The Use of Probalistic Cost Estimating, CEVP®, in the Management of Complex Projects to Defined Budgets

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Summary

In the late 1990s significant underestimation of cost and schedule for major infrastructure projects became a signature issue. Numerous projects including London's Jubilee Line, the Channel Tunnel and Boston's Central Artery/Tunnel Project experienced very large cost and schedule overruns that were highly visible and broadly criticized. Studies of individual projects and histories, showed that overly optimistic estimating was not a new problem and identified several fundamental issues that needed to be corrected. A central theme of the more successful of these new methods was the explicit consideration of uncertainty (risk and opportunity) in the estimating process.

An early leader in developing risk-based approaches to cost and schedule estimating in the US was the Washington State Department of Transportation (WSDOT) which, in 2002, developed its Cost Estimate Validation Process (CEVP®). CEVP was registered by WSDOT to recognize the Agency as the developer of this specific process and to require that use of CEVP would adhere to WSDOT Guidelines (www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment). Key principles of CEVP have now been broadly incorporated in policies, procedures and requirements of other Agencies.

This paper deals with the application of key management principles, as informed by the CEVP method, to the Alaskan Way Viaduct replacement project in Seattle. The preferred alternative, a bored tunnel, will replace an existing elevated viaduct, damaged in an earthquake, with 4 lanes of traffic in the largest TBM driven soft-ground tunnel to date. Management principles included: developing and communicating a clear, quantified understanding of the project with a strategy for delivery; definition and management of potential risk and opportunity; use of value engineering; managing to budget and; clear communication with the public and stakeholders. These are addressed in this paper.

Keywords: Project Management, Cost Estimating, Risk Identification, CEVP, Value Engineering, Risk Management

Figure 1
- Existing Alaskan Way Viaduct

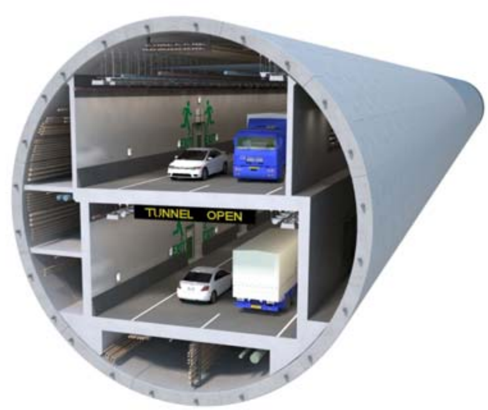

Figure 2
- 4-lane stacked deep bore tunnel

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Figure 3 - Plan of new Alaskan Way Tunnel and Associated Waterfront Improvements

1. Introduction

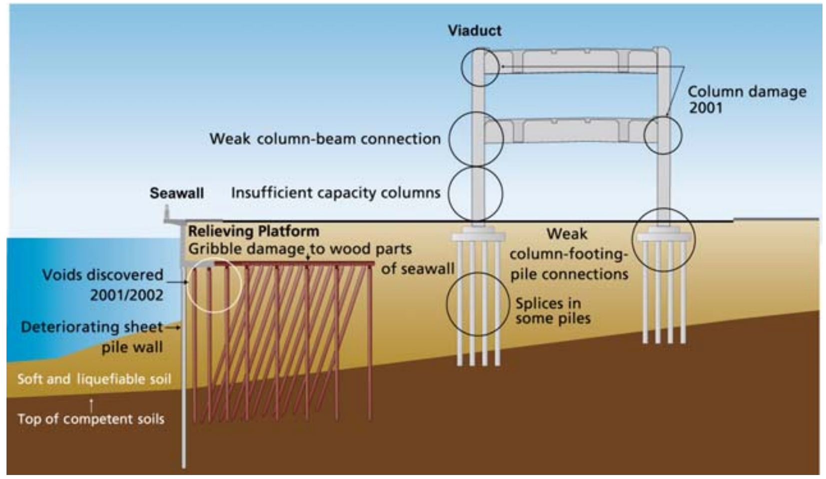

Figure 4 – Existing Viaduct & Seawall Vulnerabilities

Concerns about significant underestimation of the cost and schedule for major infrastructure projects became a signature issue in the late 1990s as numerous projects such as London's Jubilee Line, the Channel Tunnel and Boston's Central Artery/Tunnel Project experienced problems with delays and cost overruns that were highly visible and broadly criticized. The history of these estimating problems was studied and reported, notably the work of Pickrell [1], Reilly [2] and Flyvbjerg [3]. These studies confirmed that estimating difficulties were not a new problem and that a number of fundamental policy and practice changes offered the potential for improvement. In response to this better understanding of the estimating problem, there have been significant developments by government agencies and industry in the development of improved methods for cost and schedule estimating. A central theme of the more successful of these new methods was the explicit consideration of uncertainty, or risk, in the estimating process.

Coupled with better cost estimating procedures were better management practices. In Washington State the driver for new management practices was a legislated requirement that the estimated cost for a project (adjusted for escalation and some small tolerances) could not increase beyond its authorization. As the implementing agency, the Washington State Department of Transportation (WSDOT), developed and implemented new practices, including a Cost Estimation Validation Process (CEVP) for evaluating cost and schedule estimates and new project management processes that also used CEVP as a tool to capture and manage uncertainties during planning and design. This paper describes how WSDOT uses CEVP and their project management process to deliver projects that do not cost more than the authorized budget.

This can be illustrated by actions taken by WSDOT in developing a better cost estimating process and then using that process to better understand the probable cost and schedule for major projects, including the Alaskan Way Viaduct replacement project in Seattle - the case study which is used in this paper.

2. The Alaskan Way Viaduct Replacement Project (AWV)

2.1 Background – early project alternatives, cost questions

The February 28, 2001 Nisqually earthquake, one of the largest recorded earthquakes in Washington state history measuring 6.8 (moment magnitude scale), severely damaged many buildings in western Washington State including the 2-level State Route 99 highway in Seattle, which ran along the Seattle waterfront. WSDOT immediately began planning for a replacement structure. In July, 2001 one of the authors was tasked, by the Secretary of Transportation, to outline world-class replacement options, suitable for this scenic waterfront location.

Initial concepts included a new viaduct or a cut-and-cover tunnel (2 alternatives) along the waterfront, as well as deep-bore road tunnels on several alignments under the city of Seattle.

Presentations were made to the State Transportation Commission, the Mayor of Seattle and City leadership representatives [4]. After the presentations, the first question a reporter asked was: "What is the cost of these alternatives?". Given the complexity of the project and its very preliminary concept, the answer was "When we better understand the specifics of the project we will develop preliminary cost estimates". The reporter pressed for a cost – but, the same answer was given several times. Finally, the reporter agreed it was not reasonable to state any cost until we understood the specifics of the project.

2.2 Early cost numbers usually lead to "cost overruns"

This press for an early cost number is one reason why we have "cost overruns". If managers are forced to give a number too early in the development, we know it cannot be correct – however, the public will remember that early (and usually low) number when contractors submit their prices and when the project is complete. The discrepancy between the early "number" and the actual contract bid award amount becomes a basis for criticism and erodes the public's trust in the ability of agencies to accurately estimate project costs and schedules. The discrepancy is again highlighted upon completion of construction - since on highly complex and challenging projects the final cost of construction frequently is not the amount awarded at contract notice-to-proceed, due to changes and risks that eventuate during construction.

Additionally, at the early stages, there are many possibilities and uncertainties, so there is a broad "range of probable cost" at that point. A single number is not a valid statement of final cost.

2.3 Better cost estimating needed

Shortly after the above presentations and cost questions, in early 2002, a Washington State Senator questioned the Secretary of Transportation about a large cost under-estimation for a road project. The Secretary agreed that a better methodology was needed and asked one of the authors, with colleagues, to develop a better cost estimation process.

2.4 The basics of "the cost problem"

As part of defining "the cost problem" a review [5] of relevant data led to the following findings:

1. There is a general failure to adequately recognize that an estimate of future cost or schedule involves substantial uncertainty (risk),
2. Uncertainty must be adequately included in cost estimating,
3. Cost estimates must be validated by qualified professionals including experienced construction personnel who understand "real-world" bidding and construction,
4. Large projects experience significant scope and schedule changes that affect the final cost,
5. Provision for significant scope and schedule changes must be made in the cost estimates and management must deal competently with managing potential changes,
6. Future costs should be represented as a range of probable cost not a single number,
7. Inadequate communication with the public compounds the problem of poor estimating.

2.5 WSDOT's Policy – a Management and Communications Strategy

To address this, WSDOT's strategy included policy changes that would deal openly with the process of public infrastructure cost estimating so that the public would better understand, and would be better informed, as project managers and elected officials make critical project funding decisions. WSDOT decided to open the "black box" of estimating [6, 7] and present a candid assessment of the range of potential project costs, including acknowledgement of the uncertainty of eventual project scope, the inevitable consequence of cost escalation, and other major risks. Key concepts that were identified as principles for the new approach included:

- Avoid single number estimates. Recognize that at any point in the development of a project, from initial conceptualization through the end of construction, an estimate will require selecting a representative value, considering many factors that are inherently variable,
- Use a collaborative and consistent assessment process that combines high levels of critical external peer review expertise, particularly in construction cost estimating in a competitive environment, with appropriate roles and responsibilities for the Project Team and independent experts,
- Acknowledge that both cost uncertainty and schedule uncertainty are major contributors to problems with project estimating and incorporate both in the evaluation methodology,
- WSDOT saw the clear advantage, in fact the necessity, to integrate the effects of cost and schedule uncertainty,
- Use a high level of rigor identifying and quantifying probabilities and consequences of risks,
- Be practical and use common sense notions of risk descriptions and quantification. The new cost estimating method was to be completely rigorous and treat uncertainty in ways that acknowledged correlation, dependencies and other probability principles. However, the sources of information and definition of uncertainty were likely to encompass a range which might extend from highly quantified issues to those where subjective opinion from the contributors was all that would be available. This range of uncertainty needed to be captured objectively,
- Produce data that could be understood by the ultimate audience, the public.

2.6 The CEVP process

WSDOT acted on these findings by developing an improved cost estimating methodology, the “Cost Estimate Validation Process” or CEVP [5]. In doing so, WSDOT drew on previous cost validation and risk methodologies [8, 9]. The process included a base plan and strategy for project delivery, an associated base cost estimate, validation of that cost by independent (i.e. external) experts and the inclusion of uncertainty (risk and opportunity) in the estimate to produce a “range of probable cost and schedule”.

The approach includes a high level of cost validation with a comprehensive assessment of the risks that could impact a project and an analysis approach which explicitly quantifies these potential risks and their impacts for input to risk management. The CEVP output provides both a better description of the cost and schedule (as a range and distribution) and the data to inform a project management approach that includes dealing with uncertainties. Because WSDOT and the State Legislature had set a priority on delivering projects to meet budgets, WSDOT’s management process was focused on that objective.

The CEVP process, including improvements made since 2002, has been extensively documented [10, 11, 12, 13, 14].

2.7 CEVP was linked to management goals:

A CEVP analysis is more than a cost estimate - it is an analytical tool to better understand and manage the project and to define the cost and schedule characteristics of its components and the uncertainties that are inherent in the project. Some of the goals include:

1. To inform project managers, executives, decision-makers and others regarding the basis for decisions that must be made,

2. To identify and quantify uncertainty (including risk and opportunity events, variability, escalation, etc.),
3. To identify opportunities to add value, reduce risk and lower cost/schedule,
4. To evaluate risk management, risk mitigation strategies and risk management procedures,
5. To clarify and define the project for the project team - creating a more aligned and informed team and executive,
6. To understand - we can best manage what we understand - therefore a commitment to deliver is dependent on the quality of that understanding.

CEVP is especially useful in identifying and quantifying, as sufficiently as required or possible, risks and aggregated uncertainties (including risk and opportunity events, variability, escalation, etc.). It can also consider management capability, continuity and the potential effects of political changes.

2.8 Specifics of the CEVP Process

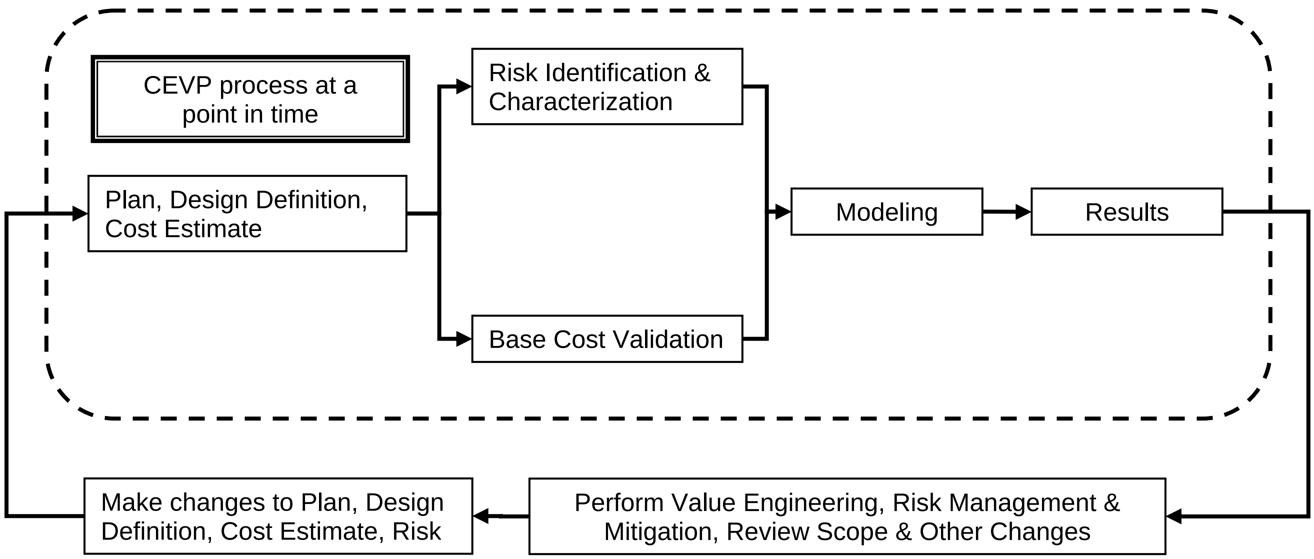

Figure 5 – CEVP process for Cost, Risk, Risk Management, Value Engineering, Scope Changes

Figure 5 illustrates the core elements of the CEVP approach to evaluating a cost and schedule estimate and the use of CEVP in a project management process. CEVP (the process within the dashed lines) reflects the project at a "point in time" and incorporates three principal and integrated components:

1. Cost validation,
2. Risk identification and characterization and,
3. Modeling.

CEVP follows the structure of a "base plus risk" [14] approach to probabilistic evaluation in which a reference project cost and schedule estimate, "the base", is defined and validated as a reasonable statement of the project outcome <u>if the project goes as planned</u>. The likelihood that there will be deviations from this plan because of specific project uncertainties is described in a set of risks (threats and opportunities) that are combined with the base to describe the potential outcome.

The CEVP process begins with a description of the plan, design approach, strategy, schedule and cost for the project as currently conceived, at a point in time. This description is provided by the project team and is supported by as much documentation as needed to undertake a critical examination of the plan. Each of the following parts – cost validation, risk identification and quantification and modeling - is then considered in an interactive workshop environment. Validation of the input data is provided in part through the use of external, independent Subject Matter Experts (SMEs) who are important to eliminate or reduce the optimistic bias, typical of the project team.

The results of a CEVP evaluation is a rich source of information that represents the potential outcomes of the project. Curves representing probabilistic range and distribution of cost and schedule are key outcomes and can illustrate a variety of data - for example costs in current dollars, costs in year of construction dollars, etc.. Cash flow and other special purpose reports are also typical. The results can be shown in histogram form (Figure 6) or as a cumulative probability curve.

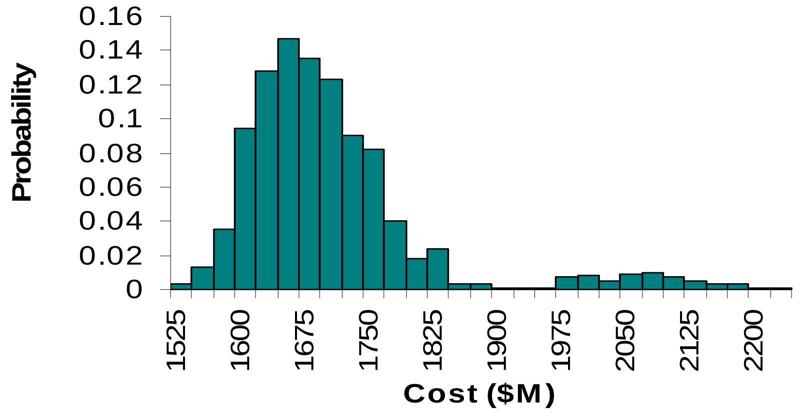

Figure 6, Typical CEVP output – probability vs. cost

A key output is a listing of the uncertainties (risks, opportunities) that have been used in the evaluation, ranked to reflect their impact on cost and schedule. Ranking allows the top impact risks to be given priority in risk management and risk response planning.

3. Management using CEVP, Risk Management and Value Engineering

A CEVP evaluation may be done at many stages in the development of a project and, as illustrated in Figure 4, periodic updates of the CEVP evaluations are appropriate as part of a process which uses CEVP to guide and inform management of changes during the planning and design process. Following a specific evaluation at a point in time the results can be used to guide changes to the project such as risk management, value engineering, scope and/or schedule changes - to improve the likelihood of meeting project objectives, especially meeting the agreed budget and schedule.

3.1 Design evolution, updates to program plan, scope, schedule

As changes in the project plan are incorporated in the design, the detailed design will advance. From time to time the evolving project plan can be reevaluated and the cycle shown in Figure 4 will be advanced and updated.

In the WSDOT approach there are typical times in project development when such an update is appropriate. These are dependent on the type of contract (e.g. design-bid-build or design-build) the complexity of the project and need. There is also a simpler Cost Risk Assessment (CRA) process for smaller projects. For a typical design-bid-build project updates are made:

1. Early in the initial project planning
2. Shortly before the environmental process is concluded,
3. After environmental Record of Decision (ROD) when the design concept is approved,

4. At approximately 60% design completion when the uncertainty of technical elements is better defined and can be used for design refinement,
5. Just prior to the final engineer's estimate to confirm expectations for project bidding.

3.2 Evolution of uncertainties

A sufficient and complete definition of uncertainties (risks and opportunities) is key to CEVP and other risk-based approaches to infrastructure project management. These uncertainties, along with the characterization of the likelihood (probability) and consequences (impacts to cost and/or schedule) of the uncertainties, are the basis for evaluating the expected outcomes (range and distribution) of cost and schedule for the project. These then become targets for management to improve project delivery. As a project progresses, individual uncertainties evolve and are either retired, revised, confirmed - or defined as having reached a residual status when there is no remaining potential for the risk to change until the project is competed.

3.3 Risk Management

For most projects it is possible to mitigate risk by specific actions taken by the project team or others in accordance with established risk management procedures [15, 16, 17]. For example, an investment in the gathering of additional design information can change the understanding of a risk, such as the risk that boulders will be encountered during the boring of a tunnel. A geotechnical investigation (e.g. soil borings), can supply information to confirm that the risk is active and to quantify the potential impact. The results of the borings will change the understanding of the risk by either confirming that the original assumptions about boulders were correct or revising the risk (increase or decrease) to be consistent with the new information. Appropriate risk response actions can then be taken to reduce exposure to that risk.

Some risks can be reduced by investment to address a deficiency. Assigning more staff to review, revise and/or validate contract documents might reduce the risk that there will be claims for errors and omissions. Similarly, the risk that there will be a challenge to the environmental process might be reduced by delaying the schedule so that additional documentation can be collected – e.g. for a biological or archaeological assessment.

The results of a CEVP evaluation specifically and quantitatively identify risks that, when mitigated, will improve project outcomes. As these risks are addressed, the project risk profile is reduced and therefore the expected final cost and/or schedule is also improved. Subsequent CEVP evaluations then quantify the cumulative impact of these actions.

3.4 Value Engineering (VE)

Value Engineering is an important process to manage within agreed budget and schedule. VE examines project functions according to an established process and seeks to maintain that function at reduced cost. By identifying cost-reduction options that maintain function, the VE process will reduce the CEVP base cost (or schedule) and may reduce the risk profile. These changes reflect actions to improve the probability of meeting objectives, similar to risk management.

3.5 Adjusting Expectation of Scope, Cost and Schedule

In many cases Risk Management and Value Engineering will not be sufficient to bring the project within the targets for cost or schedule and other actions will be required. For the majority of WSDOT projects taken to bid or constructed in the past 8 years some additional changes have been required, usually an adjustment to the project scope or schedule or both. CEVP results in these cases have provided the data to guide the decisions about which changes in scope or schedule are necessary to deliver a project consistent with expectations or constraints.

3.6 Management to budget takes priority

For any major infrastructure project it is normal to find that the scope, schedule and cost are in conflict and meeting all expectations for these three elements is usually not possible. The current controlling legislation for both WSDOT and the US Federal Transportation Agencies has clearly set cost as the priority constraint for transportation infrastructure projects. The consequence of this policy priority for most WSDOT projects has been a decision that the project plan and design will be managed to meet budget requirements. The actions of WSDOT during the past decade reflect this policy and CEVP has been an important tool to guide this process.

When the results of a CEVP assessment have indicated that the project is likely to cost more than the authorized budget and that risk management or value engineering are unlikely to reduce cost sufficiently, WSDOT has typically changed the scope or schedule or both. In a small number of cases, additional funding has been requested - but reducing scope has been the most common solution.

3.7 CEVP – a tool for managing to budget and schedule

CEVP was initially developed as a tool for Agency managers to use in evaluating cost and schedule estimates for projects with a defined scope and delivery strategy. In application by WSDOT, however, the results of the CEVP assessments soon became the basis for overall project management and a key process for managing to fixed or highly constrained budgets. WSDOT had traditionally managed projects tightly and had a good history of delivering close to budget. This meant that they were in a good position when, in 2003, the State Legislature passed regulations that required all projects to be delivered at or near a line-item budget set by the Legislature.

The practice that evolved within WSDOT to meet these requirements [13, 14, 17, 18] was to use best management practices and the results of a CEVP analysis to:

1. Identify the likelihood that a project would be delivered within budget and schedule
2. If the project is projected to come in above budget, to perform value engineering, change scope, manage risks and take other necessary actions, using the CEVP results, with additional modelling, to guide these changes.

This approach has proved to be successful for WSDOT in managing most of its larger construction projects and was used extensively on the Alaskan Way Viaduct Replacement Project, which has aggressive cost and schedule targets. Design decisions for the Alaskan Way Project illustrate how WSDOT has effectively used CEVP and a CEVP-related project management process to guide this major infrastructure project to be in a position to be delivered within the current budget authorization. This will be further examined in the case study following.

4. Case Study – The Alaskan Way Viaduct Replacement Project (AWV)

4.1 Early alternatives, evolution of the project design

Figure 7 – Existing Viduct

As noted earlier, following the Nisqually earthquake in 2001, WSDOT began planning for a replacement structure to the damaged viaduct. Initial concepts included a new viaduct or a cut-and-cover tunnel (2 alternatives) along the waterfront as well as deep-bore road tunnels on several alignments under the city of Seattle.

Given the several alternatives, cost would be a significant factor. In 2002, in parallel with the development of the CEVP process (as described previously) an evaluation of probable cost was made using the new CEVP process. The CEVP evaluations provided a critical and valuable measure of the likely cost and schedule for each of the options being considered. The design concepts at that time were very preliminary and subsequent refinement in the concepts dramatically changed the scope, cost and schedule for all potential solutions.

The initial results showed that the probable cost of most alternatives was significantly in excess of budget expectations. Accordingly the CEVP results were used to guide changes and refinements of the design concepts during the next five years and periodically, usually about every year, the concepts were updated using the CEVP process.

By 2007, after consideration of over 70 alternatives, plans for replacing the Viaduct had advanced and major environmental studies were being completed. In early 2008, a group of stakeholders representing business, neighbourhood and economic interests was convened to advise regarding final alternatives.

4.2 Viability of the deep bore tunnel, December 2008 / January 2009

In December of 2008, two alternatives – a surface option (Figure 8) and a viaduct option (Figure 9) - were presented to the stakeholders, who rejected both and instead suggested serious consideration of a deep-bore tunnel option, separating the State highway though Seattle from the waterfront and significantly reducing the impacts to business and waterfront development.

Figure 8 – Surface Option

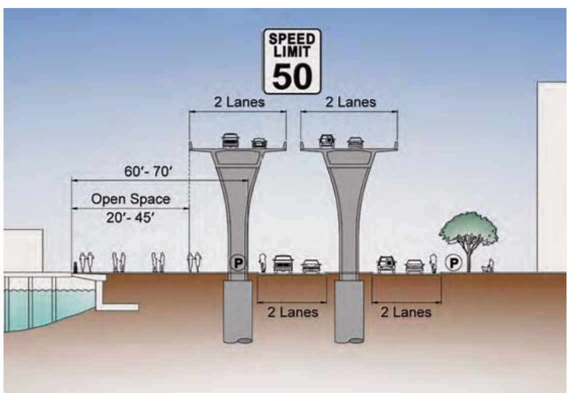

Figure 9 – Viaduct Option

4.3 Deep bore tunnel alignment

The deep bore tunnel, identified as the preferred alternative in October 2010, reconnects the street grid at the ends of the tunnel and removes the viaduct along the waterfront. The tunnel maintains a vital route for people and goods through downtown, while also improving the environment of the waterfront and opening it up for other public uses. A major advantage is that construction impacts to businesses and the traveling public would be minimized. Using a tunnel boring machine allows construction of the new facility while the existing viaduct stays open to traffic.

Figure 10 –Deep-bore Tunnel Alignment

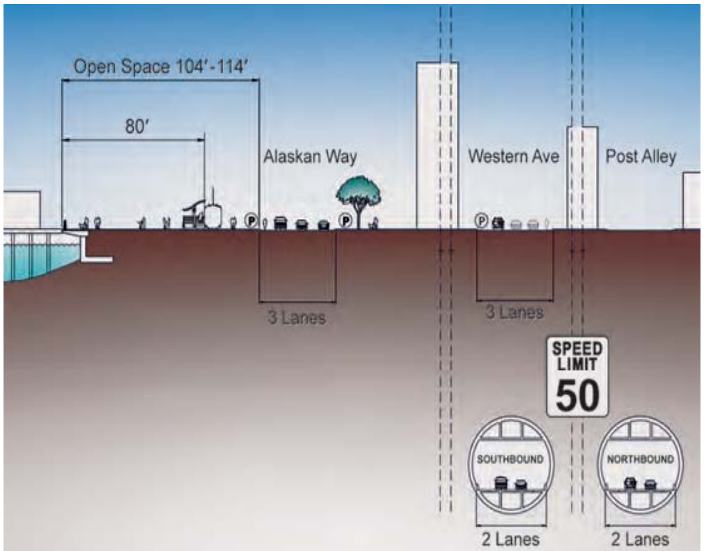

Figure 11 – Twin bore tunnel concept

In 2008, WSDOT was concerned about the cost of a tunnel alternative – at that time two tunnels, each with 2 traffic lanes were being discussed. The probable cost of these was reasonably well known and was higher than desired. The possibility of one very large tunnel with stacked 2 by 2 traffic lanes was substantially cheaper - essentially by eliminating multiple cross-passages, keeping the alignment generally under city streets and requiring one TBM and drive (the continuing earthquake danger to the existing viaduct meant that schedule for the twin tunnel approach required 2 TBMs). The large-single bore alternative needed to be evaluated quickly and the cost needed to be sufficiently defined so that the State Legislature, which was about to come to session, could act to authorize work to proceed on the design and to allocate construction funding.

In January 2009 the existing cost estimate was quickly evaluated, compared with other indicative cost data (from different engineering studies and companies) and a preliminary range of cost established - based on fundamental cost principles. This resulted in a budget determination by WSDOT of $1.9 billion for the tunnel and associated systems, as part of the full Alaskan Way Viaduct Replacement Project of $3.1 billion ($2.4 billion from State and Federal funds, $400 million from tolls and $300 million from the Port of Seattle).

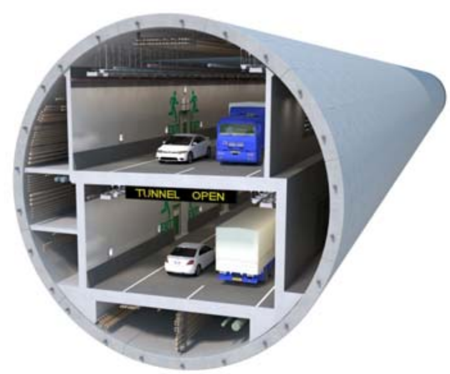

Figure 12 – Tunnel, cross-section

Although preliminary engineering was at a low level, the range and budget were considered reasonable and, at that time, included a substantial reserve for risk and inflation of some $415 million for the tunnel component. The proposed budget was adopted by the Legislature in April 2009 and the single bore tunnel was made a higher priority for environmental evaluation within the ongoing EIS process.

4.4 Environmental process

The environmental process requires that the project carry forward three alternatives – the bored tunnel, cut-and-cover tunnel and elevated structure. These alternatives will be discussed in the Final Environmental Impact Statement, scheduled for release in mid-2011. FHWA, WSDOT and the City of Seattle have identified a bored tunnel as the preferred alternative, because it would minimize construction disruption, maintain a vital route for people and goods through downtown and improve the waterfront environment

4.5 WSDOT Management actions

Immediately work on advancing preliminary design and to complete the environmental process was begun, the project team was augmented by senior WSDOT and consultant managers, a high-level strategic advisory team was constituted and the process of advancing the design of the project and its associated cost and schedule was begun - sufficient to inform design and contracting documents for internationally qualified and experienced design-build teams to bid on the contract, at or under the established budget.

4.6 Managing to budget, using an enhanced CEVP process

WSDOT uses a mix of contracting strategies to manage within budget for all projects. The AWV approach included use of an enhanced CEVP process [18], value engineering and risk mitigation to reduce cost while maintaining function and dealing with potential risk. This approach included changes to the project configuration to reduce cost and risk in order to meet budget requirements, informed by international examples, use of international experts as well as input from the shortlisted design-build teams.

During 2009, two iterative cycles of CEVP, value engineering and risk management were performed, with changes to the project being made on a continuous basis. During that year, as design evolved, there was strong pressure to increase scope and add elements, particularly in terms of more facilities (including adjacent “related” elements), type of structures, more redundant systems, quality of elements etc. Resisting increases that raised probable cost over budget was imperative and required specific knowledge of the cost implications of ongoing design development. Because of the on-going quantification of probable cost by project element, the source and cost of these changes was known sufficiently and could be acted on, essentially in “real-time”.

As a result, many changes were made to the project - modifying the tunnel's design to address several significant cost elements and risks identified during the 2009 value engineering and iterative CEVP estimating process. This included moving the tunnel's south end alignment west to avoid impacts to the sensitive buildings of the historic Pioneer Square neighbourhood and moving the tunnel's north end north-west to reduce the number of properties needed and to avoid conflicts between contractors within the construction zone. As the tunnel’s design advanced, in discussions with the shortlisted design-build teams, additional changes and risk sharing strategies were implemented to more explicitly define costs, risks and risk-sharing.

The $1.960 billion budget, set according to the early 2009 range estimate, was substantially maintained by these actions (the 60% CEVP result at the end of 2009 was $1.967 billion) but only after many significant scope and value engineering changes plus extensive risk management and mitigation actions – i.e. <u>a prime example of an owner managing to budget in challenging circumstances</u>. The result was reported to the Governor and Legislature [19] who continued to strongly support the project and the single bore tunnel. The EIS process has now identified the tunnel as the preferred alternative.

4.7 Contract documents, design-build teams, Request for Proposal (RFP)

Development of the design progressed in parallel with a request for submittal of qualifications from international contractors and preparation of the Request for Proposal (RFP) documents. Four design-build teams were shortlisted in early 2010. Draft RFP documents were released in late February and allowed early engagement with the design-build teams to address risk and contract structure. The final RFP documents were issued on May 26, 2010. WSDOT’s project team continued to work with the design-build teams to finalize contract terms, budget, and appropriate provision for risk and inflation. Proposals were received from two design-build teams on October 28, 2010

4.8 Announcement, design-build proposals, October 2010

As a result, on October 29, 2010 Washington State Governor Gregoire announced that both design-build contractor teams had submitted bids for final design and construction of the SR 99 bored tunnel at or below the established contract price limit - set by WSDOT considering expected costs, how risk was allocated and how this would be managed during construction The design-build proposals are now being evaluated by WSDOT to determine a "best value" and selection of the successful contractor for construction is expected in December 2010.

5. Discussion and comments

There is a clearly defined budget for the AWV project [19] - set by the State Legislature and involving from the City of Seattle, Port of Seattle and other stakeholders. The final cost of the delivered project must be under the authorized budget – essentially $1.96 billion for the tunnel, interior structures, ventilation buildings, tunnel and roadway systems and supporting facilities, North and South approach structures and under $3.1 billion if including connecting structures and other contracts essential for operation of the facility. Through the use of CEVP, value engineering, risk management and risk mitigation actions, as input to key management decisions, WSDOT has prepared a preliminary design and strategic plan to maximize their ability to deliver the project within the budget authorized and to deliver the operating facility in the shortest reasonable time.

Cost overruns on major transportation infrastructure projects are not inevitable. More than 50 WSDOT projects since 2002 have been bid within the authorized budget limits. Integrating CEVP with other strong project management principles has allowed WSDOT to identify, quantify and manage potential risks to successful completion of projects within budget. Defining and validating base costs and risks, managing those risks and making quantitatively informed changes to project plans has been, for them, a successful approach.

The CEVP / project management process has been successful because WSDOT, and the State of Washington, have set a clear priority on delivering transportation projects within the authorized budget. In many projects this priority has required that the targeted schedule or scope of the project must change and, for most projects, the scope and/or schedule has changed during preliminary and final design. A key tool in this process has been CEVP with its focus on a highly structured process that identifies and manages the uncertainties - risks and opportunities - that can, and will, impact eventual project completion.

6. Conclusions

The Washington State Department of Transportation initially developed CEVP as a tool to objectively and quantitatively evaluate cost and schedule estimates for infrastructure projects. CEVP has now become an integral part of a disciplined management process for the planning and design of projects by validating base cost estimates and identifying, quantifying and managing potential risks that will impact project delivery. By defining a policy that puts a very high priority on managing project cost within budget, the CEVP informed project management process has allowed WSDOT to intelligently change project scope, configuration and schedule and to structure risk-sharing in contract documents to better deliver projects at or under authorized budgets.

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