# ENHANCING PUBLIC VALUE THROUGH THE APPLICATION OF VALUE ANALYSIS AND RISK ANALYSIS ON MEGA PROJECTS IN ONTARIO

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Stephen Holmes is a Professional Engineer with the Ontario the Ministry of Transportation with extensive experience in the planning, design and construction of highway infrastructure. Stephen has coordinated the Ministry of Transportation's VE program since 1999. The VE program has grown to become the leading VE program in public infrastructure in Canada, responsible for over $750 M in cost savings/avoidance and many changes that improved value. Under Stephen's leadership, Ontario's VE program has won awards from the American Associate of State Highway and Transportation Officials, and the Canadian Society of Value Analysis.

Stephen is a member of the American Association of State Highway and Transportation Officials (AASHTO) VE technical committee and is a director of the Canadian Society of Value Analysis (CSVA). In 2009 Stephen received a presidential citation from SAVE International for Value Improvement in Government. Stephen also led the development of an innovative new approach to Value Analysis training, and the course was awarded a Gold award from the Canadian Society of Training and Development in 2009.

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## Abstract

The Ontario Ministry of Transportation (MTO) leads Canadian agencies in the use of VA/VE/VM. Ontario's Ministry of Transportation has seen an expansive growth in the use of VE from an early focus on policies and standards to a robust program that uses the Value Methodologies to improve value in projects, products, services and organizational structure. This presentation will highlight why and how VE and Risk Analysis has been used on Ontario's largest ever infrastructure projects.

It is difficult for infrastructure owners to know if they have achieved value in large, technically complex (Mega) projects. Mega projects often have aggressive schedules and many constraints. Ontario has turned to using VE and Risk Analysis to systematically challenge the project assumptions and provide decision makers with the opportunity to consider alternatives to the proposed solution. The VE and Risk Analysis process results in Subject Matter Experts developing alternative designs that reflect the true constraints and project risks

**Building on a Successful VE program.**

MTO has had a formal VE Program since 1998. The program has grown from a focus on policies and standards to VE studies on all manner of projects, processes and products. By the end of fiscal year 09/10, the VE program has achieved a cumulative cost savings/avoidance[1] of $758,420,859 [2] since the inception of the program as indicated in Figure 1 – Cumulative Cost Savings. There has been a steady progression in the use of VE in increasingly more complex projects, with Ontario now undertaking VE studies on the provinces largest ever infrastructure projects

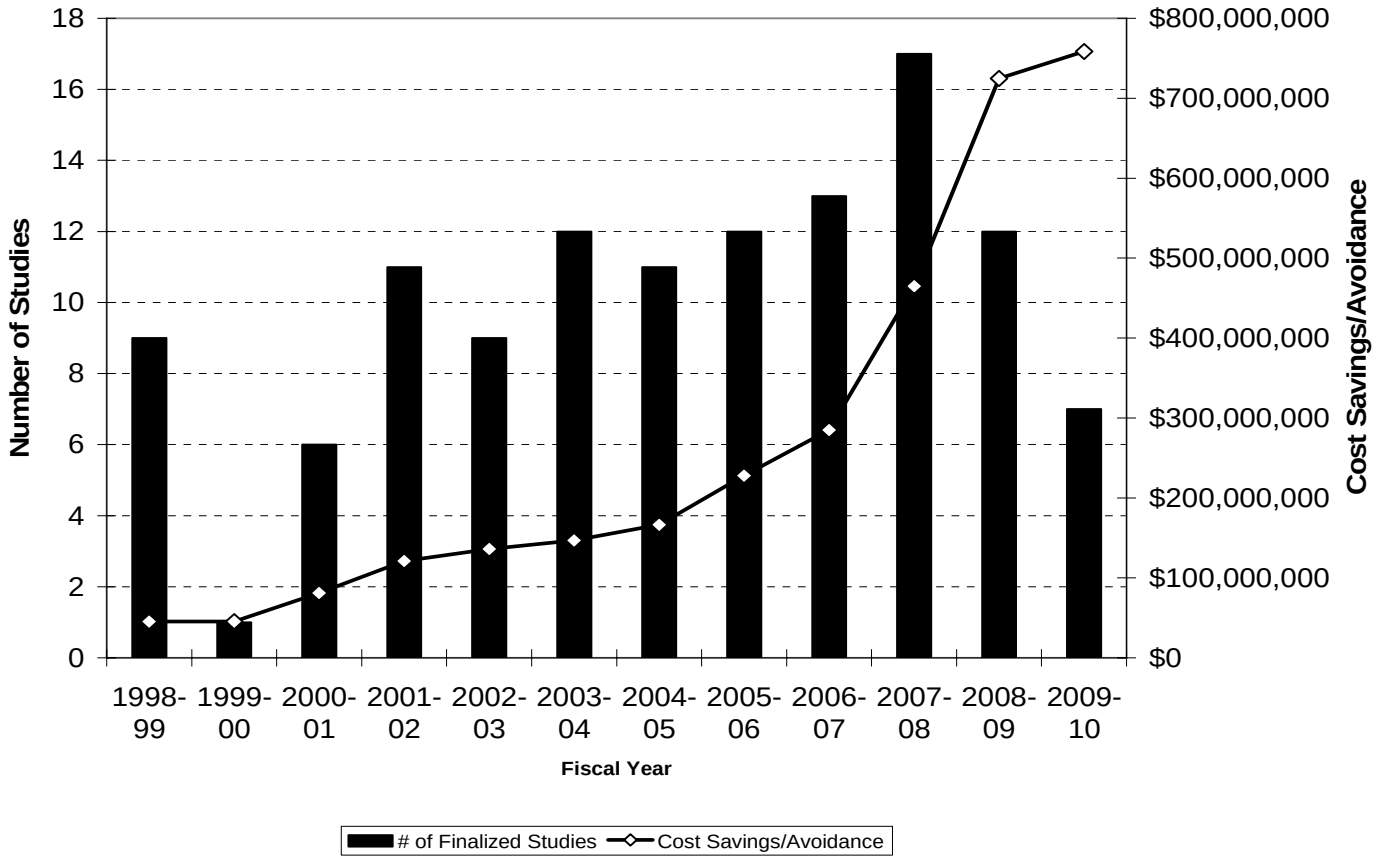


**Figure 1 – Cumulative Cost Savings**

**Ontario's Mega Projects**

Ontario has undertaken VE studies on a number of a large infrastructure projects. This paper is drawing observations and conclusions from the VE studies that Ontario undertook on the 2 largest ever infrastructure projects, the Windsor Detroit Gateway and the Highway 407 East Extension as shown in Figure 2 – Ontario's Mega Projects. Both of these projects are a high priority for the government and are being funded and built through design build finance and maintain agreements. A brief background for the projects is provided below.

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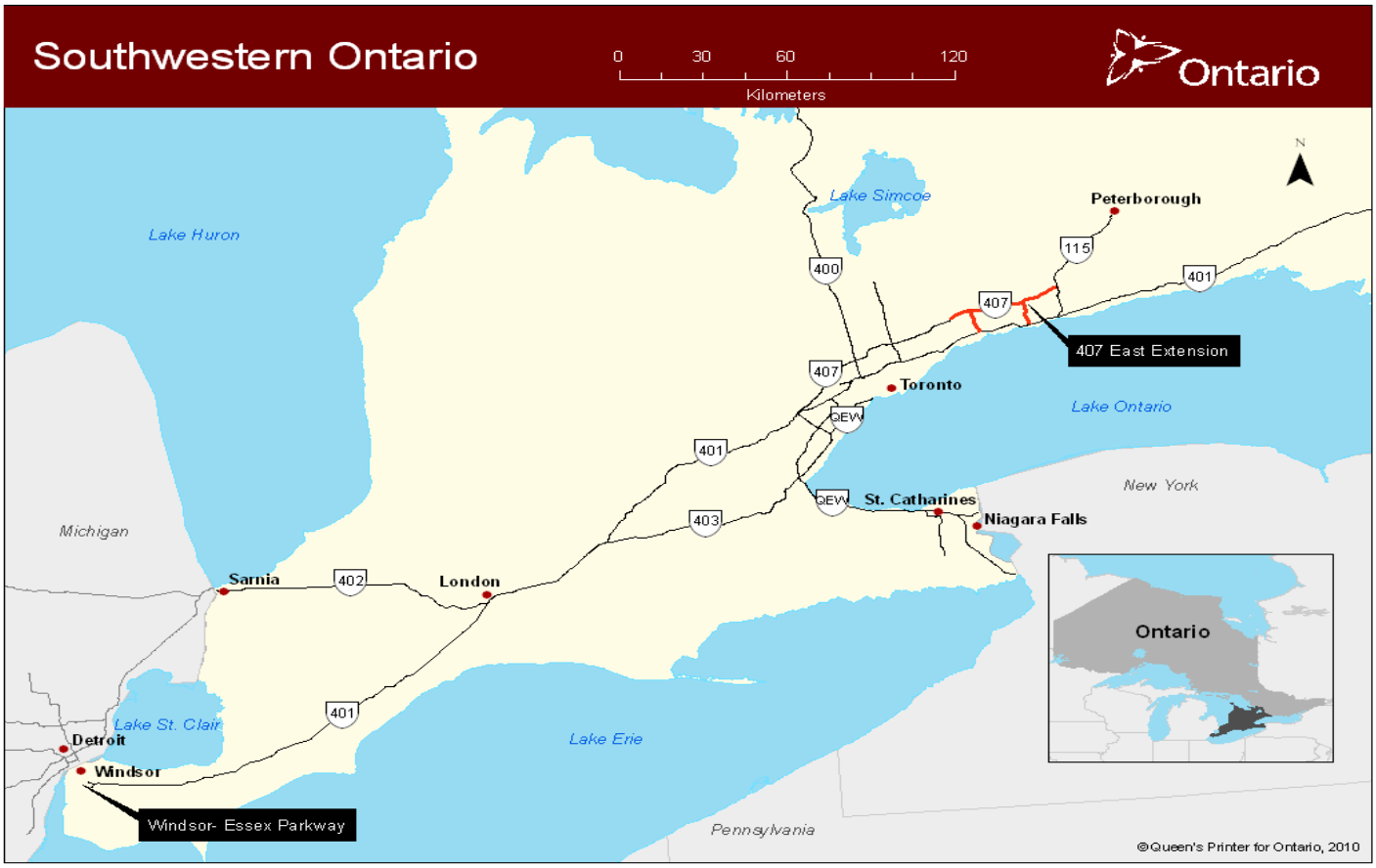


**Figure 2 – Ontario's Mega Projects**

***Windsor-Essex Parkway***

The Windsor-Detroit Gateway is a vital transportation artery between Canada and the United States. This border crossing is the busiest international trade corridor in North America and is Canada's largest border crossing. Over 16 million cars and trucks cross the Windsor-Detroit Gateway every year and in 2003, approximately $140 billion worth of goods passed through the Gateway. The development of additional border capacity is a national priority in both countries to support the dynamic just-in-time economy in Canada and the United States.

VE studies were done on all of the crossing projects, but this paper will discuss the VE studies for the Windsor-Essex Parkway. The Windsor-Essex Parkway as shown in Figure 3 Windsor-Essex Parkway, is an extension of an existing freeway (Highway 401) through an urban area to the foot of a new International Border Crossing bridge on the Detroit River. It consists of an 11 km, six- lane below-grade freeway, with 11 tunnels, separate service roads for local traffic, 20 kilometres of new public trails, and more than 300 acres of green space.[3]


**Figure 3 Windsor-Essex Parkway**

### *Highway 407 East Extension*

The Highway 407 East Extension will extend an existing freeway across the top of Toronto by 50 km to Highway 37/115 as shown in Figure 4 - Highway 407 East Extension. The project also includes two 10 km links between Highway 407 and Highway 401. The project is being planned by the public sector but it will be designed, financed and built by the private sector. Initially, provincial and federal governments committed to building this extension by 2013 as part of package of "FLOW" projects to reduce commute times and pollution in the Toronto area. The initial commitments to the 2013 date were made by the provincial and federal governments while planning was underway but before a route had been selected. The Ministry of Transportation had not secured environmental, property, or municipal approvals or agreements at the time. The project was under great time pressure.[4] The current commitment is to complete a 19 km freeway extension and a 10 km link between Highway 407 and Highway 401 by 2015 through a Design, Build, Finance, Maintain agreement[5]


**Figure 4 - Highway 407 East Extension**

***Mega Project Characteristics***

To apply VE to mega projects, it is necessary to understand that mega projects have some special characteristics that must be considered in planning the VE and Risk Analysis workshops. Based on the experience of the author, a review of the presentation, VE for the Mega Projects, and the features of the mega projects reviewed for this paper, the characteristics of a "Mega" project is the following:

- Mega projects are complex, have multiple partners involved in the funding or approvals, and many other stakeholders.
- Governments focus on mega projects and typically make public statements/commitments on when the project will be completed.
- A mega project generates a high degree of interest with the public because it affects many potential users and stakeholders.
- Complex projects have many possible solutions. The design team has to focus on getting a solution through the approval process to meet schedule commitments.
- Schedule commitments create a sense of urgency in the project teams. They are often reluctant to take time out of their project for VE or Risk Analysis. The number of days to complete the planning of the project is limited. A change in design resulting from a VE or Risk Study can be seen as an obstacle to completing the project in time.
- Mega projects can take a long time in the pre-development stage. Technology, codes, standards and criteria can change during this period.[6]
- Changes occur in the project staff, management staff, delivery strategies, funding strategies and schedules. Mega project are often delivered by alternative delivery methods.The project schedule dictates that the VE study has a fast turnaround, with:
    - Documents available just before the workshop and a very short pre-study period.
    - Pressure to minimize the duration of the workshop.
    - Short time for implementation of ideas from the workshop.

**Windsor-Essex Parkway, Value Planning**

The first VE study for the Windsor-Essex Parkway was undertaken when the route between the termination of the existing freeway and the new crossing of the Detroit River had been selected and approved by the permitting agencies and governments. The planning team had developed 5 different highway alignments within the route with many different interchange and local road configurations. An independent VE team was charged with determining if there was a 6$^{th}$ alternative that should be considered in the environmental screening of this project. The VE study team identified the functions and risks for the project and developed many modifications to the proposed highway alignments which were carried forward into the environmental screening process.

Perhaps as important as the screening process was the fact that the VE team also evaluated and ruled out alternatives that they found did not achieve good value. There had been statements from the local community that a tunnel was the only acceptable option. The VE team included an internationally renowned subject matter expert in tunnelling who was asked during the presentation phase about why a tunnel option had not been developed by the VE team. His response in why a tunnel was not a viable option aided in confirming the concepts that were viable.

***Proof of Concept through VE.***

The extension of freeway through an urban area is challenging and creates a high degree of public interest as many property owners, existing road users, and green spaces are affected. Large mega projects are sometimes challenged through the courts and through the environmental permitting process as was the case for the Windsor Border Crossing Projects.

In a complex project with many different possible alternatives, it is useful to be able to assure to outside agencies and the public that all reasonable alternatives are being carried forward into the

environmental screening process. A VE study provides an independent review of the project needs and risks and can help ascertain if the proposed solutions meet these needs[7]. Function analysis can be used to identify the project needs and to enable the team to develop alternatives without reference to the already proposed alternatives.

In a typical VE study, the team identifies the best value alternative. It is important to avoid exhibiting a bias when developing ideas for consideration in an environmental assessment for a new facility. If a VE team identifies the "best option" prior to meeting the legal requirement of a full environmental review, there could be a finding of bias. To avoid this outcome, the VE team cannot pick the best alternative. A VE team can develop alternatives while minimizing any bias through function analysis. Determining how each alternative achieves the necessary functions can enable the teams to develop alternatives without identifying what they think is the best alternative.

***Windsor-Essex Parkway VE/Risk Analysis Study***

The workshops were undertaken in the early stages of preliminary design. The environmental screening process had been completed and the specific highway location and alignment, interchange locations, and general property requirements had been approved. The VE/Risk study objective was to improve value for the approved highway alignment prior to the project. The VE/Risk study was undertaken prior to project being submitted for final environmental approval. At the time, the project was very contentious. The VE study and the Risk Analysis (risk based cost and schedule estimate)[8] needed to be undertaken by a consultant team that was independent of the team responsible for the preliminary design.

The VE/Risk Study was held as part of a 13 day joint VE and Risk Analysis workshop conducted over a series of three workshops over a 6 week span[9]. The study design is shown in Table 1 - Windsor-Essex Parkway Study Design. The subject matter experts were drawn from 14 consulting firms, the Ontario Ministry of Transportation, Transport Canada, Infrastructure Ontario and the Michigan Department of Transportation. The Risk Analysis workshop involved developing a risk based cost and schedule module using a Monte Carlo simulation.

**Table 1 - Windsor-Essex Parkway Study Design**

| | DURATION | TEAM | ACTIVITIES |
|---|---|---|---|
| Workshop 1 (VE/Risk) | 5 days | 41 Subject Matter Experts, 2 CVS, 2 Risk Elicitators | Site Visit, Information Phase, Function Analysis, Draft Risk Register, Creative Phase |
| Workshop 2 (Risk) | 3 days | 27 Subject Matter Experts, 2 Risk Elicitators | Develop Unmitigated Probabilistic Cost/Schedule<br>Identify Top Risks<br>Identify Potential Mitigation Measures |
| Workshop 3 (VE) | 5 days | 31 Subject Matter Experts, 2CVS, 2 Risk Elicitators. | Information Update – Presentation of Risk Results<br>Revisit Creative Phase – Risk Mitigation Ideas<br>Balance of VE Job Plan<br>(Idea Development, Evaluation, Presentation)<br>Develop Mitigated Probabilistic Cost/Schedule |

The VE and Risk Analysis resulted in many changes to the horizontal and vertical alignment, cross-section, bridge configurations and service roads and over $200M in cost avoidance from the base case design.
The success of the VE and Risk Studies resulted from:

- Extensive pre-planning on how to combine the teams, share resources, and facilitate a large group.
- The first workshop was a 5 day combined risk and VE session. It was designed to brief the VE and Risk team on the project and involved the information phase / briefing, risk register, function analysis and creative phase. The VE and Risk teams gained a common understanding of the project through development of the risk register and function analysis.
- The risk analysis enabled the team to better understand both the overall risks, and the specific risks that influenced cost and schedule, thus allowing the team to focus on the development of mitigation measures through the generation of VE ideas and alternatives. This also enabled quick implementation of the ideas because the risks were understood.
- The size depth of the subject matter expert team enabled detailed proposals to be developed to be compared to the base case. The 1 to 2 weeks duration between the workshops accommodated engineering work to further develop ideas.
- A number of successful VE studies had been conducted previously on this and other border crossing projects. MTO and the other agencies were aware from past experience that changes could be expected and were willing to implement the changes. They understood that on large mega projects there are many possible solutions.

**Hwy 407 East Extension VE Study**

The Highway 407 corridor has been studied for decades. Design direction and assumptions had been made and built upon by successive teams and project managers over the years. When the government committed to proceed with the extension of Highway 407, time was of the essence.

Two VE studies were undertaken on the Highway 407 project during the planning phase. The corridor is 50 km long, with many complex issues. However the most complex highway configurations and highest value targets for the project were the connections between the 407 east extension at the Highway 35/115 and at Highway 401. These connections were the subject of separate, 3 day VE studies.

The VE study at the connection of Highway 407 to Highway 35/115 resulted in a change of design philosophy that resulted in $129M in cost savings/avoidance at the connection[10]. In order to make a change in direction, the VE team consulted with and received concurrence from the various technical departments before submitting the change in design to a decision making meeting.

***Supporting Decision Making in Mega Projects***.

There is always opportunity to improve value in any project. The size and complexity and schedule pressure of a mega project provides many opportunities for new ideas. It is important to challenge design assumptions and directions. To invest time and people into a VE study when the mega project is under schedule pressures requires confidence that the study will yield results that will be implemented. To achieve results the VE and Risk study have to be carefully planned.

The VE process is particularly effective at getting teams from diverse backgrounds to synthesize a great deal of information in a short time period in order to develop viable alternatives that improve value. The project schedule dictates that the VE study has a fast turnaround, with a very short pre-study period, pressure to minimize the duration of the workshop and very little time for implementation of ideas from the workshop. The VE team has to develop focused and detailed alternatives so that an implementation decision can be made quickly. The team must focus on pre-selected high value target areas. For example, the 407 Extension, the VE teams were focused on the freeway to freeway connections, rather than the entire 50 km corridor.

Decision makers need to know that a complex project has been challenged prior to making the decision to submit the project for environmental approvals and essentially lock down the project. VE supports the decision makers because they invest staff and time in a short process that generally either yields changes to the design or validates that a complex solution is providing good value. Both the Hwy 407 Extension VE studies and the Windsor-Essex Parkway resulted in many substantive changes which decision makers approved. The changes were quickly implemented into the preliminary design and included in the final submission for environmental approvals.

## References

[1] Cost savings/avoidance are defined as the difference in cost between the proposed design and the design that results from the VE study. Savings are attributed to the project if the changes from the VE study are carried forward to the end of the design phase.
[2] Cost savings/avoidance from 1998 until the end of FY 09/10.
[3] Information obtained Nov 8, 2010 from http://www.mto.gov.on.ca/english/engineering/border/windsor/dric.shtml
[4] Information obtained on Nov 10, 2010 from http://news.ontario.ca/mto/en/2010/09/information-on-flow-and-other-transit-projects-in-the-greater-toronto-area-1.html
[5] Information obtained on Nov 10, 2010 from http://www.infrastructureontario.ca/en/projects/mto/407/profile.asp
[6] Information obtained from Randal Sprague Presentation - VE for the Mega Project, AASHTO VE Conference 2009 - http://www.wsdot.wa.gov/partners/aashtove/2009-Presentations/30-Sprague.pdf
[7] Value Engineering's Role in Improving the Environmental Process, Gary Meyers, 2007 AASHTO VE Conference
[8] For more information on risk based estimating, refer to the 2009 CSVA conference paper Introduction to Cost Risk Analysis & Risk Mitigation
[9] Information from the 2009 CSVA Conference Presentation – Lessons Learned in Coordinating VE and Cost Risk Analysis for a Mega Transportation Project- http://scav-csva.org/conf_09_program.php#lessonsLearned
[10] Further information is available from the 2009 CSVA Conference - http://www.scav-csva.org/publications.php?file_id=265

## Conclusion

The VE and Risk Analysis process results in Subject Matter Experts developing alternative designs that reflect the true constraints and project risks. An independent VE study can be used to improve the legal sufficiency of a project at the concept stage, prior to submission of the project for environmental screening. Finally, a VE study during the preliminary design of the project can improve the confidence of decision makers that the proposed solution is achieving good value.