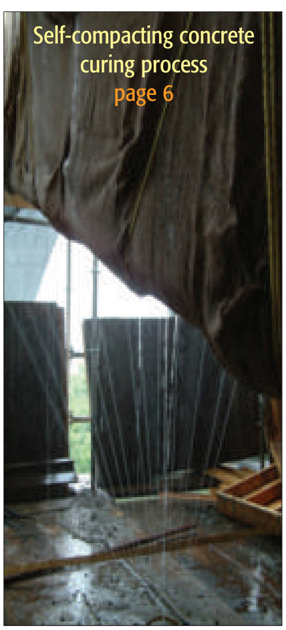
M I N I S T R Y   O F   T R A N S P O R T A T I O N

# Road Talk

Ontario's Transportation Technology Transfer Digest • Winter 2006 • Vol 12 Issue 1





Self-compacting concrete curing process

page 6

## Several Innovations Ensure Safe and Timely Travel

# New Southbound High-Occupancy Vehicle Lane & Tunnel on Highway 404!

Seeing the light at the end of the new High-Occupancy Vehicle tunnel on Highway 404.

MTO coordinated the construction of a new 11.2-kilometre High Occupancy Vehicle (HOV) lane and tunnel. This HOV lane, linking southbound Highway 404 to the westbound Highway 401 collector lanes, opened on December 13th, 2005. HOV lanes are one of the many initiatives MTO is promoting to manage highway congestion and reduce commute times for travelers.

There are several innovations that were incorporated into the design and construction of the new HOV ramp/tunnel at Hwy 401/404 to help ensure a safe and timely experience for highway travellers. One new feature is the pre-cast concrete louvers installed in advance of the tunnel to shade the eyes of drivers from the sun, which will help provide a smooth transition between the changing light levels. Secondly, an 800m weave lane constructed on southbound Highway 404, in advance of the tunnel, provides vehicles exiting the HOV lane the opportunity to safely merge with traffic heading to the Don Valley Parkway (DVP) without slowing down or blocking the HOV lane.

A groundbreaking technology incorporated into the HOV tunnel design is the Advance Warning System (AWS). The goal of this technology is to minimise the number of primary and secondary collisions within the tunnel while reducing the incident response time for COMPASS Operations. The AWS combines a series of loop detectors located within the tunnel and a video incident detection system. Once the system has detected either slowed or stopped vehicles, it automatically activates two portable changeable message signs (PCMS) to warn drivers of slow or stopped traffic within the tunnel. In

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**Road Talk** is prepared and published quarterly by the Resources Planning Office of the Program Management Branch, Ontario Ministry of Transportation. Road Talk is distributed electronically in both PDF and HTML forms and is available at: www.mto.gov.on.ca/english/transtek/roadtalk. This publication reports on innovations and new technology relating to highway management; the design, construction, operation and maintenance of highway infrastructure.

Readers are encouraged to submit articles, news items and comments to
Kristin MacIntosh, Editor, at:
Resources Planning Office
Program Management Branch
Ontario Ministry of Transportation
4th Floor, 301 St. Paul Street
St. Catharines, ON, Canada L2R 7R4
Phone: 905.704.2645
Fax: 905.704.2626
Kristin.MacIntosh@mto.gov.on.ca



**Technology Transfer** is a communication process by which information, regarding an improvement in a product or method, is exchanged and implementation into practice is facilitated.

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addition, the COMPASS Operators are immediately alerted of the incident and have the capability to view it via cameras mounted within the tunnel. Depending on the nature of the incident, the COMPASS Operators can alert emergency services, the media and the public.

Lastly, a Fixed Automated Spray Technology (FAST) System was installed at the ramp and tunnel to prevent the formation of frost and/or ice on the road. The system is composed of a fully functioning Advanced Road Weather Information System (ARWIS) station and a high-pressure spray system mounted on the right side of the ramp. A remote processing unit receives information from the various road and atmospheric sensors, as well as from the ARWIS station, and calculates if a frost or freeze event is about to occur. When certain weather conditions are measured, the sensors send a signal to nozzles located in the right shoulder of the roadway, which then spray a fine mist of anti-icing solution (potassium acetate) over the road.

The technological innovations that MTO integrated into the new southbound HOV lane and tunnel on Highway 404 ensure safe travel for its users. ●

For more information, contact Heather Glass, Highway Engineering Office, at (416) 235-5521 or Heather.Glass@mto.gov.on.ca

**Above:** FAST nozzle embedded in the pavement of the ramp and tunnel.
**Below:** Pre-cast concrete louvers installed at the tunnel entrance to protect drivers from looking directly into the sunlight.

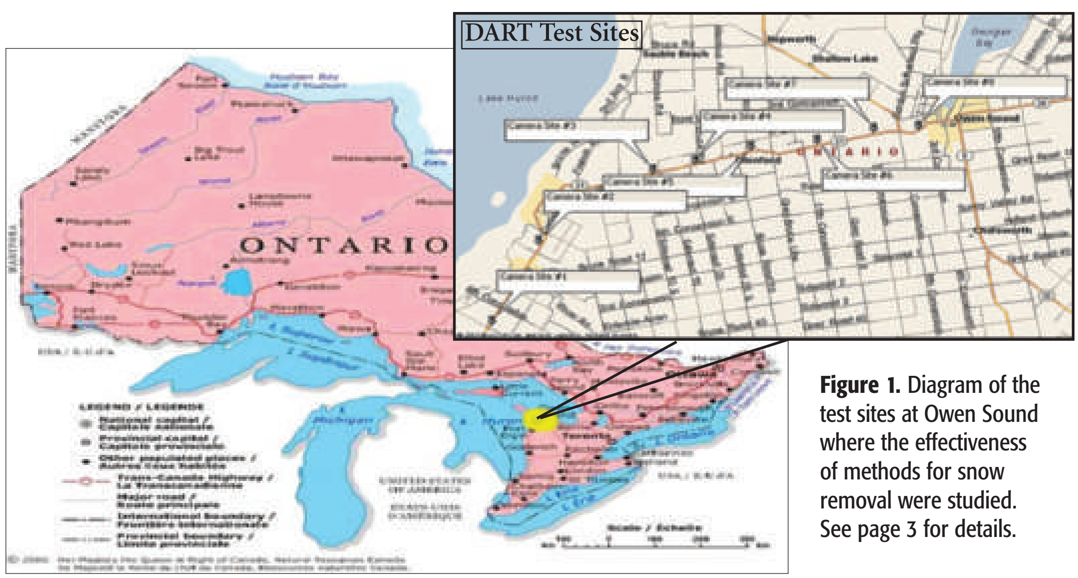



**Figure 1.** Diagram of the test sites at Owen Sound where the effectiveness of methods for snow removal were studied. See page 3 for details.

**Research Confirms Effectiveness For Snow Removal**

# Pre-Wet... You Bet!

Alternative de-icing and anti-icing methods have been widely adopted in MTO maintenance practices. Dr. Liping Fu and his research team at the University of Waterloo have been working with MTO, under the Highway Infrastructure Innovation Funding Program (HIIFP), to quantify all the benefits of winter technologies.

MTO dedicates a significant amount of resources every year to keep roads and highways clear of snow and ice for public safety. This includes placing approximately 500,000 to 600,000 tonnes of traditional rock salt. Alternative snow and ice control methods, such as pre-wetting and direct liquid application (DLA)*, have gained increasing popularity among MTO maintenance managers because of their potential to reduce salt use. Pre-wetting adds liquid salt to the rock salt as it is being applied to the pavement to reduce the "bounce" and keep it on the road. DLA is an anti-icing strategy that pre-treats highways using liquid salt before a weather event (i.e. snow storms) thereby preventing precipitation from bonding to the pavement.

The basis of Dr. Fu's work is to analyse data collected from a large field test called De-icing/Anti-icing Response Treatment (DART) in the winter season of 2002-2003. The test site was a 50-kilometre section of Highway 21 located in the Owen Sound area of MTO's Southwest Region (Figure 1, page 2). Different chemical application protocols, varying by material type, application rate and method, were tested. Video surveillance cameras at eight sections comprising the test site recorded snow cover at 10-minute intervals. Each pass of the snowplow across each test section was recorded either manually or with an Automated Vehicle Location (AVL) system, providing records on the time, direction, vehicle speed, chemical type and application rate. Furthermore, MTO's Road Weather Information System (RWIS)* station and supplementary information from Environment Canada provided data on air and pavement temperature, wind speed, and precipitation.

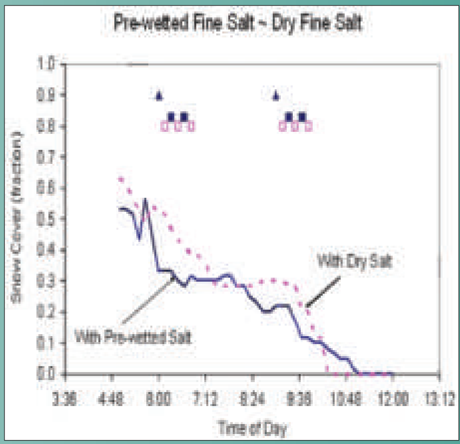
The team's research involved a series of group comparisons and statistical modeling of snow cover under different chemicals and application methods over 20 snow storms recorded in winter 2002-2003. The comparative study focused on three scenarios: pre-wetted salt vs. dry salt, pre-wetted salt with different pre-wetting liquids, and pre-wetted salt with different pre-wetting rates. Advanced statistical models were calibrated to capture the effects of various road weather factors on the effectiveness of alternative liquids.

Several important findings have emerged from the initial phase of Dr. Fu's research. First, the analysis confirmed the expectation that pre-wetted salt is more effective than dry salt. More importantly, they found that, under the same conditions and application rates, pre-wetted salt outperformed dry salt by 17.9 - 40.0% in terms of reducing snow cover (Figure 2).

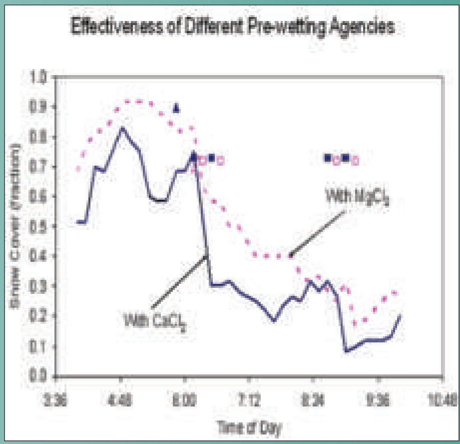
Second, the work identified substantial evidence on the relative performance of the three commonly used pre-wetting agents: Calcium Chloride ($CaCl_2$), Magnesium Chloride ($MgCl_2$) and Sodium Chloride brine (NaCl). It was found that $CaCl_2$ was the most effective agent under the conditions tested, regardless of the dry salt rate and pre-wetting ratio. $CaCl_2$ outperformed $MgCl_2$ by 9.5 - 71.4% and NaCl by 37.5% in terms of average snow cover (Figure 3).

Lastly, based on the statistical models developed for snow melting trend, the tests quantified the effects of road weather factors (i.e. temperature, snow fall, blowing snow) and salt applications on snow removal. For example, the models indicated that maintenance treatments were less effective under high wind, which could be explained as a result of blowing snow. The analysis also verified the positive effect of residual salt accumulated over a storm event.

Dr. Fu's research team has made significant progress in quantifying the relative effectiveness of different liquids and treatment methods, with challenges still ahead. The next step is to work on developing performance models that could be used to predict how road surface conditions will evolve over time after a specific treatment. With continuing efforts, MTO will be able to develop new guidelines and decision support tools to help maintenance managers determine optimal treatment plans in terms of where and when to treat, and what treatment to use. ●




**Above:** Figure 2 **Below:** Figure 3




Visit our past Road Talk issues for more information regarding:
* DLA,in February 2002 issue
* RWIS,in February 2003 issue

For more information, contact
Max Perchanok, Maintenance Office,
at (905) 704-2638 or
Max.Perchanok@mto.gov.on.ca or
Liping Fu, Department of Civil Engineering,
at (519) 888-4567 or lfu@uwaterloo.ca

### Where is Asset Management Going?

# Stewards of Infrastructure Investments

Asset Management has become the way of doing business at MTO. In its initial stages of development, Asset Management may have been regarded as a special project or an extra assignment, however, it has become the way MTO plans, measures and chooses infrastructure investments. How funding is pursued now, compared to five years ago, demonstrates the importance of performance measures, inventory data and well-developed Asset Management strategies.

Stewardship of infrastructure remains firmly entrenched as the responsibility of MTO staff with more focus on long-term planning, and less on short-term thinking. Simple and powerful questions are being asked everyday, for example: What performance will I get out of this investment? What alternative gives me the lowest life-cycle cost? How will this investment decision affect the infrastructure five or twenty-five years from now?

Part of the Asset Management mindset includes continuous improvement and effectiveness, so the need to develop more tools and processes is on-going. "When we embarked on this journey five years ago, we knew there was a lot of work ahead," says the Head of Investment Planning, Alison Bradbury. "We tackled problems of inconsistent tools and processes and helped people learn where we're going. Resources in the regions have been dedicated to Asset Management and this has addressed a gap we saw early on in the project. We've achieved a lot and there is even more interesting work to come – especially now that we have developed a dozen Corridor Investment Plans* for the province!"

> **"We've achieved a lot and there is even more interesting work to come!"**
>
> **-Alison Bradbury-**
> **Head of Investment Planning**

Corridor Investment Plans are a compilation of 25-years of investment proposals required along a highway corridor to meet specific performance measure targets for condition, as well as safety and mobility. As Corridor Investment Plans are created and refined in the regions, tools such as computer applications for inventory and investment planning are being developed to support the new business environment. Furthermore, tools like PEAT (Priority Economic Analysis Tool†) are being developed and implemented. Another key tool is the Condition Assessment Program (CAP), which will help improve the assessment of infrastructure condition and allow MTO to justify maintenance operations. Also, methods for life-cycle costing and trade-off analysis will be further developed and enhanced to achieve consistency and ease of use.

As Asset Management continues to evolve, more staff are involved as projects and activities need to be simplified, automated and standardised. This is done to ensure consistency within and among the regions, leading to better planning and investment of public dollars. The creation of the Program Planning units, within the regional organisation structure, was a key step forward two years ago. MTO's Program Management Branch will continue to revise and optimize its organisation to sustain and drive Asset Management.

The future is bright for Asset Management at MTO. Much has already been accomplished and more details are being addressed through continuous improvements, new tools and staff being engaged in the process. Asset Management is not a project or extra assignment anymore! How MTO plans, invests and monitors the infrastructure now and in the future is Asset Management. Simply said, it's how we do business. •

Visit our past Road Talk issues for more information regarding:

* Corridor Investment Plans, in Summer 2005 issue

† PEAT, in November 2004 issue

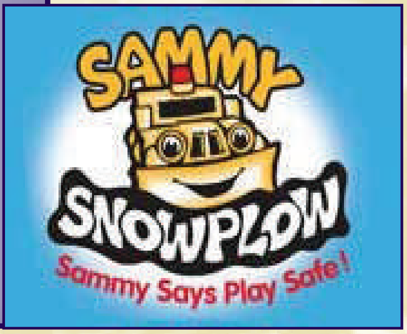
For more information, contact
Alison Bradbury, Investment Planning Office,
at (905) 704-2652 or
Alison.Bradbury@mto.gov.on.ca

## Exciting Way To Promote Winter Safety To Children!

The Department of Transportation and Public Works in Nova Scotia has been busy introducing elementary school children to a new educational animated character. Sammy Snowplow creates awareness about winter safety through the use of an interactive DVD that is full of fun, memorable and educational messages. This "Sammy Says – Play Safe!" program also helps parents and teachers recognise the necessity of promoting winter safety to children.

The Department's road maintenance staff created all the safety pointers in the video. "They do the work and they see the dangers," said Ron Russell, the Minister of Transportation and Public Works. "Having them deliver these messages through Sammy will have a real impact."

For more information visit www.sammysnowplow.ca or contact Linda Laffin, Transportation and Public Works, (902) 424-3289, or llaffin@gov.ns.



## Developing Software For Automated Display of Pavement Temperatures

# How Cold is That Pavement?

MTO is working on minimising its use of road salt while continuing to keep roads safe for winter driving. In recent years, MTO has implemented innovative techniques such as combining rock salt with pre-wetting liquids to ensure the salt adheres to the pavement, and adjusting application rates more precisely to differing temperature and snow conditions.

These winter maintenance methods are most effective when road managers receive accurate and timely information about pavement temperatures, since that data enables them to select the appropriate salt application rate for that given area. Obtaining information regarding pavement temperature unique to each region is beneficial since weather and temperature conditions vary with time of day and location along a route.

MTO is developing software to improve maintenance operations that will automatically display pavement temperatures on a web-based mapping program. The system can be used to make decisions on whether to adjust salt application rates, and if so, by how much.

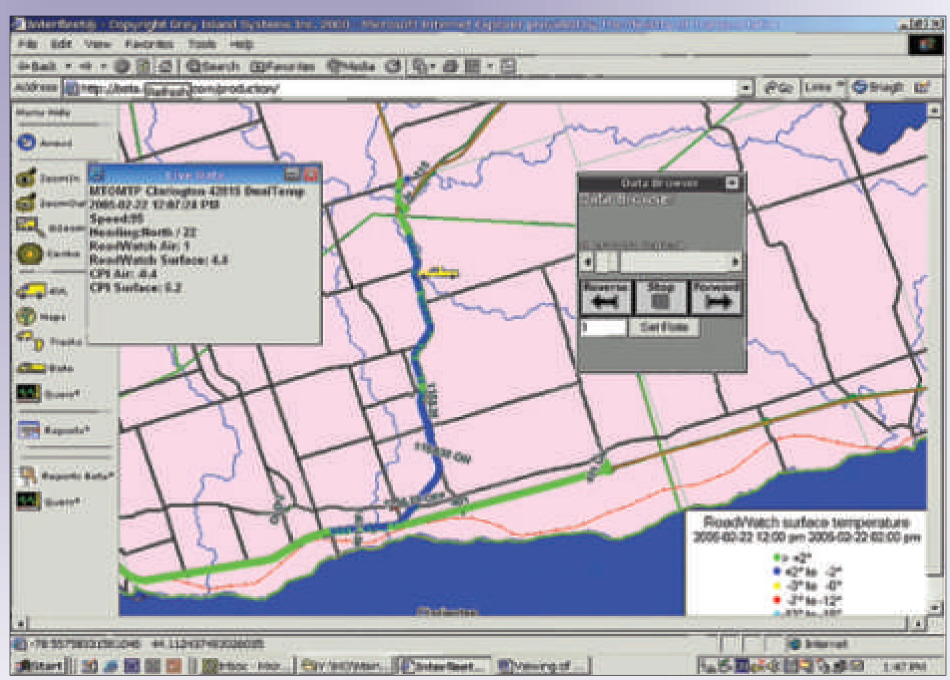
The AVL system, mounted on patrollers' trucks, retrieves pavement temperature readings that are measured by infrared thermometers. The pavement temperature information is relayed to a central computer every few seconds by a GPS-based cellular communication link. The temperature data is then recreated on a map that is accessible by the road manager. Pavement temperature ranges are plotted in different colours along the route, making it easy to observe where salting rates could be adjusted, or alternate de-icing materials selected, based on the temperature range observed.

In the graphic below, the weather and ground conditions (pavement temperature) of the highways were obtained by the AVL system on the patroller's vehicle, and displayed on the web-based mapping program. The green section in the display indicates roadway temperatures above +2ºC, which is a condition where salt is not needed. The highway sections in blue indicate temperatures in the +2ºC to -2ºC range where, depending on the other road and weather conditions, an application of road salt could be considered.

The automated display of pavement temperature will provide the necessary information regarding road and weather conditions. This innovative AVL technology will greatly aid MTO in improving their winter maintenance systems and decrease the amount of road salt applications on highways, resulting in both cost and environmental savings.

For more information, contact Max Perchanok, Maintenance Office, at (905) 704-2638 or Max.Perchanok@mto.gov.on.ca

**Below:** Web-based mapping program displaying weather and ground condition data obtained by the AVL system.




## MTO Technical Manuals Now Free Online

Technical manuals are now available for downloading or printing from the MTO Library Catalogue free of charge. Users may search for the manuals using the title, subject or author. The library webpages are located at www.mto.gov.on.ca/english/transrd/ or, for French, at www.mto.gov.on.ca/french/transrd/

The Ontario Provincial Standards, Traffic Volumes and Contract Design Estimating and Documentation databases can be accessed from the same webpages.

Print copies of the manuals may be purchased from Publications Ontario. www.publications.gov.on.ca/english/ or www.publications.gov.on.ca/french

Please note that MTO Technical Manuals are published in English only.

Questions regarding access to the documents should be directed to the MTO Library at library@mto.gov.on.ca

### The Concrete Facts On An Emerging Technology:

# Self-Consolidating Concrete

Self-consolidating concrete (SCC) is one of the most innovative technologies in concrete construction today. SCC eliminates the use of vibrators and allows faster concrete placement while improving its consolidation. SCC's ability to reduce voids in the mixture leads to better concrete quality, durability and surface appearance. In addition, this technology reduces labour needs and work site noise. These benefits make SCC an improvement from traditional concrete that needs to be consolidated by vibration to remove air pockets to achieve optimum concrete properties and fill formwork.

This technology has the potential to be used in MTO applications where there have been problems achieving proper consolidation with conventional cast-in-place concrete, due to difficult access for vibrators. Potential areas for SCC use include: barrier and parapet walls, piers, columns, and re-facing. It is also suitable for pre-cast concrete products such as girders and culverts.

After success in Japan and Europe, this technology is being introduced in North America. However, before SCC can be used widely, a number of practical issues must be addressed, including development of standards for its production and testing. Individual countries and producers tend to adopt their own SCC tests, making comparison of experiences impossible. Absence of standard tests has prevented SCC use in general construction practises because owners are reluctant to use a non-standard technology. To address this concern, North America is currently preparing guidelines and standard test methods: the American Concrete Institute will be publishing an Emerging Technology Series document regarding production and use of SCC; the Canadian Standards Association published a list of recommended test methods, including acceptance criteria, in the 2004 edition of the national concrete standard.

MTO prepared draft specifications for SCC and used it on a trial basis in pier rehabilitation at the Garden City Skyway, St. Catharines, in the summer of 2005. The contract called for concrete patches made by pumping concrete into forms, but MTO accepted the contractor's proposal to use SCC instead. MTO required their draft specifications for SCC be met in addition to the normal requirements for concrete

**ABOVE:** SCC surface finish of the Garden City Skyway pier.
**BELOW:** General view of the Garden City Skyway pier rehabilitation.

strength and air void parameters, for durability. This was also the first contract with a linear shrinkage limit requirement for concrete to minimise drying shrinkage cracking.

SCC requires a new approach to testing that is unique from what the industry is accustomed to. Properties such as flowability (ability to completely fill formwork without entrapped air pockets), passing ability (ability to pass between steel reinforcing bars and other narrow spaces without clogging) and segregation resistance (ability to prevent separation of stone and paste in the mix) are evaluated as part of MTO's specification for SCC. Concrete should be tested prior to placement to verify that SCC meets all three properties, otherwise, a good quality hardened concrete cannot be achieved.

In the case at Garden City Skyway, MTO relied on supplier-developed test methods and trial batches for evaluating the ability of concrete to meet the ministry's requirements. All the specified concrete properties, including compressive strength, air void system and linear shrinkage were met. The method was successful, although there were a few isolated problems with the bond of the patching/refacing to the parent concrete. SCC can cause high pressure on forms, due to its highly fluid nature, and create blowouts of formwork where bracing is insufficient. During the trial contract SCC did not always fill out forms completely. However, use of additional air vents in the formwork may alleviate this problem.

To mitigate the challenges of SCC, MTO will continue working with the concrete industry to develop a common set of test methods to measure flowability, passing ability and segregation resistance, as well as a performance-based concrete acceptance process. This technology's amazing potential to produce a high quality product, minimise the use of vibrators, quicken the construction process and fill formwork without segregation is sure to make the challenges of improving SCC worthwhile. ●

**Right:** Using a V-funnel to evaluate the flowability and stability of SCC in a field test.

For more information, contact Jana Konecny, Concrete Section, at (416) 235-3711 or Jana.Konecny@mto.gov.on.ca
or
Karen Smith, Central Region Quality Assurance, at (416) 235-5459 or Karen.Smith@mto.gov.on.ca

## Transportation Risk Analysis

# Expecting the Unexpected

To more appropriately assess costs and schedules for infrastructure projects, MTO has used a new procedure commonly referred to as "risk-based cost and schedule analysis". This process is designed to replace traditional practices of using "contingencies" and schedule "float" (or leeway) since projected outcomes usually differ from final project performance. The analysis is typically handled in a workshop involving the project team, the risk team, and the independent experts for added perspective – similar in form to Value Engineering sessions.

> **"We knew we had to do something to develop better estimates earlier."**
>
> **-Jennifer Brown-**
> **WSDOT Program Manager**

Teams divide the project into manageable activities and identify timeline relationships among them. For example, one particular project required legal traffic signal plans to be completed prior to executive review and construction tendering. However, property acquisition could be finalised while legal signal plans developed. After divisions are made, a base cost and duration for each activity are established, assuming that the project will proceed as planned. This allows the team to identify potential problems and consequences, as well as make a fair judgment about the probability of what may or may not go wrong. This process provides a complete project picture that traffic professionals and stakeholders can appreciate because it considers all factors. This approach is applied simultaneously to scheduling because cost and time are directly related.

By compiling a list of identified uncertainties, the team creates a risk register that quantifies both the likelihood and the consequences of something going wrong. A computer model is then used to handle calculations, to link activities, and to simulate the effect that each uncertainty will have on the project's outcome. Finally, the schedule and costs are presented in chart form to show the chance of achieving any given value or time, as well as to show a prioritised register of the uncertainties.

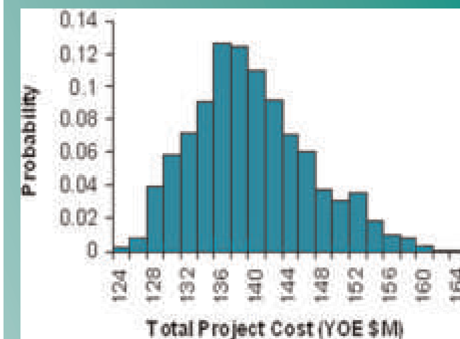
The risk register is also a tool for monitoring projects from concept to final construction and adjusting expectations along the way. The closer the activity gets to completion, the more certain the management team will be about total costs. Such a risk analysis is an ideal complement to MTO's current Value Engineering and Risk Management processes.

Washington State's Department of Transportation (WSDOT) has pioneered this innovative approach using a Cost Estimate Validation Process (CEVP) procedure. WSDOT tried a new estimation technique after their Route 167 expansion experience that started with a cost estimate of $150 million and ended ten years later at $972 million. "We knew we had to do something to develop better estimates earlier, and we had to figure out a way to talk about estimates with the public," said Jennifer Brown, a WSDOT program manager. By the end of 2003, ten large WSDOT transportation projects and over 100 smaller projects had been reviewed using CEVP.

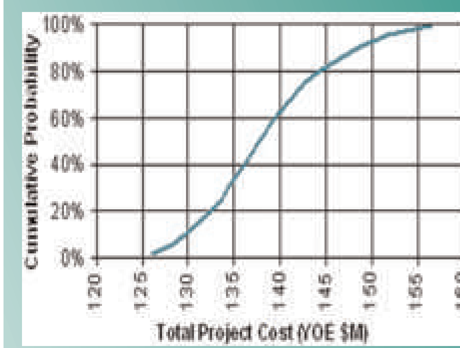
WSDOT's use of probability-based methods to estimate infrastructure costs has generated interest across North America, primarily for proactive financial and project management. MTO recently applied the process to the planned widening of the QEW through St. Catharines and several projects in Windsor.

Ranked risk register, showing top five risks to project schedule.

| Risk Rank | Sum of Expected Delays To All Affected Activities (Months) | Risk Event |
|---|---|---|
| 1 | 4.6 | C4. System-wide construction staging issues |
| 2 | 2.5 | E9. Delay in approvals |
| 3 | 1.9 | C23. Other construction duration uncertainty |
| 4 | 1.9 | D4a. Uncertainty in structure design -municipal replacement structure |
| 5 | 1.6 | D3a. Uncertainty in structure design for bridge replacement |




**Above:** Probability distribution for total project cost funds including simulated additional overhead costs related to project delays.




**Above:** Cumulative probability distribution for total project cost (i.e. 80% chance that the project will be delivered for less than $145M).

Lastly, by using the results of this process as a communication tool, public officials have been able to demonstrate that they have a process in place for managing public funds. Risk-based cost and schedule analysis allows for identifying, prioritising and addressing problems before they become major issues, which is one of the best ways to reduce project disruption, cost over-runs, and delays. "WSDOT has performed an unprecedented public service with these latest cost estimates," wrote the Seattle Post-Intelligencer in an editorial in June 2002, "It is a much needed dose of fiscal reality." •

For more information, contact Steve Holmes, Highway Design Office, at (905) 704-2286, or Steve.Holmes@mto.gov.on.ca or
Storer Boone, P.Eng, at (905) 567-4444 or sboone@golder.com

### Functional Performance Specifications

# Knowing What You Need

The Ontario Ministry of Transportation (MTO) has introduced an innovative Value Engineering technique that helps stakeholders communicate their requirements to designers called "Functional Performance Specifications" (FPS). This technique, which has recently been used successfully by the ministry on several projects, produces a report that clearly defines project requirements to the designer without limiting the solutions. Originally developed for the manufacturing sector in France and used extensively in the government sector in Quebec, these MTO initiatives mark the first use of FPS in Ontario.

An FPS report results from a facilitated workshop in which project stakeholders identify their requirements as functions, an active verb and a measurable noun. Each function is characterized based on criteria (how the function is accomplished), level (the acceptable result for each criteria), and flexibility (how much a level can be negotiated) as shown in the car-buying example in Figure 1.

MTO first applied FPS in the planning of the Traffic Volume Information System II (TVIS II), a software database that will store and provide information about traffic volumes on provincial highways to traffic professionals. The use of FPS allowed MTO to clearly define the features and goals of the software database project prior to development of the database.

**Figure 1.** Characterizing a function in a car-buying example.

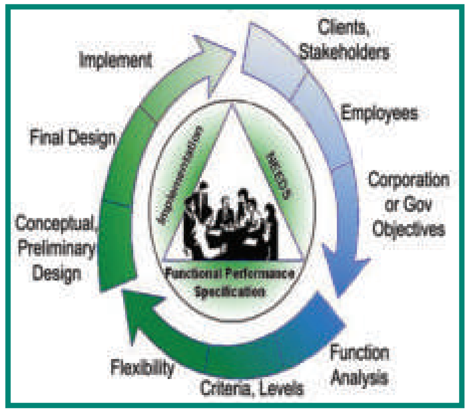
| Function | Criteria | Level | Flexibility |
|---|---|---|---|
| Select Car | Number of Passengers<br>Style Type<br>Fuel Efficiency<br>Price | 5 Passengers<br>SUV<br>12 litres/100km<br>$15,000 | F0 (no flexibility)<br>F3 (very flexible)<br>F1 (minimal flexibility)<br>F2 (medium) |

Building on the effectiveness of using FPS to define database requirements, a three-day study characterized required functions for a prototype concept for a truck inspection building. The designers used FPS to develop architectural concepts for building and the prototype was quickly approved because it met stakeholder needs.

MTO also applied FPS to determine criteria for the installation of Fixed Automated Spray Technology systems (FAST – see Road Talk, Nov.2002). "By following the FPS process, we were able to quickly define, as a group, the requirements and performance criteria for investing in Fixed-Automated Spray installations," said Area Engineer Mike Pearsall.

MTO has found FPS to be a very effective technique in working with stakeholders to define their requirements on a variety of projects.

In projects where the needs are not clear, FPS can be of benefit because the process favours dialogue between stakeholders, owners, and suppliers. FPS is an excellent procedure for establishing performance criteria including technical, staffing, societal and regulatory criteria. FPS is also useful early in a project life where supplier innovation is an advantage. FPS lends itself to defining requirements for new products or services, changing business requirements, projects with multiple stakeholders and to clarify fixing business requirements prior to I.T. development.




FPS flow chart featuring all steps in the process.


For more information, contact Andrew Beal, Traffic Office, at (905) 704-2948, or
Andrew.Beal@mto.gov.on.ca
or
Steve Holmes, Highway Design Office, at (905) 704-2286, or
Steve.Holmes@mto.gov.on.ca


## Reader Response

### Got a great article idea for Road Talk?

Send us any ideas, comments, or suggestions concerning local innovations, workshops, or seminars that you would like to see included in future issues.

*Road Talk* is also available in French.

**By Email:**
Kristin.MacIntosh@mto.gov.on.ca
**By Mail:**
Ontario Ministry of Transportation
Resources Planning Office
Program Management Branch
4th Floor, Garden City Tower
301 St. Paul Street
St. Catharines, Ontario, L2R 7R4
**By Fax:** 905-704-2626

## Upcoming Conference Information

April 18, 20, 26, 2006
Gravel Road Maintenance & Design
Owatonna, Brainerd, Thief River Falls, MN

April 30 - May 3, 2006
2006 North American Snow Conference
Peoria, IL

May 3 - 4, 2006
Environmental Geospatial Information for Transportation
Washington, DC

May 9, 11, 2006
Best Pavement Design Practices
Hutchinson, MN

## Conference Reports For MTO Subscribers

There have been several conference reports recently posted on the internal Provincial Highways Management Online website, such as:

*2005 World Steel Bridge Symposium & Workshop -Nicolas Theodor

*AASHTO Technical Committee On Roadside Safety & Task Force 13 -Mark Ayton

*International Association For Impact Assessment -Dave Wake

Check them out at:
http://intra.mto.gov.on.ca/divsites/sites/od/conference.htm