CEVP ®
Cost Estimate Validation Process
CSVA Conference 2004

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Why an Estimate is Not a Number

Estimates are uncertain . . .

- Ultimate project cost and schedule cannot be known with certainty during estimating and design
- Project cost and schedule are functions of many variables
  - scope and strategy
  - other policy
  - technical (e.g., associated unit costs and quantities)

They are essentially a snapshot in time

. . . Therefore single number estimates are dangerous

- “Number” hits the street before estimate is complete or more often does not include all of the uncertainty inherent to a project
Estimate Refinement

Cost or Schedule

Risk Management Objective

Range of Uncertainty

if many risks occur

if few problems confirmed

estimate

1%  3%  10%  20%  30%

Design Level
Uncertainty in Traditional Estimating

- Unrecognized Cost
- Known but Not Quantified
- Known and Quantifiable (can include small uncertainty)

Total Cost

Conservative Estimate - with Allowance

Estimate at any point in time
Traditional Estimating

- All known and unknown risks are equally weighted
- Expresses very little knowledge of project risks

Risk Assessment

- Ability to weight known risks according to potential impact to project cost and schedule
- Better defines those risks we can identify and refine the amount of unknown risks

<table>
<thead>
<tr>
<th>Risk or Opportunity</th>
<th>Geotech</th>
<th>Enviro</th>
<th>ROW</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20%</td>
<td>40%</td>
<td>30%</td>
<td>10%</td>
</tr>
</tbody>
</table>
Poor assessments of uncertainty lead to poor estimates . . .

Impacts of poor cost and schedule estimates include:

- Cost and schedule over-runs or under-runs
- Reduction in scope
- Resource competition
- Media attention / negative publicity
- Public mistrust
Impacts of Uncertainties: WSDOT

We have a strong estimating track record:

- Construction generally completed within 10% of Engineer’s Estimate
- Cost of change orders during construction 6-7% of bid price
- Overall programs delivered within 3-5% of total budgeted biennial program
However . . . we have our share of ‘black-eyes’ too:

<table>
<thead>
<tr>
<th>Project</th>
<th>Year 1</th>
<th>Cost 1</th>
<th>Year 2</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 167</td>
<td>1990</td>
<td>$150 million</td>
<td>2000</td>
<td>$972 million</td>
</tr>
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</table>
Goal: “WSDOT Must Build and Maintain Public Trust & Confidence”

Problem: Cost Estimating is complex and inexact, but:

- Current budgeting procedures and processes require that large projects provide precise cost numbers to facilitate budget and decision-making processes.

- Risk Assessment and Risk Management is not new to the transportation field or WSDOT, however no formalized process was in place.

Solution: WSDOT must open the “black box” of estimating so the public can be better informed as they, and elected officials, make funding decisions.
Requirements of the Project Delivery Tool

- Communicate cost in terms of ranges
- Aid in removing team bias
- Validate cost estimate and schedule
- Serve as an aid in public communication
- Provide a focus for risk management efforts
A New Tool Emerged: CEVP®

- Evaluate estimate
- Break down known items, uncertain or “risky” items (contingencies, allowances, etc)
- Build back up
  - Better defined, more accurate numbers
  - Include uncertain risk/opportunity events
- Run simulation model
  - Integrated cost and schedule model
- Express costs and durations to complete the project in terms of ranges (distributions)
- Prioritize critical risk and opportunity factors to enable more-effective project management
CEVP® Participants and Process Steps

- **Workshops, interviews:**
  - preparatory
  - base/risk assessment (1 or 2)
  - risk management / updates

- **Participants:**
  - project team
  - review team
    - facilitator / elicitor
    - base assessments
    - risk assessments
    - technical experts (validate)
    - modeler

**Review Project Scope and Strategy**
(Flow Chart and Assumptions)

**Review Activity**
Base Costs, Durations, and Escalation Rates

**Develop Cost and Schedule Uncertainty Model**

**Evaluate Uncertainty and Sensitivity in Cost and Schedule**

**Identify and Evaluate Risk-Management Strategies and Other Plan Changes (optional)**

**Report Results**

**Update (optional)**

**Develop Risk Registry**

**Assess Risk Inputs**
**CEVP® - Base Cost Determination**

- Determine the “base” costs - the most probable cost that can be expected if the project goes as planned
- Remove all contingency - i.e. provision for unknowns (representing uncertainty - risk and opportunity)

- Consider at the particular stage of the project:
  - What are our assumptions? Where do they come from? How valid are they, how do we know?
  - What do we know we know? (components, units, prices)
  - What do we know but can’t quantify? (allowances)
  - What do we know we don’t know? (uncertainty of items)
  - What don’t we know that we don’t know? (uncertainty)
Develop the project schedule ("flow chart") of major activities required to complete the project.

**Flow Chart**

- **Permits**
- **PSE**
- **ROW**
- **Bid**
- **Construction Phase 1**
- **Construction Phase 2**
- **Each segment**

- **Pre-ROD Engr**
- **Pre-ROD Permitting**
- **NEPA / SAC**
- **Pre-ROD ROW Plan**
- **Post-ROD Engr**
- **Post-ROD Permitting/approvals**
- **Post-ROD ROW Plan**
- **Funding**
- **General permits/approvals**
- **ROW Plan Approval**

- **TDM**
- **Off-site mitigation**
- **I-5 IC**
- **Portage Bay Bridge**
- **Montlake IC**
- **Montlake Blvd**
- **Floating Bridge / Approaches**
- **Points Segment**
- **Bellevue IC**
- **405 IC**

**Finish**
Potential Risk Events

1. unanticipated permitting requirements (not incl connectivity), initial vs. subsequent
2. unacceptable connectivity enhancements
3. difficulty in locating adequate retention pond sites
4. incr seismic criteria (and other design criteria)
5. difficulty in constructing avalanche bridge foundations
6. tunnel construction problems
7. other bridge problems
8. hauling may not keep up (for each of 4 stages)
9. unbalanced earthworks
10. not meeting planned crossover points before winter (each of 4 stages)
11. unforeseen weather event (for each of 4 stages)
12. rest area
13. slope stability problems
14. scope changes
15. other (all low risk items combined)
## Identify Risk + Opportunity Events (Assess Impact + Probability)

<table>
<thead>
<tr>
<th>Potential Risk or Opportunity</th>
<th>Cost Change</th>
<th>Schedule change</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Existing floating Bridge failure, or b) Bridge failure before replacement completed</td>
<td>a) -$170m b) -$35m</td>
<td>a) +24 months b) +24 months</td>
<td>a) 5% b) 3%</td>
</tr>
<tr>
<td>Simplify interchange to reduce Right-of-Way taking costs</td>
<td>+$150m</td>
<td>-8 months</td>
<td>40%</td>
</tr>
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</table>
2. Unacceptable connectivity enhancements

- **issue:** There are no published criteria or detailed accepted science regarding connectivity for sites like the project site. Because of this, the USFS may not accept proposed connectivity enhancements at Gold Creek, Price Creek, the connectivity bridge east of MP 62 and at Easton Hill.

- **impacts:** Disagreement about connectivity issues could cause delays in the NEPA process and delay the ROD, delays in permitting for the right-of-way, additional engineering cost and delays in completion of engineering, and additional bridge construction requirements and costs. The Team estimates that this issue could cause a 6 month delay in either the NEPA process or the permitting process (but not both). The team also estimates that this issue could cause a construction cost increase of up to $25M.

- **likelihood:** The Team assigned a probability of “possible to likely” for this event, or a 25% chance of occurrence based on input from Paul Wagner, Senior Biologist at WSDOT Office of Environmental Affairs.

- **mitigation:** WSDOT should continue open dialog with the USFS regarding options for connectivity. The project offers significant environmental improvement compared to the current situation and WSDOT should be aggressive in pursuing credit for out-of-kind mitigation in other areas.
What’s Next?

- Determined our Base Costs, Project Flow Chart and Uncertainty Events (Risk + Opportunity)

- Combine these probabilistically in order to generate probable ranges of cost and schedule (Monte Carlo simulation)
Evaluate Uncertainty

Uncertainty in Activity “Base” Costs
Uncertainty in Activity “Base” Durations
Risk Events (likelihood of occurrence, and likelihood for cost and duration changes if the event occurs)
CEVP® Results

Combine base costs, risk and opportunity events, with probabilities, to create potential ranges of cost & schedule

Cost Risk Contribution By Item

<table>
<thead>
<tr>
<th>Rank</th>
<th>Relative Contribution to Risk Cost¹</th>
<th>Risk or Opportunity Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23%</td>
<td>Ongoing ETC Governance &amp; Staff Issues</td>
</tr>
<tr>
<td>2</td>
<td>18%</td>
<td>O&amp;M Subsidy Risk</td>
</tr>
<tr>
<td>3</td>
<td>9%</td>
<td>Contracting Process</td>
</tr>
<tr>
<td>4</td>
<td>7%</td>
<td>Additional Parking Required</td>
</tr>
<tr>
<td>5</td>
<td>7%</td>
<td>other risk items</td>
</tr>
<tr>
<td>6</td>
<td>7%</td>
<td>Urban Design Risk</td>
</tr>
<tr>
<td>7</td>
<td>6%</td>
<td>Utility Relocation Issues</td>
</tr>
<tr>
<td>8</td>
<td>5%</td>
<td>Other Scope Risk</td>
</tr>
<tr>
<td>9</td>
<td>3%</td>
<td>Power Systems Cost Uncertainty</td>
</tr>
<tr>
<td>10</td>
<td>3%</td>
<td>Foundation Design Risk</td>
</tr>
</tbody>
</table>

¹ Relative Contribution to Risk Cost
Schedule comparison after Risk Management was initiated

Total Project Duration (months after Jan/03)

Probability

Jul-02  Mar-03
What does it take to do CEVP®?

- A knowledgeable/committed owner (who wants to know the “potential cost”)
- A well-shaped project estimate
- Available/involved project team members
- Sufficient independent subject matter experts
- Skilled risk and cost elicitors (debiasing)
- Risk modeling - technology and experience
- Time / available funding
The CEVP® “Bottom Line”

- CEVP® provides full disclosure of the risks and potential variability of large projects very early in the public process.
- With this disclosure comes better information that the public and elected officials can use to make better decisions.
- Contingency is replaced by specific risk and opportunity events - quantified magnitude and probability.
- Allows “what-if” analysis on the developed CEVP® model.
- Risk and opportunity events can be used as input to the Value Engineering process - saves some “up-front” process.
- Risk management plans can be developed - based on the defined/quantified risks.
- Provides the structure for project management to think more strategically, inclusively and longer-range.
The Public-release effort produced interesting results

“Giving citizens a range of costs, including full disclosure of the variables, “is not only politically smart, but it’s common sense”…”

John Reilly, reported in the Seattle Post-Intelligencer, June 9 2002

“Shocking or not, the Department of Transportation Has performed an unprecedented public service with these latest cost estimates. It is a much-needed dose of fiscal reality. The department offered realistic cost-range estimates”
“CEVP® produced very useful results”

“The Transportation Department developed its new numbers through a new process called “cost estimate validation” or CEVP, which features another layer of review by outside experts...The agency’s Urban Corridors Administrator characterized it as an effort to deal more openly and honestly with risks and uncertainties.”

Seattle Times, June 2002

“Giving citizens a range of costs, including full disclosure of the variables, “is not only politically smart, but it’s common sense”...”

Seattle Post-Intelligencer, June 2002

“...transportation department effort to plan more accurately and manage money more effectively...So give DOT some credit for those intimidating estimates. They should show us that it’s way past time to pass a funding package and get to work. Delay will only increase the cost.”

Spokesman-Review
June 2002
CEVP® has been registered by WSDOT to recognize their sponsorship of its development and to ensure that the term is not loosely applied in other settings to cost review procedures that contain less than all the tools and controls that have been incorporated into the process, as used at WSDOT.
Connection to Other Project Delivery Tools

The Risk Assessment process and outcomes have a direct connection on many other project delivery tools including:

- Scheduling
- Estimating
- Risk Management
- Value Engineering
Similarities and Differences between VE and Risk Assessment:

Similarities:

- Both are tools that aim to enhance overall project delivery through such things as technical review and analysis as well as improved communication.
- Both use team settings that include the project team as well as external subject matter experts.

Differences:

- In VE, the scope may change. In risk assessment, the scope is assumed to be set.
Risk Assessment and VE: An iterative Cycle

Risk Assessment workshop follows VE study . . .

- Prioritized areas of risk can be value engineered for ways to minimize their impact on project cost or schedule

Example: Right of Way acquisition is identified as the largest contributor of a project’s overall risk both in schedule and cost.

- VE study may focus on alternative strategies for acquiring Right of Way or reducing the overall number of parcels.
Risk Assessment and VE: An iterative Cycle

VE study follows the Risk Assessment workshop . . .

➤ Changes in scope/strategy need to be reflected in the project’s cost and schedule estimate

Example: Alternate method of construction for an urban interchange proposed that reduces overall construction duration.

➤ Base cost for related bid items need updating

➤ Base schedule for related work items need updating

➤ Associated risks/opportunities may be eliminated or their assessments updated
Risk Assessment and VE at WSDOT

Integrated Risk Assessment and Value Engineering Program

- Scheduling for either tool is coordinated with the potential for the other occurring
- Results for one are used as input for the other
- Both programs are housed in the same office
- Policy development is coordinated
Questions ? ? ?