting to major capital projects like Highway 1 in Kicking Horse Canyon, located east of Golden in the Southern Interior of B.C. On a yearly basis, ICBC contributed in the range of $2.5 – $ 3.5 million to Ministry projects under operational program areas such as: Rehabilitation, District Betterments, Heartlands/Oil & Gas, Mountain Pine Beetle, Capital, Signal Upgrade, Strategic Highway Improvement, Border Improvement, and Safety Studies.

A Partnership Project

ICBC has been a strong funding partner for various counter-measures targeted towards the reduction of off-road and crossover-type crashes on provincial highways. These measures included roadside and median barrier as well as the installation of shoulder and centreline rumble strips. Of these, the project with the highest visible success rate has been the installation of a median cable barrier.

In 2007, the Ministry installed the very first median cable barrier on Highway 1 near Chilliwack to reduce median cross-over crash severity. Cable barrier consists of tensioned steel wire ropes mounted on frangible posts. It is designed to prevent an errant vehicle from striking an oncoming vehicle which could potentially be fatal.

Median Cable Barrier – Highway 1 near Chilliwack

Since its installation, there have been numerous impacts to the median cable barrier which have prevented potential fatal crashes. The cable barrier has performed very well. The key benefit of the cable system is its ability to capture or redirect vehicles, and reduce forces on the vehicle occupants which reduces the probability of injury. The positive results from using cable barrier have created wider interest and consideration throughout the province. Currently, additional median cable barrier project are under way. These projects provide ICBC with a high rate of return on their investment.

Supporting Research & Development

Besides typical road safety projects, ICBC has been a strong partner in developing engineering tools and improving the road safety engineering profession and practice. The Ministry's Crash Prediction Models for British Columbia and the Crash Modification Factors for British Columbia,

document emerging methodologies that approach safety proactively and ensure that road safety is an explicit priority in transportation planning and design. ICBC was a funding partner in completing the above reports and later sponsoring workshops for many Ministry staff and Consultants.

Influence in Development of Ministry Policies

Road Safety Audit

ICBC was instrumental in the early stages of introducing road safety audits to the province and brought in national and international experts to share their knowledge from which many Ministry staff and Consultants benefited.

The Ministry developed their Road Safety Audit policy in 2004. A road safety audit is a formal and independent safety performance review of a road transportation project by an experienced team of safety specialists, addressing the safety for all road users.

Every Ministry of Transportation and Infrastructure road project over $100,000 meeting the criteria outlined in the policy document is subject to a safety audit at the appropriate stages.

Road Safety Audit – Highway 1 – Clayburn Road to Harris Road

Roundabouts

ICBC actively promoted roundabouts throughout the province. In 2004, the Ministry introduced their roundabout policy. The modern roundabout has been successfully implemented in countries throughout the world. Benefits that have been realized by both transportation officials and road users include reduction in the severity of crashes, reductions in vehicular delays and reduced greenhouse gas emissions. Roundabouts also continue to effectively move traffic during power outages.

Roundabouts – Highway 1/ Mt Lehman interchange

The Ministry's policy is to consider a roundabout as the first option for intersection designs where a greater degree of traffic control than a two-way stop is required. It also states that roundabouts shall be considered on all roadways including high speed (70 km/h or greater) corridors. Roundabouts may be considered for intersections with interchange ramps.

To date, fourteen roundabouts have been built on roads under the Ministry's jurisdiction. Seven more are in the design and construction phases.

Moving Forward

The ICBC's Road Improvement Program is a positive example for the Provinces and Territories across the country. With ICBC's contributions, the Ministry was able to advance more safety projects. These projects improved road safety at many intersections, highway sections, and bridges throughout the province and also helped ICBC manage escalating claims costs.

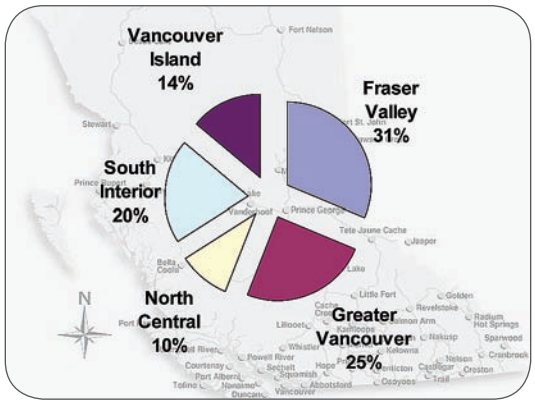
This strong partnership should continue to further the safety mandates of both agencies. Together, and through coordinated efforts in engineering, enforcement and education, more will be achieved in the future to make our roads safer.

Working with Our Communities

David Dean, P.Eng., and David Hill, P.Eng.
Road Safety Engineers
Road Improvement Program

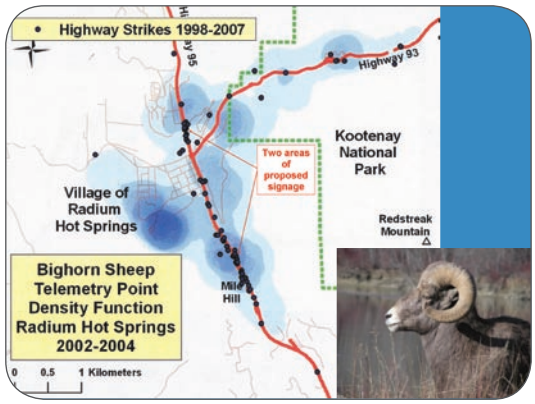
The Road Improvement Program works with its municipal partners in order to reduce crashes at high-risk road locations and to encourage a higher priority to infrastructure projects that will reduce crashes. In the past 10 years ICBC has invested significantly in road safety engineering partnerships with municipalities throughout the province in order to reduce the frequency and/or severity of crashes and reduce claims costs.

The Road Improvement Program meets its objectives by assisting the municipalities in a number of ways:



Proportion of RIP Funding by Region, 2005 – 2009

- Helps identify high-crash locations by providing crash data and tools for analysis;
- Encourages municipalities to explicitly utilize road safety as a criteria for prioritizing road improvement funding;
- Encourages municipalities to expand proposed road improvements to include safety upgrades;
- Assists with funding of studies at high-crash locations to identify countermeasures that would reduce crashes;
- Assists with funding road safety improvements based on an expectation of crash reduction and reduced claims costs;
- Offers set programs known to improve safety including sign upgrades, traffic signal head upgrades, enhanced curve delineation, skid-resistance surfacing, STOP sign in-fill, traffic calming, and shoulder / centre-line rumble strips;
- Provides technical assistance for the planning and design of modern roundabouts, as well as construction cost sharing; and
- Provides independent audit teams to undertake road safety audits on key road design and construction projects.



Highway 95, Radium Hot Springs " Big Horn Sheep" warning signs

The assistance from the Road Improvement Program is particularly invaluable to smaller communities where resources are lacking to effectively deal with road safety issues. In association with other regional and local ICBC departments around the province, the Road Improvement Program helps to raise the profile of road safety in the public eye.

Road Improvement Projects occur throughout the province yielding benefits to all B.C. motorists.

It is my pleasure to sincerely thank ICBC for delivering and funding the Road Improvement Program over the last twenty years. I have applied for funding from this program during that period and been very pleased at the professional manner in which ICBC staff have reviewed, discussed, inspected, evaluated and approved projects and final payments.

The majority of the projects that I have presented would not have been approved in the municipal budget nor constructed without the contributions received from the program. The continued involvement by ICBC in providing the Road Improvement Program has ensured that where road safety concerns have been identified and solutions evaluated that a positive and sustained improvement in road safety has materialize.

I would also compliment ICBC staff on their continued support while working with local government and the RCMP on traffic and road safety committees.This has been a great asset in delivering engineering, education and enforcement programs for road safety in a very effective way.

Kevin Lagan, P.Eng.
Director of Operational Services,
Operational Services Department,
City of Courtenay

Knight Street Corridor, Vancouver A Commitment to Improving Road Safety and Partnership

Alison Y. Wong, P.Eng., PTOE, Road Safety Engineer
Road Improvement Program

The Knight Street Corridor located in the City of Vancouver is a major north-south arterial street in the city and is a major truck route. It has long been one of the corridors in B.C. that has the highest crash occurrences. The Road Improvement Program has worked diligently with the City of Vancouver to invest in improving the safety of the corridor since the early 1990s.

Below is a brief recap of the working history and potential partnerships for the future:

1991 / 1992 – Conducted the Knight Street Corridor Traffic Operational and Safety Review to identify problematic locations, safety issues concerning these locations, and to map out an improvement strategy that has spanned almost two decades. One of the major safety problems along the corridor was the lack of exclusive left-turn lanes resulting in high frequency of rear-end and left-turn related crashes. The improvement strategy identified for the long term was to implement left-turn lanes at major signalized intersections along the corridor subject to major land acquisition.

1993 / 1994 – ICBC invested a total of $103,400 for various improvements, including additional traffic signal heads, installing raised pavement markers, and minor improvements at various intersections.

Tertiary signal head shown on the right hand side

1995 – ICBC invested $100,000 for the construction of exclusive left-turn lanes at the Kingsway intersection.

1997 – ICBC invested $35,000 for the construction of eastbound and westbound left-turn lanes at the East 57th Avenue intersection.

1999 – ICBC invested $250,000 for the construction of exclusive left-turn lanes at the East 41st Avenue intersection.

1999 – ICBC invested $100,000 for the construction of northbound and southbound left-turn lanes at the East 1st Avenue intersection.

2005 – ICBC invested $115,000 for the construction of exclusive left-turn lanes at the East 6th Avenue intersection, and another $24,000 at the Kingsway intersection for the construction of a centre median along Kingsway.

2007 – ICBC invested $250,000 for the construction of exclusive left-turn lanes at the East 49th Avenue intersection.

ICBC, through the Road Improvement Program, has invested approximately $1 million in improving the safety of the Knight Street Corridor over the past 20 years.

The next step will be working with the City to add left-turn lanes to the northbound and southbound directions at the East 57th Avenue intersection, and to add left-turn lanes to the East 33rd Avenue intersection. Minor improvements to the curvilinear section between East 54th and East 57th Avenues are planned, as well as the installation of a centre median (with new design and access management) between East 14th Avenue and Kingsway.

Knight Street at 49th Avenue: Before and After left-turn lane installation

Municipal Road Safety Audit (RSA) Program

Geoffrey Ho, P.Eng., Road Safety Engineer
Road Improvement Program

ICBC, through the Road Improvement Program, has been promoting the benefits of Road Safety Audits since 1997. A road safety audit is defined by the Canadian Road Safety Audit Guide (TAC, 2001) as:

> *A formal and independent safety performance review of a road transportation project by an experienced team of safety specialists, addressing the safety of all road users.*

It can be seen from the definition that the road safety audit is a very important proactive tool to make sure that road transportation projects are designed and constructed to the highest level of safety possible within the constraints of the project to reduce the frequency and severity of crashes. The RSA focuses on all road users, and plays an important part in providing a sustainable transportation network.

ICBC's Road Improvement Program has sponsored a number of research papers, projects, seminars and workshops with the assistance of local road safety engineering consultants and international road safety audit experts from the United Kingdom, New Zealand and Australia. As a result of ICBC's promotional and advocacy efforts and with assistance from ICBC, the Ministry of Transportation initiated a Pilot Project to evaluate the RSA process in 1999, and subsequently implemented a road safety audit policy for Ministry projects in 2004.

A road safety audit aims to ensure that a clear message is delivered to all road users.

Most local municipalities have limited resources to conduct road safety audits, thus limiting the application of an effective and proactive road safety engineering tool. In 2001, ICBC started a Municipal RSA Program to partner with British Columbia municipalities to conduct road safety audits, with the long-term goal of incorporating RSA as part of the process in the delivery of road transportation projects for municipalities in British Columbia. The road safety audits were conducted by the road safety engineers of the RIP.

Road Safety Audit: Before and After, River Road in Delta

Between 2001 and 2009, the ICBC RSA Program had audited a total of 155 road transportation projects in various stages of design. The municipal partners showed continued demand for road safety audits, and the process is becoming more widely accepted. For more complex municipal projects, road safety audit is becoming more common place as part of the project delivery requirements.

The type of projects audited by the ICBC program includes:

- new road construction projects
- development-driven projects
- major reconstruction projects
- widening projects
- traffic calming projects
- rehabilitation and retrofit projects

ICBC would like to thank the municipal partners who participate in the RSA Program for their continued support.

Modern Roundabout Program

Julian Rozental, P.Eng., Road Safety Engineers
Road Improvement Program

The beginnings of the ICBC Modern Roundabout program can be traced back to approximately 1997 – 1998 as a result of interaction with safety experts from Europe and Australia, who were reporting significant safety benefits in their countries resulting from the implementation of modern roundabouts.

At the time, interest was slowly emerging amongst professionals in North America, despite historical scepticism resulting form failed experiences with large rotary intersections. The experiences with "rotary" intersections of the 50s were considered to be a major obstacle in the way of re-introducing a new type of "circular" intersection. There was further confusion between the Modern Roundabout and the "traffic calming circles" which were appearing concurrently.

There were many in British Columbia (and elsewhere) who were pointing to the "Edmonton experiment" with rotary intersection as "proof" that Modern Roundabouts will "never work" not only in B.C., but in Canada and North America.

As in many other fields of road safety, ICBC had the foresight to go beyond the conventional and explore new, promising road safety solutions, even when odds were not looking too good.

To this end, the RIP commissioned a preliminary review of the subject in 1998 which resulted in the report Investigation into the Safety Benefits of Modern Roundabouts – Delcan Corporation, July 1998. Subsequently, ICBC initiated discussions with some off its partners on the basis of the very positive findings of that review.

The first modern roundabout built in B.C. and funded by ICBC was in Ladysmith in 2000, followed by three more up to 2002. Throughout this period there was still significant reluctance and scepticism from professionals, decision makers and the public at large towards roundabouts.

The RIP has nevertheless continued to actively pursue the roundabout subject and was very active in an advocacy role throughout the province. The "Modern Roundabout Program" became an "official" part of the Road Improvement Program in 2001. Under its mandate, a serious advocacy effort was made that was reflected in activities such as:

A modern roundabout at 30 Avenue and 31 Avenue, Vernon

- Development of presentation materials;
- Conducting workshops and presentations throughout the Province to the decision makers (Councils, Translink, BCMA, MOTI) and professionals alike;
- Development of preliminary planning and design guidelines;
- Participation in public forums;
- Continued contacts with overseas experts and participation in national and international forums;
- Working with municipalities and the Ministry of Transportation and Infrastructure (MOTI) to identify suitable sites and actively being involved in all the phases of various projects;
- Development of educational material and the distribution of driver information brochures where required by the implementing agency; and
- Partnering in funding implementation of projects.

RIP staff became the subject matter "expert" in B.C. and was recognised in Canada as one of the pioneers on the subject. RIP was also instrumental in introducing the modern roundabout concept to the Ministry of Transportation and Infrastructure early in the program and assisted in planning, design and funding of the first three roundabouts on the provincial network.

A modern roundabout at Chemainus Road and Henry Road, North Cowichan

Most of the "advocacy" activities peaked between 2002 and 2004. By 2005 – 2006 roundabouts gained significant acceptance with all our partners and today, roundabouts are not only "accepted," they have become "desirable." It has been widely acknowledged and recognised that ICBC's pioneering work was instrumental in making British Columbia the leading province in Canada to adopt the Modern Roundabout and to make the Modern Roundabout a "household" name in our province.

Between 2000 and 2009 the RIP has assisted in funding 31 roundabouts, providing a total funding of $1,831,950. Although "only" 31 roundabouts were ultimately funded from the program in the past 10 years, this is the result of over 140 sites being considered and reviewed. Many were also implemented in the Province without ICBC funding, as the Modern Roundabouts are no longer regarded as a "curiosity."

A simple before-and-after evaluation conducted on the modern roundabouts implemented between years 2000 and 2006 based on the summary BIU provincial claims data up to 2008 indicate a reduction in injury claims of close to 70 per cent and an overall reduction in claims of approximately 34 per cent at all the treated sites.

Roundabout Success in North Cowichan

The District has built six modern roundabouts since 2005. ICBC has assisted in funding all six roundabouts. When the first roundabout was opened in Chemainus in 2005 there was some resistance from the public, but since then the roundabouts have become very popular. The District prepared, with the assistance of ICBC, a brochure on roundabout use for the Public which we have made available on our web site along with other instructional videos on the use of roundabouts.

Our observation has been that our modern roundabouts are a "Green" way of handling busy intersection traffic resulting in almost no idling and substantially safer intersections than ones controlled by a traffic signal.

During the Nov 2009 flood when we had to close a number of roads and detour traffic around the flood zone, the roundabouts performed very well under extreme traffic conditions.

We plan to build our seventh roundabout in 2010.

John Mackay, P.Eng.

Signs and Signal Visibility Upgrade Program

Alison Y. Wong, P.Eng., PTOE, Road Safety Engineer
Road Improvement Program

When I looked back to the humble beginning of my road safety experience 18 years ago it all started with a simple question on the human side. My question was how could we as the professional traffic engineers help to improve the perception and reaction ability for drivers. With that question in mind, we then started to pilot different schemes to enhance the reflectivity and visibility of traffic control displays.

Early in the program corridor-wide improvements to add tertiary signal heads at high-crash intersections were initiated with support from our municipal partners which proven to be effective in crash reductions. Then when the technology breakthrough was available to significantly increase the reflectivity of sign materials, we had the opportunity to upgrade all existing signs for traffic control to enhance the visibility in order to increase the perception and reaction time from the drivers' perspective.

Other pilot programs such as adding the yellow backboards to primary signal displays, stop sign in-fill for uncontrolled local intersections, install curb bulges and raised crosswalks to improve the visibility of pedestrians and even support our partners to enlarge the overhead street name signs are all aimed to assist all road users to be able to react effectively and safely in the course of their travel.

These measures and programs had worked successfully for the past 18 years and continue to contribute in crash reductions in B.C. Again, we are all creatures of habits at the end of the day. Simple measures that can help to provide the critical bit of information in an effective manner do prove to add safety benefits to our society.

300mm signal lenses improve the visibility of traffic signals

West Vancouver — Westmount Road Traffic Calming Project

Brent Dozzi, P.Eng., PTOE, Manager, Roads and Transportation
District of West Vancouver

The Westmount Road Traffic Calming Project is an example of a neighborhood, local government, a crown corporation (ICBC) and private industry (Westmount Chevron) working collaboratively in partnership to address an issue important to all — improving road safety.

Westmount Road is a collector road as well as home to 45 residential homes. Westmount Road is also one of West Vancouver's top five roads for speeding — speeds greater that 140 kilometres per hour have been measured. It also has a history of severe crashes including two fatalities involving children. For those reasons and a strong desire by residents to enhance the livability of their neighborhood, the four previously mentioned organizations combined their local knowledge, technical and financial resources to develop and construct a traffic calming scheme intended to slow (not impede) vehicular traffic. A series of center medians and a mini-roundabout function to slow vehicular traffic while the landscaped devices and community sign draw attention to the residential aspect of the neighborhood rather than what was the previous focus — an asphalt pavement race track.

Staff have since measured the effects of the traffic calming and are pleased to report up to a 10 per cent reduction in the 85th percentile speed (65.5 to 58.9 kilometres per hour) and an 84 per cent reduction in the number of vehicles traveling at excessive speeds (greater than 70 kilometres per hour).

A mini-roundabout on Westmount Road

City of North Vancouver:
Traffic Calming Program in the City

Dragana Mitic, P.Eng., Assistant City Engineer, Transportation
City of North Vancouver

The Traffic Calming Program for the City of North Vancouver started in 2001 with the goal of enhancing the safety and liveability of neighbourhoods. The Program provides a comprehensive approach to identifying and resolving neighbourhood traffic and transportation problems through the application of traffic calming measures such as corner bulges, median islands, traffic circles, speed humps, speed advisory signs, surface treatments and other devices.

Traffic calming measures have been proven means of improving safety in the neighbourhoods, and for the past several years the Insurance Corporation of British Columbia (ICBC) partnered with the City in implementation of this program.

Since the inception, the City developed seven traffic calming plans, of which five have been implemented. The evaluation results indicate that neighbourhood plans have been successful in reducing vehicle speeds, discouraging through traffic, and minimizing conflicts between road users. Overall, the Program has been successful in increasing safety of road users and improving liveability of neighbourhoods, reinforcing importance of the local government — ICBC partnership to achieve sustainable road safety.

A corner bulge on a local road

A marked crosswalk to accommodate pedestrians

Cameron Street Bridge Prince George

David Dean, P.Eng., Road Safety Engineer
Road Improvement Program

The old Cameron Street Bridge was a 70-year-old bridge that provided alternating-direction traffic and was closed down in 2005 due to significant structural deficiencies. It provided a crossing over the Nechako River separate from the Highway 97 John Hart Bridge, and provided an important link for heavy vehicles between industrial areas along River Road and north shore of the Nechako River. Commuter traffic also used the Bridge. With the Bridge closed since 2005, the traffic that historically used the Bridge had been reassigned to travel through other streets within Prince George (such as Highway 97, 5th Avenue, and Carney Street) and the John Hart Bridge.

Route Distribution With / Without Bridge

A study was undertaken in 2008 to review the impacts of the new Cameron Street Bridge with respect to the existing no-Bridge road network from a safety perspective. This involves reviewing the existing and anticipated future traffic patterns, as well as their impact on the frequency and severity of crashes. The EMME/2 transportation model was used to predict distribution of traffic, and crash prediction models were utilized to predict overall annual crash reductions with the new bridge. The resulting safety benefits allowed the Road Improvement Program to contribute $96,800 towards the project which was completed in 2009.

Harvey Avenue (Highway 97) Upgrading, City of Kelowna

David Dean, P.Eng., Road Safety Engineer
Road Improvement Program

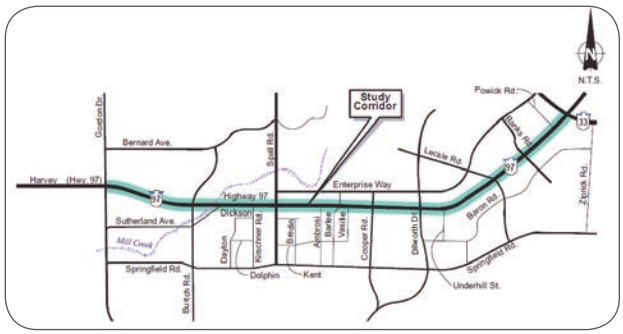
Planning for the widening of Harvey Avenue (Highway 97) was underway in 2007 for the addition of a third westbound travel lane. The Ministry of Transportation, City of Kelowna, and ICBC identified the opportunity to investigate the potential for safety improvements that could be undertaken in conjunction with the road widening project, and commenced with a two-part study. The first was a road safety audit that was conducted on the preliminary design of the road widening, and the second was a traffic operations and safety review of the Harvey Avenue corridor. The purpose of the review was to identify additional improvements that could reduce the frequency of motor vehicle crashes within the corridor, and the potential for Road Improvement Program funding that could be contributed towards the safety benefits.

After a systematic review of the physical, traffic and crash characteristics along the study corridor, crash causes were identified and improvement strategies were developed for the corridor. These were then evaluated by the project team to determine the practical and financial capability of incorporating the recommendations into the road widening project.

Safety improvements throughout the corridor were able to be added to the project including:

- Signal head upgrades
- Turning restrictions
- Sight line improvements
- Left turn bay extensions
- New signal phases

The Harvey Avenue studies and additional road safety improvements emphasized the benefits of our partners working together to identify road safety issues and to pursue implementation of mitigation measures.



Contributions to Road Safety Engineering in British Columbia and Canada

Geoffrey Ho, P.Eng., Road Safety Engineer
Road Improvement Program

Over the past two decades, the Road Improvement Program has made significant contributions to advance the knowledge in road safety engineering to both British Columbia and Canada. Through the experience gained through research, working with our partners, and implementation of projects, the engineering community has benefited greatly through advances in the knowledge of various aspects of road safety engineering. Some of the highlights of the Road Improvement Program's contribution include:

- A **Traffic Conflict Procedure Manual (Second Edition**) in 1995 that is used throughout North America to supplement in-service road safety reviews.
- A **Safety Design Guidelines for Parking Facilities (First Edition)** in 1998 to provide best practice for architects and engineers to reduce off-street crashes.
- A **British Columbia Community Traffic Manual** that was produced in 1999 and updated in 2002 to provide guidelines for effective traffic management and road safety for communities in British Columbia. This manual was distributed for free to all British Columbia road authorities.
- Conducted research in the effectiveness of replacing 200mm traffic signal heads with 300mm heads. As a result, a "Traffic Signal Head Upgrade" Program was introduced in conjunction with the BC Hydro Powersmart Program to replace smaller signal heads to larger and more energy efficient signal heads.
- Conducted research in the effectiveness of highly reflective signs and pavement markings. The "Sign Upgrade Program" was developed subsequent to identifying the potential benefits of having high reflectivity in signage and road markings. Another example was investing in projects to provide high reflective road markings along the Sea-to-Sky Corridor.
- The Road Improvement Program had recognized the potential benefits of modern roundabouts since the mid-1990s. Through research and technology exchange with European and Australian experts, ICBC was able to identify that roundabout would play an important role in improving intersection safety. In 2000, the "Modern Roandbout Program" was initiated by ICBC as a means to invest in modern roundabout conversions in the province.
- Research studies in various emerging topics and their effect on road safety, such as Intelligent Transportation Systems (ITS), High Occupancy Vehicle (HOV) Lanes, single-vehicle crashes, cycling and road safety, commercial vehicle safety, trip reduction programs, travel demand management, congestion, transit and land use planning, red light cameras, anti-icing agent, signal coordination, traffic calming, school zone safety, network planning, roadway lighting, rumble strips, and anti-skid materials.
- Holding numerous technical seminars and workshops on important topics that are of interests to B.C. road authorities. These topics included Road Safety and Human Factors, Road Safety Audit, Modern Roundabouts, Intersection Safety, and the AASHTO Highway Safety Manual.
- Providing research funding to the University of British Columbia researchers to investigate various aspects of road safety engineering:
  - Automated traffic conflict analysis using video sensors
  - Crash prediction models for signalized and unsignalized intersections
  - Road safety and design consistency
  - Identifying Driver-Related Accident Prone Locations
  - Safety Aspects of Traffic Signal Design.

- The Road Improvement Program provided funding to the Transportation Association of Canada (TAC) and the Canadian Institute of Transportation Engineers (CITE) for a number of their publications, including:
  - Canadian Guide to Neighbourhood Traffic Calming
  - The Canadian Guide to In-Service Road Safety Reviews
  - Synthesis of North American Roundabout Practice
- Road Improvement Team members were the main authors of the TAC Canadian Road Safety Audit Guide (Paul de Leur and Geoffrey Ho). Members of the Road Improvement Team contributed to the TAC Canadian Road Safety Engineering Handbook committee, and they authored the recently published Book 1 – Road Safety Engineering Management Guide (Geoffrey Ho and Julian Rozental).
- Members of the Road Improvement Program are members of the Canadian National Committee of the World Road Associations. Paul de Leur sits on Technical Committee C.2 Safer Road Operation, and Geoffrey Ho sits on Technical Committee C.1 Safer Road Infrastructure.
- As a result of the success of the Road Improvement Program, it was emulated by other insurance agencies in North America, including Saskatchewan Government Insurance (SGI), AAA Michigan, and State Farm Insurance.

Future Trends in Road Safety Evaluation and Research

Tarek Sayed, Ph.D., P.Eng., Professor and Distinguished Scholar
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It has been 20 years since ICBC started its very successful Road Improvement Program which resulted in significant savings in property damage, personal injuries and fatalities due to reduced road crashes. The program has some unique aspects which include conducting thorough and robust evaluations and the funding of innovative road safety research. These two aspects of the program will be highlighted in this article along with some future directions.

1.0 Evaluating Road Safety Improvement Programs

It is common that many road safety professionals believe that "common sense" and "practical experience" are sufficient to provide a valid indication of the effectiveness of road safety initiatives. At times, there can be some opposition with efforts that try to "prove the obvious" and that there is no need to undertake a comprehensive evaluation of safety initiatives that are "believed" to be effective. However, in the majority of cases, the success of road safety initiatives are not "self-evident," even to road safety professionals that have considerable practical experience. There is rarely a simple cause and effect relationship associated with road safety initiatives. Usually, several factors that influence safety in different ways operate simultaneously on a transportation system, including such things as changes in traffic volume, driver population, speed, and weather conditions (among others). Therefore, the importance of conducting rigorous evaluations of road safety improvement programs cannot be overstated.

From the outset of the program, ICBC recognized the value of conducting accurate evaluations to ensure the proper allocation of available funding. A study was initiated in 1993 to establish a framework for evaluating the economic feasibility of road safety improvement projects. The study described simple methods that could be used to quantify the costs and benefits of road improvements. Realizing the limitations of the 1993 study and the need to conduct a more accurate and robust economic evaluation of the road improvement program, another study was completed in 1996. Typically, there are a number of confounding factors that threaten the validity of before/after safety evaluations. If these confounding factors are not properly addressed, there is a risk of biased estimation of the true safety performance. The methodology reported in the 1996 study was useful for conducting reliable economic evaluations of safety improvement projects and to account for confounding factors. Since the preparation of the 1996 Program Evaluation study, there have been several advances in road safety research. The use of crash prediction models and the Empirical Bayes (EB) technique have become standard safety practice and are commonly used for time series safety evaluations. Methods for assessing the reliability of evaluation results are also more frequently used, and overall, a better understanding of evaluation techniques has been achieved. As a result, the methodology that was used in both the 2001 and 2006 Road Improvement Program Evaluation studies deployed advanced evaluation techniques that ensured reliable results. These techniques are also used for the 2009 Program Evaluation.

The current popular state-of-the-art road safety evaluation is based on the Empirical Bayes Odds Ratio (EB-OR) methodology. To account for confounding factors, the EB-OR approach usually uses two data sets: a comparison group and a reference group. It is important to emphasize that these two data sets serve different purposes and therefore have different roles. A comparison group of sites is used to correct for time trend effects, including the confounding factors of history and maturation. Comparison sites are commonly chosen so that they experience similar traffic and environmental conditions to those of the treated sites, but were not subject to any treatment. Care must be exercised in selecting the comparison group to ensure that the time periods for the treatment and comparison sites are similar and that

the factors influencing safety are similar between the two groups. Therefore, proximity to treatment sites should be the main criterion for comparison sites selection. The OR is used to capture the change of the crashes in the comparison group to the change of the crashes in the treatment group. Additionally, a reference group is used to correct for the regression-to-the-mean artifact. Locations selected for improvement inherently have high crash counts, a portion of which are solely due to random variation in annual crashes. Crashes in subsequent years may decline independently of any improvements made. To account for this bias, a large group of sites that are similar to the treatment sites are used to develop a crash prediction model (CPM). The EB approach is used to refine the estimate of the expected number of crashes at a location by combining the observed number of crashes (at the location) with the predicted number of crashes (from CPM).

For future evaluations it is recommended to use the Full Bayes (FB) approach. The FB approach most important advantage is related to the data requirement issue. It is commonly known that the availability and reliability of crash records is the main problem associated with safety evaluations. By integrating the estimation of the CPM and treatment effects in a single step, a reference group of sites is no longer required therefore eliminating the need for collecting a larger data set. These advantages allow additional flexibility in the development of CPMs, which due to the FB approach, are capable of accounting for the different variations and properties that exist in crash data.

2.0 The Role of Safety Research

There is a recognized need for road research which focuses on improving our understanding of the interaction between crash factors and their relation with engineering countermeasures. Most of current research on road safety focuses on the statistical techniques to model crashes. Less attention has been devoted to improve our understanding of crash causes and contributing factors. This is unfortunate, given the lack of complete understanding of the complex interaction of crash factors and how safety measures work. Statistical analysis is an integral part of accident research, however, a better understanding of the problem is required before attempting to apply any statistics. Crashes represent instances in which the road system has failed, yet our understanding of the failure mechanism is poor, thus reducing the accuracy of the diagnosis and remedy processes. The main factor missing from road safety research is the use evidence-based scientific research to extract meaning from data that already exists.

The University of British Columbia, with funding from ICBC and other partners, has been conducting road safety research that focuses to improve road safety analysis and the level of knowledge associated with the safety implications of traffic operations and highway design. This research is helping to reshape how road safety problems are identified and evaluated. One example of this innovative research is the Automated Road Safety Analysis Using Computer vision Techniques.

The research represents an attempt to advance the engineering methods for road safety analysis and data collection through automated analysis of video data. Most road authorities establish road safety improvement programs (RSIPs). These programs are generally dependent on the availability of historical crash records and therefore, the success of the program is governed by the quality of this data. However, there are well-recognized availability and quality problems associated with crash data. As well, the use of crash records for safety analysis is a reactive approach: a significant number of crashes has to be recorded before action is taken. Because of these problems, the observation of traffic conflicts has been advocated as an alternative or complementary approach to analyze traffic safety from a somewhat broader perspective than crash statistics alone. The Traffic Conflict Technique involves observing, recording and evaluating the frequency and severity of traffic conflicts at an intersection by a team of trained observers. However, incomplete conceptualization and the cost of training observers and collecting traffic conflict data have been factors inhibiting extensive application of the technique. The purpose of this research is to develop a comprehensive system for traffic conflict detection/ safety analysis in video data. Video sensors were selected because they provide rich, detailed, inexpensive, and permanent observations of traffic scenes. The research attempts to contribute to traffic safety in several ways. It provides a tool that is capable of automated safety analysis of video data. Moreover, this approach to safety analysis is proactive, there is no need to wait for crashes to be recorded before action is taken. As well, this approach should offer a better understanding of vehicle crash failure mechanisms, particularly the crash-avoidance behavior of drivers which should help our diagnosis of the safety problems and the selection of safety countermeasures. With an understanding of the types and degree of severity of potential crashes from the extracted conflict data, economic analyses could be performed for more precise estimates of cost savings of mitigated crashes. This would result in more effective investment of the funds available towards the improvement of road locations for the

reduction of crashes. This type of analysis is of much interest and value to both road safety and insurance agencies. Ultimately, the research should lead to a reduction in the number and severity of road crashes. There are several ongoing research projects in this area in Canada, the U.S. and Internationally. Three Figures to the right show Examples of this research.

In this article, the role of innovative road safety research and evaluation has been emphasized. It is the ability to be forward thinking based on recognized safety science that has allowed ICBC's Road Improvement Program to succeed in the past and by continuing to look into the future, we will be able to realize similar success.

References

1. Ismail, K., Sayed, T., and Saunier, N. (2010) "Automated Analysis of Pedestrian-vehicle Conflicts: A Context for Before-and-after Studies", in print, Transportation Research Record: Journal of the Transportation Research Board, (Final Acceptance October 2009).
2. Ismail, K., Sayed, T., Saunier, N. and Lim, C. (2009) "Automated Analysis of Pedestrian-Vehicle Conflicts Using Video Data", Transportation Research Record: Journal of the Transportation Research Board, Vol. 2140, pp. 44 – 54.
3. Saunier, N., Sayed, T., and Ismail, K. (2010) "Large Scale Automated Analysis of Vehicle Interactions and Crashes," in print, Transportation Research Record: Journal of the Transportation Research Board, (Final Acceptance February 2010).

Figure 1: *Sample of automatically detected pedestrian-vehicle conflicts in a Downtown Vancouver study (Source: Ismail, Sayed and Saunier, 2009)*

Figure 2: *A sample of automatically detected pedestrian-vehicle conflict in a before and after safety study of a pedestrian scramble phase in California (Source: Ismail, Sayed and Saunier, 2010)*

Figure 3: *A sample of an automatically detected vehicle crash in a safety study in USA (Source: Saunier, Sayed and Ismail, 2010)*

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