WSDOT Guidelines for CRA-CEVP Workshops

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Washington State Department of Transportation

“We may not be able to get certainty, but we can get probability…” CS Lewis

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Foreword

Since 2002 the Washington State Department of Transportation committed to a program of risk based estimating for larger and more complex projects; much work has been accomplished and much has been learned in the area of risk based estimating. It is also recognized that much work remains and the learning is a continuous process.

This set of guidelines, provides a comprehensive resource for those conducting or participating in Cost Estimate Validation Process (CEVP®)[1] or Cost Risk Assessment (CRA) workshops. This document includes specific guidance for: Project Teams, Risk Leads, Cost Leads, Region CRA Coordinators and Subject Matter Experts. The approach outlined in this guidance establishes consistency in the practice of risk-based estimating but also provides the flexibility and scalability necessary in dealing with a wide variety of projects which can vary in terms of size, location and complexity. The Cost Risk Estimating Management team, as a part of the Strategic Analysis and Estimating Office of WSDOT coordinates and delivers risk-based estimating workshops for the state. The work done in the past would not have been accomplished without the committed and diligent work and contributions of our partners in the consulting community and WSDOT staff who have contributed to the development of these guidelines.

The problem of inaccurate cost estimating has dogged transportation projects for years. Those close to the transportation industry may recognize the following scenario: early in project definition, during planning, an estimate of a project cost and schedule is made known. Early figures based on a rudimentary scope of work with few project details are meant to be a rough approximation of the project but somehow this can become a public "pronouncement" of a project's cost and schedule. As the project develops and moves through scoping and early design phases, much more knowledge about the project becomes available and the cost and schedule estimates may change considerably (they tend to increase). As more becomes known about a project's scope, with the rising knowledge comes an understanding that contending with some elements of the project will require significant additional resources. Such elements could be related to scope, environmental mitigation and permitting, rising cost of right-of-way as corridors develop in advance of the project, utilities, seismic, and other considerations. When projects are built the actual cost will be in "Year of Expenditure" (YOE) dollars which is substantially higher than the early estimate based on "Current Year" (CY) dollars.

It is important to fully understand what is "known" about a project. Those items that are "not yet known" must also be addressed, which includes uncertainty and risk, including both threats and opportunities. Uncertain events in the future can pose threats or present opportunities. Project estimates must consider risk and uncertainty.

[1] "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. From here on, just the acronym CEVP will be used to reference the process."

Three questions posed by the public, and planners, are fundamental to the search for a more accurate estimate on projects:

How much will it cost? ***How long will it take?*** ***and Why?***

One answer WSDOT found to these fundamental questions is the realization that an estimate is more accurately expressed, not as a single number, but as a range. To put this into practice, WSDOT developed the Cost Estimate Validation Process, CEVP, for projects over $100 million, and subsequently the less intense Cost Risk Assessment, CRA, workshops for projects valued between $25 million and $100 million.

To determine an accurate estimate range for both cost and schedule, key risks must be identified and measured. To present a comprehensive portrayal of a project in terms of cost and schedule we must begin with a solid, well-prepared and well-documented base estimate. The base estimate documentation must include a "Basis of Estimate". Once a quality base estimate is prepared we can examine the uncertainties and risks associated with the project. Base cost is defined as the planned cost of the project; the base cost does not include contingency. A list of risks is created of both opportunities and threats, called a Risk Register. The risk assessment replaces general and vaguely defined contingency with explicitly defined risk events that includes for each, their associated probability of occurrence and impact on project cost and/or schedule. The risk component, for projects over $10M, is developed as part of a formal or informal cost risk workshop.

Estimating project costs and schedules and their likely range of possible outcomes, is an important task for WSDOT project managers and team members. Estimates are developed consistent with best practices in the industry. This process is consistent with the professional codes of ethics to which many of the workshop participants are bound. The agreements listed below represent fundamental aspects of estimating for public works projects, and are consistent with the American Society of Civil Engineers, ASCE (https://www.asce.org/inside/codeofethics.cfm) and the Association for the Advancement of Cost Engineering AACEI (http://www.aacei.org/membership/about/CanonEthics.shtml) nationally recognized codes of ethics. Ten "Agreements" for workshop participants:

I agree to:

1. observe the highest standards of my profession;
2. communicate honestly and effectively;
3. be accountable and open in my estimating practice;
4. listen as others speak without regard to position or title;
5. foster broad participation in the process;
6. exercise authority appropriately and **not** pressure others to develop estimates to a pre-determined dollar figure;
7. be a good steward with public funds for projects for the public good;
8. strengthen my understanding and practice of the principles and values of estimating uncertainty and risk;
9. work to deepen my understanding of estimating project costs and schedules;
10. continue my education and the education of others.

Helpful Hints for Project Teams

(quick reference, more detailed information can be found in the body and appendix of this document)

1	Be prepared: know what it is you want to evaluate at the workshop; be able to clearly describe the scope of the project; have a well organized, up-to-date, and easy to present project schedule and cost estimate – appropriate to the level of project development.
2	Submit workshop request form ***after*** you are clear as to the project alternatives and/or scenarios you want evaluated. Allow at least 8 weeks advance notice from the time the workshop request form is submitted and when the first prep session will be held.
3	Use the Project Management Process as outlined in the WSDOT Project Management Online Guide.
4	Follow the guidance provided in this document.
5	Keep workshop attendance to a manageable size. An effective workshop has all of the necessary people present -not more than necessary. Too many people in a meeting can make it less effective, cumbersome and slow. Read the section on Pre-Workshop and Workshop Meetings in this document – particularly: Cautionary Notes Regarding Workshop Dynamics
6	Make sure the project manager and/or assistant project manager attend the workshop. It is crucial that someone able to speak from the owner's perspective be present throughout the workshop.
7	Familiarize participants with the workshop process in advance of the workshop. The Strategic Analysis and Estimating Office can provide a representative from the CREM team to provide training and orientation in advance of the workshop.
8	When the workshop is over, it is over! The workshop is a "snapshot" examination of the project and issues of concern should be brought up during the workshop. Elicitation of risks and their characteristics are completed by the end of the workshop, then the modelers need to complete the modeling and analysis of the information generated at the workshop without interference and disruption due to post-workshop wrangling and debate. Following the completion of the analysis risk response actions are to be developed and incorporated, by the project team, into the risk management plan. Benefits of the process resonate for weeks and months following the workshop as the project team uses information gained from the workshop into their day to day decision-making and project development activities.

A note about risk, uncertainty and estimating:
"It is better to be approximately right rather than precisely wrong."

CRA and CEVP® Workshops: Statement of Purpose

Provide a useful, sound and objective, analysis and report that the Project Team will own and act upon to improve, validate/confirm their project cost and/or schedule. Workshops, conducted collaboratively with cost-risk experts and project team will:

1. ***Define and review or validate cost and schedule base estimates*** using a Lead Cost and Schedule Reviewer, Subject Matter Experts and WSDOT specialists.
2. ***Replace (or greatly reduce) the traditional project "contingency"*** with key identifiable risks that can be more clearly understood and managed.
3. Under the direction of a risk lead ***identify and quantify key events*** in a project that can cause a significant deviation from the base cost and/or schedule.
4. ***Perform a Monte Carlo simulation analysis to model the collective impact*** of base and risk issues for the complete project as a system.
5. ***Produce an estimate of a reasonable range and distribution.***
6. ***Promote pro-active risk management by project teams***. Provide the project team with actionable information on risk events that allow them to manage the risks (threats/opportunities) on an on-going basis, via mitigation strategies to better control project costs and schedules.
7. ***Document assumptions and constraints*** used in developing the estimated project cost and schedule range.
8. ***Discuss and develop concepts for responses*** to risks to the schedule that could impact the cost of the project.

CRA and CEVP® Seven step process:

1. Project and Method Selection.
2. Structuring the Project Team Effort.
3. Define and Evaluate the Base Cost Estimate and Schedule.
4. Assess Uncertainty and Risk.
5. Quantifying Uncertainty in the Project Cost and Schedule.
6. Probabilistic Analysis and Documentation.
7. Implementation and Performance Measurement by the Project Team.

Base and Risk Defined

The Base Cost represents the cost which can reasonably be expected if the project materializes as planned. Base Costs are initially estimated and accepted by the Project Team, prior to the workshop. The Base Cost Estimate is reviewed and validated during the Risk Workshop by the Cost Team and Subject Matter Experts.

The Risk component is a combination of the probability of an uncertain event and its consequences. A positive consequence presents an *opportunity*; a negative consequence poses a *threat*. In a project context, it is the chance of something happening that will have an impact upon project objectives. It includes the possibility of loss or gain, or variation from a desired or planned outcome, as a consequence of uncertainty associated with following a particular course of action.

NOTE: Additional terms can be found in the glossary document.

Risks are listed in a risk register
Risk input quantified *(P & I)
Monte-Carlo Analysis
Ranked risk register from analysis
*P = Probability, I = impact

Project team develops response actions for key risks, enters into RMP
Risks and Response actions monitored
*RMP is regularly updated
*RMP = Risk Management Plan

We can think of risk management as depicted above, the two pillars of risk management are "IDENTIFY and ANALYZE" the risks then in the second pillar "RESPOND, MONITOR and CONTROL" project risk.

Unless we incorporate the second pillar we are not realizing the full value of risk management. When preparing our project management plan and work activities for our project, **we must include both pillars of risk management in our plan**.

The preparation activities before the workshop, the workshop itself, and the analysis of the input comprise the first pillar. The second pillar requires that the project manager and project team develop response actions for the key risks, document the response actions and incorporate into their risk management plan (as part of the project management plan update), and track the risks and the effectiveness of the response actions. A follow-up analysis can be performed to demonstrate the effectiveness of the response actions.

This flowchart is an "at-a-glance" reference, please review relevant portions of the WSDOT Guidelines for CRA-CEVP Workshops for more details..

Workshop Request by project team

Project Team includes risk management in their project management plan

Pre-Workshop Activities

(review CRA website, workshop guidelines and other reference materials)

1
PROJECT TEAM
Confirm: Project Title, PIN, WIN, Mileposts are correct and WOA is setup. Complete the workshop request form and send to region CRA coordinator who forwards to the CREM office (form on CREM website).

2
CREM OFFICE
Provides: Orientation to Process
Contacts and negotiates with consultant participants (Risk Lead, Cost Lead, SMEs). Prepare task orders.
Prepare and distribute Prep Session Agenda to participants.

3
PROJECT TEAM
Assemble project information; hosts prep session, invites region participants and others they regularly work with from HQ.
Including: current basis of estimate and project cost estimate, scope and schedule.
Review reports and risk registers from prior workshops and/or VE studies.
Prepare a list of issues of concern See workshop guide for more information.

4
PREP SESSION – CREM/RISK LEAD(s)
Direct PREP SESSION
Risk Lead develops draft project flowchart and makes notes for review and comment.
CREM lead prepares action items.

5
CREM OFFICE
Invite external independent SMEs and HQ specialty groups identified at the Prep Session to participate in the workshop.
Prepare workshop agenda and send Outlook invite to all participants. Arrange Advance Elicitation Interviews

6
PROJECT TEAM
Work with CREM and COST LEAD to begin review of cost estimate.

Workshop

7
CREM Workshop Leader and Region Coordinators direct the workshop. RISK LEAD takes the lead during risk elicitation, the COST LEAD takes the lead during cost review and validation. PROJECT TEAM hosts the workshop.

PROJECT TEAM provides:
Meeting venue; preferably with internet connection.

Visual aids such as:
Aerial photos
Project Exhibits
Story Boards
Plan Sheets
R/W Sheets
Etc.
and
Project information such as:
Basis of Estimate
Reviewed and validated Project Cost Estimate (in Excel Spreadsheet);
Backup documentation for cost estimate
Project Schedule
Environmental Documentation
R/W Parcels information
R/W Cost Estimate
Other Pertinent Information

Typical Workshop Format:

CRA/CEVP workshop process overview
Workshop Introduction

Finalize project flowchart and scenarios with base durations

Confirm validated base estimate

Build Risk Register

Assess uncertainty in cost and schedule

Identify and Evaluate Potential Risk Management Strategies

Set date for mitigation review meeting

CREM lead prepares action items.

Reporting

(Post-Workshop Activities)

8
RISK LEADS
Perform Monte Carlo analysis and prepare a presentation of ***PRELIMINARY RESULTS***.
Prepare ***DRAFT REPORT*** and send to CREM Office and Cost Lead and Project Manager.
Project Manager forwards report to project team for review.

9
PROJECT TEAM
Conducts a thorough and speedy review of the draft report and promptly sends comments to CREM who works with the Cost-Risk-Team to bring draft report to a ***FINAL REPORT.***

The final report is typically finished within 2 weeks after receiving and resolving all comments from the draft report.

10
PROJECT TEAM
RISK RESPONSE
RISK MONITORING and CONTROL
Implement response strategies.
Incorporate into PMP update.
Work with CREM OFFICE to Assess and measure impact of response plan.
Monitor effectiveness of risk response actions.
Maintain and update RMP.

11
CONSULTANTS
Prepare and submit final invoices.

12
CREM OFFICE
Approve invoices for payment, close task orders.

Figure 1 Pre-workshop, Workshop, and Reporting Activities

Table 1 Workshop Team (typical participants)

Project Team Members	Role & Responsibility
*Project Manager	Project resource and decision maker.
*Estimator	Prepare and document project estimate.
*Scheduler	Prepare and document project schedule.
*Lead Designer	Primary resource for design questions.
Key Technical Experts	Specialty groups as needed.
Subject Matter Experts (SME)	**Role & Responsibility**
SMEs	SMEs provide external review and validation of the project cost and schedule estimates. Provide objective review and comment regarding project issues, risks and uncertainty. At the end of the workshop the SMEs should provide a brief (i.e. one page summary of their thoughts about the workshop).
Cost-Risk Team Members	**Role & Responsibility**
*Risk Lead	Leads risk elicitation and manages meeting during risk elicitation.
Risk Lead Assistant	Assists with risk elicitation and meeting management during risk elicitation.
*Cost Lead	Leads Base Cost Review and validation; manages meeting during cost review.
Cost Lead Assistant	Assist cost lead as appropriate.
CREM Workshop Coordinator	Coordinates agenda and participants, works with project manager to insure well-being of the workshop.

* These participants should also attend the prep session.

Recommended Participants

Preparation for the workshop may take one or several meetings depending on the project size, complexity, and knowledge of the participants. The project manager/project team should work with the workshop coordinator and cost-risk team to identify the best combination of participants at each meeting. All participants do not need to attend all meetings. The goal is to make effective use of time for all parties in a manner that insures a sound and objective analysis.

Workshop Teams and Participation - The Right Size and Participants

The criterion for project workshop team membership has to be "Who is absolutely critical to solve the problems we are dealing with?" The criterion of "criticalness" should include not only technical expertise and responsibility for implementation but also problem-solving and team skills. Workshop participants should:

1. Be involved, and
2. Be heard –related to their responsibility and/or expertise.

Pre-Workshop and Workshop Meetings

1. Prep Meeting(s)

Should be attended by both the Risk lead and the Cost lead and by the Project Team as they will be tasked to help develop the project flowchart, assemble initial project costs/durations and develop a list of risks that are candidates for significant impact on the project schedule or cost. At this meeting additional participants will be identified who

should participate at the upcoming workshop. The identification of needed support from Subject Matter Experts (SME) is an especially important outcome of the prep session.

2. Estimate and schedule review

During the time between the prep session and the workshop the cost lead and certain SME's review the project team base cost and schedule estimate and provide recommendations for their consideration. (See the scope for the cost lead for a sample of review questions that should be asked at this stage). ***Estimate review and base cost validation should begin in advance of the workshop. The Draft estimate and flowchart/schedule should be reviewed by affected project team disciplines prior to the workshop. The pre-workshop base cost estimate and flowchart/schedule must be submitted to the WSDOT region risk manager and all significant stakeholders outside of WSDOT prior to the workshop.***

3. Workshop

(attended by Project Team members, the cost risk team, and necessary SMEs and/or project specialists)

The overall workshop objectives are:

1. Review and/or validate base cost estimates.
2. Identification of uncertainties and elicitation of risks in a risk register.
3. Characterization of uncertainties and risk.

Conditioning Workshop Participants

Prior to the actual workshop, participants need to know what to expect and what is expected of them. In addition they need to be counseled to avoid bias and to be as impartial as possible during the discussions that ensue at the workshop. Individuals need to be open to listening to all opinions and not stubbornly advocate a predetermined point of view. The following paragraphs discuss procedures for conditioning the project team and subject matter experts to ready themselves for the workshop. It is presumed the risk leads and cost leads are already aware of potential biasing and will be alert to it as they lead their respective portions of the workshop.

Conditioning Project Team – Overview for "bias reduction"

Project teams are the primary focus of the CEVP and CRA workshop process. The project team knows their project and the contents of the schedule and cost forecasts better than anyone else. The CRA/CEVP environment provides an excellent opportunity for the project team to step back and share their forecasts with other experts in project development and delivery. The assurance of an accurate project cost estimate and schedule forecasts begins when a project teams initiates and aligns their team for the project. It is recognized that project teams work hard to maintain the quality of their estimates and schedule forecasts. Project teams, particularly in early project development, usually are optimistic about their project. An optimistic estimate is a low estimate. Project teams should guard against this bias toward optimism at all stages of project development. This bias has been observed to reverse itself as a project approaches completion of design. As the contract package begins to come together in advance of the ad date, project managers/engineers may become increasingly guarded

about the financial needs of the project and state estimates for costs and schedule that are too high, thereby driving the project cost estimate higher.

Overall, the purpose of the CRA/CEVP is to provide a sound base estimate and add to the set of risk events that will cause the project to turn out differently than planned. Attempting to correct estimates outside this framework will make it difficult to disentangle effects and make the management of risks less effective. Identification and quantification of risk events will provide the project team with knowledge regarding identified risk events. The project manager must decide what action to take in response to the identified risks. The Project Manager may choose to avoid, transfer, mitigate, or accept the risk. Decisions regarding risk management may affect project budget and schedule.

Conditioning Project Team—Procedures

It is important to prepare the Project Team before and during the upcoming meetings and review with them the steps needed to complete the cost risk analysis.

1. Emphasize the "Statement of Purpose" from above, to the Project Team and other workshop participants.
2. Prep Meeting (ideally held a number of weeks prior to workshop).
   a. Contact the Project Lead and arrange for a visit to the Project Site. This can occur the morning of the Prep Meeting. At this time, the Project Lead can discuss the project and significant risks faced by the team.
   b. Send the Project Lead an example project flowchart (template) from a recent project. Contact the Project lead to let them know that the draft project flowchart will need to be complete by meeting's end.

      The Flowchart will usually be much less detailed than the Project Team's project schedule and plan. However the flowchart needs to include sufficient flexibility to show the complete set of project activities and the basis for the Project Team's strategy.
3. Review with the Cost Lead the basis for the estimate of project cost and schedule durations and discuss contacts for conference calls to discuss the reviewer's comments prior to the workshop.
4. At Prep Meeting, remind Project Team to work up an initial lists of "risks to the project"—both threats and opportunities—that have the potential to cause the project cost/schedule to be significantly and measurably different than planned
5. Condition the participants that it is o.k. to have outcomes significantly different from planned (as long as they are plausible). Let them know that variation from planned is expected to be greater at earlier stages of a project design.

Conditioning Subject-Matter Experts—Procedures

Proper conditioning of subject matter experts and the risk elicitor is required to reduce the bias in expert response. Three biases tend to dominate in expert response and are described below. These are the "anchoring and adjustment bias," "availability bias," and the "representativeness bias," all researched and documented in the 1970s by Kahnemann

and Tversky and further refined by others. The biases tend to work in the direction of understating the range of uncertainty.

Anchoring and Adjustment Bias

This is the phenomenon of experts thinking they know more than they actually do. If you ask an expert for their best guess first, then they will tend to provide inadequate ranges.

1. Experts should be asked for the limits of the potential ranges first.
2. When providing extremes, experts should be able to describe the type of outcome that will generate the extreme case.
3. Ask the expert for a 'plausible' low and 'plausible' high. These can be treated in a variety of ways by the analyst who quantifies the risk. A standard needs to be established.
   a. One method is to ask the expert for a plausible minimum and plausible maximum;
   b. Another method is to ask the expert for a low and high percentile (i.e. 10% and 90%) then use this information to generate the distribution;
   c. Or another low and high percentile that the expert wishes to provide.

   (@RISK has this capability with the Alternate Parameters method of defining many, but not all, distributions.)
4. After obtaining the highs and lows ask for the expert's best-guess and use that as the median value of the distribution. Studies have shown that experts, when providing their "best-guess" are providing their median (50th Percentile) estimate.

Availability Bias

Experts are always receiving new information to add to their knowledge base. Frequently, when approached for their judgment, experts will have recent information that they have not had time to "blend-in" to their knowledge base.

One practical way to address this bias is to ask the expert a simple follow-up question regarding the issue being elicited: "Is there recent information you are using to provide your judgment?" If the answer is yes, then ask, "How does that new information weigh-in relative to all the other information you have accumulated over the years?" If the availability bias exists here, the expert, will often say something such as, "That's a good question, let me think about it and get back to you." Or, "I've thought about it and I have given the new information the proper weighting."

Representativeness or Stereotyping Bias

This is the case where experts have base information, but don't use it. Instead, they match an event with a stereotypical case. Biases, in expert response, can potentially lead to understating the range, so it is important that the risk elicitor properly condition participants and monitor and question participants if a bias is detected.

Conflict resolution

Although uncommon, there may be situations where a significant difference of opinion has arisen between workshop participants, either during or following the workshop. There are many resources and references on the topic of conflict management and

conflict resolution and can be obtained by "googling" the terms and/or visiting libraries and bookstores. However a progressive process for resolving such disagreements at workshops is offered below:

1. One benefit of the CRA/CEVP workshop process is that it allows input in the form of ranges and percent probabilities. Usually the ability to capture input in ranges meets the needs of participants offering input. For example if one participant states: "this risk event could cause $1 M in additional cost…" and another says "this risk event could cause up to $3 M in additional cost…" we can simply offer to capture the risk with a $1 M to $ 3M impact – typically this will satisfy the parties with differing opinions about the impact; (note: persons offering opinions should be able to state why they have the opinion and document information used to develop the opinion).

2. If we are not able to resolve the differences by capturing it as a range, in some cases it may be appropriate to evaluate additional scenarios that address the different opinions being offered. This is practical in some cases -to a point, but having too many scenarios can add cost and complexity to the workshop and may not be necessary and/or helpful to the overall evaluation of the project.

3. If a strong difference of opinion persists and the first two options above will not resolve the matter by agreeing to gather data and meet to review and discuss the matter with the relevant parties and subject matter experts. Striving to use objective data, with guidance from the risk leads and cost lead, to reach an agreed upon input. If after a concerted effort to reach a consensus decision, it may be necessary to adopt a solution and document the dissenting opinion in the report.

When evaluating information, consider the following:

Less reliable (less certain)	**More reliable (more certain)**
One or very few observations	Many observations
Anecdote or case study	Scientific study
Unpublished	Published and peer-reviewed
Unrepeated	Results have been reproduced
Not similar project	Similar projects
No constraints or assumptions identified	Constraints and assumptions listed
No comparative explanation of information	Comparative analysis provided

Thompson, Kimberly M. Risk In Perspective, with a light touch of editing

Workshop Activities

Elicitation (characterizing risk and uncertainty)

Eliciting information from subject matter experts and project team participants is a vital part of the process. Risks are treated as events defined by both cause and outcome. A positive outcome presents an opportunity while a negative outcome poses a threat to project objectives. Elicited information is recorded into a risk register for the project and becomes input for the Monte Carlo modeling. The risk registry lists all identified risk events (both threats and opportunities); appropriate detail describing the risk event; the risk registry should be comprehensive and must be reviewed to insure that all risks and uncertainty have been quantified and that no double-counting of risk events has occurred.

- **Risk Event Properties**
  - Likelihood (probability of occurrence)
  - Consequences (impact to cost/schedule relative to base if the event occurs)
  - Relationship with other events (independent vs correlated with other events)
- **Nature of Event Occurrence**
  - Frequency of Occurrence
  - Number of Occurrences during the project
  - Number of potential outcomes (consequences)
  - Event is independent or correlated with other events or among project activities
- **Consequences of Event Occurrence to Project Objectives**
  - Defined in terms of cost impacts, schedule impacts, or both
  - Uncertainty in event outcome

Elicitation can be accomplished in a number of ways and may utilize any one or a combination of the following approaches:

- Elicitation in the workshop
- Elicitation through a questionnaire
- Elicitation interviews of individuals or small groups in advance of the workshop
- Teleconferencing
- Other methods

Preparation for elicitation includes:

- Base estimate and schedule
- Document assumptions as basis for risk assessment
- Prepare list of base uncertainties

Elicitor guidance

- Balance in participants' perspectives (watch for bias in responses)
- Formal elicitation
- Facilitated brainstorming
  - All credible ideas are listed and discussed
  - Assess for likelihood and impact of consequences (frequency/magnitude)
- Provide guidance
  - Bounding vs anchoring (see conditioning participants)
  - Worst and best case scenarios for consequences

Elicitation of Sub-Groups

Elicitation of subgroups, as opposed to having everyone attend every elicitation session, can in some cases provide a more efficient and effective approach to help ensure a properly focused elicitation with the correct SMEs present. This approach can help keep the number of individuals to a manageable size. Group dynamics may begin to deteriorate after a group reaches a certain large size (e.g. many contributions but not necessarily from knowledgeable participants), and subdividing the elicitation provides a practical offset to the size problem. The subdivision of elicitation can happen on the same day as well by allow each of the risk leads to take a group into a separate room for elicitation. The following elicitation sub-groups have been used:

1. ROW, Utilities and Railroad.
2. Environmental, Cultural Resources, Stormwater.
3. Structures and Geotech.
4. All Other: Design, Traffic, Work Zone Traffic Control, Constructability (staging/ sequencing), scope issues/uncertainties, public pressures/opposition, local jurisdiction concerns, local market conditions/uncertainties, uncertainty in the base, management and other soft costs, etc.

Cautionary Notes Regarding Workshop Dynamics

1. **The size of the group needs to be kept manageable**. Group dynamics deteriorates beyond a certain sized group. While a good mix of expert input is desired care needs to be taken that the number of participants does not overwhelm the process or diminish the effectiveness of the workshops. For example too many people in the room attempting to speak can "drown out" or dominate time that should be used to listen to the subject matter experts.
2. **Participants who are not familiar with the workshop process and/or risk based probabilistic estimating need to be educated/acclimated to the process**.
3. The workshop effort should be commensurate to project size and complexity. Choose the right size and approach for the project. **The process is scalable.**
4. The workshop environment itself should be large and comfortable. Workshop participants will be working together for several days, it is best not to have venues that are too small or confining.
5. Biases in expert response and failures to characterize distributions and dependencies can result in understatement of the tails of the distribution. Elicitors need to be well-informed on the biases and gain experience in reducing them.
6. Be careful of "discrete" thinking. The risks being quantified are schedule and cost. These are conceptually continuous random variables and can be modeled as such. However, *likelihoods* are properly modeled using a discrete distribution as discussed under "**Distributions to Consider for Quantifying Risk"**, in the appendices "Notes for Risk Modelers.
7. For specific events, discrete probabilities are appropriate.

Report Preparation

The report is built in service of and in support for the project team's risk management and project delivery efforts. Report preparation is a collaborative effort primarily between the project team and the cost risk team, with final control of editing and publishing the report resting in the hands of the project manager. Table 2 provides a general guide list for report writing.

Table 2 Report Writing Responsibility

Project Manager/Project Team ***Actively participate in the review and editing of the report.*** Own the results and use them in their management system –including communication of results and publishing the results, including the "one-pager" on the project website.
❑ An accurate and complete Workshop Request Form ❑ Project Photo for cover ❑ Cost and schedule estimates and a brief written summary describing their preparation ❑ Reconciliation of Differences from previous estimates
Subject Matter Experts Make notes during the workshop to provide to report writing efforts.
❑ Key Risks ❑ Possible Response Strategies
Risk Lead Make notes of key discussion topics during the workshop that may be helpful during report preparation, review and editing. Works closely with the project team and cost lead to insure report is useful and understandable to the project team. Document the model logic and steps taken to insure a sound and objective analysis. Clearly identify "candidates for mitigation" and potential response strategies.
Prepare a written draft of: ❑ Executive Summary, (a "one-pager" will be included for each project analyzed) ❑ Ch. 1 Project Summary and Objective as provided by Project Team at workshop ❑ Ch. 2 Project alternatives, scenarios, and flowcharts used in modeling ❑ Ch. 3 Project Workshop Notes and Key Assumptions from workshop ❑ Ch. 4 Model Results ❑ Ch. 5 Discussion of Findings ❑ Appendix material ❑ Double-check report for clear easy to understand language ❑ Check against QA/QC Checklist ❑ Bring report to final ready condition with edits in a timely manner.
Cost Lead Make notes to aid in the writing of the estimate validation.
❑ Written overview of cost and schedule estimates ❑ Written review and validation of cost and schedule forecasts in simple language
Workshop Coordinator from CREM Office The workshop report is reviewed against the Cost and Risk Quality Control Checklist.
❑ QA/QC Checklist Review ❑ Actively, regularly communicate and work with project team and cost-risk team through completion of report ❑ Obtain final copy from Project Manager for the file.

NOTE: It is recommended that a designated "Report Editor/Coordinator" be identified prior to the workshop. The Project Manager can work with the CREM office to help determine who might serve in this role. The report editor/coordinator might be someone from the project team's communication office, the cost-risk team, or other appropriate individual.

Draft Report

Two weeks after workshop (or after final inputs have been provided to risk modeler); every attempt should be made to provide inputs by the final day of the workshop. Allow one week for comments.

Workshop Report (final)

Two weeks after Draft report is delivered (one week after comments are due). The final workshop report should be ready complete with the one-pager and risk management plan spreadsheet.

CEVP Results and Capital Budget Development Data Needs

In order to load agency management systems and provide budget information specific data needs to be provided to the region program management offices. This data is then loaded in to the Capital Program Management System (CPMS) and transferred to the Transportation Executive Information System (TEIS) for use in gaining budget approval.

	Project schedule Data Milestone dates	Project Estimated Cost Data
Required Data	Begin Preliminary Engineering Begin Right of Way Acquisition Phase Advertisement Date Operationally Complete Date	Design Cost Estimate Right of Way Cost Estimate Construction Cost Estimate

Management Endorsement

Along with the data provided by the project team endorsement from agency management indicating which costs are to be used and the scheduled to be assumed is required. Guidance on use and reporting of CEVP®/CRA Results and CPMS Data Requirements is provided in Instructional Letter 4071 posted at:
http://wwwi.wsdot.wa.gov/docs/OperatingRulesProcedures/4071.pdf

Table 3 Workshop Report

Project Team Members	The project team, just as they did before the workshop, owns the project management plan, and all project development and delivery responsibilities. This includes all project cost and schedule estimates and the risk management plan. The project team owns the report for their use in aiding and assisting their risk management and project management activities.
Subject Matter Experts	During the workshop process the SMEs are responsible for their opinions and objective advice offered during the workshop and report preparation.
Risk Lead	The Risk Lead is responsible for conditioning workshop participants and for conducting the risk elicitation. The risk lead is responsible for the modeling, analysis, and conclusions to be drawn from the analysis. The risk lead is responsible for writing their portion of the report. Uses QC checklist as a guide to insure an effective workshop experience that results in a sound and objective analysis of project costs, schedules, and risks. Clearly identifies "Candidates for Mitigation" and possible strategies for mitigating these key risks.
Cost Lead	The cost lead is responsible for reviewing and validating the project cost estimate and schedule. The cost lead is responsible for preparing their portion of the report.
CREM Workshop Coordinator	The workshop coordinator is responsible for insuring the appropriate participants are in attendance at the appropriate times. In addition the review of the report against the quality control checklist will be performed by the workshop coordinator or others in the CREM office.

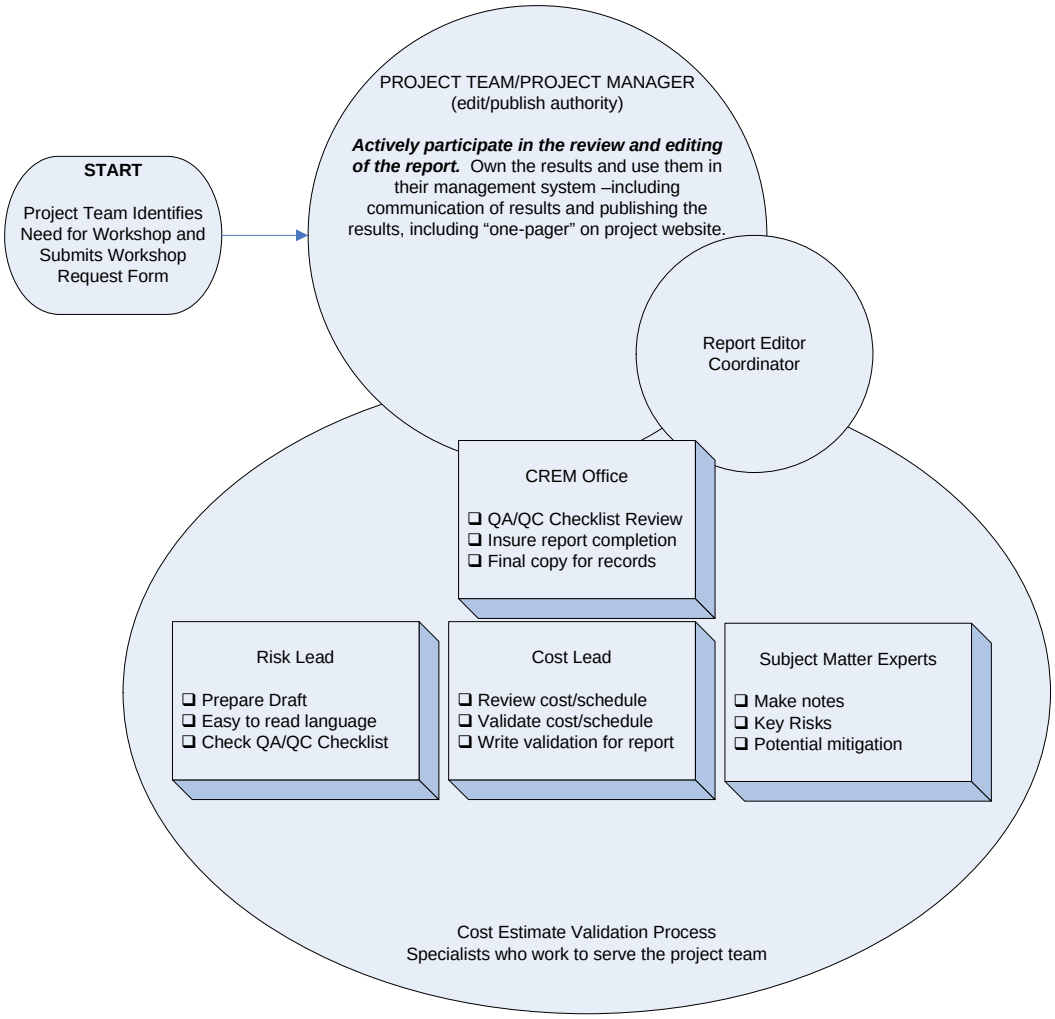


Figure 2 Report Writing

QA/QC: All have a role

PRIOR TO WORKSHOP: A reasonability check on materials developed prior to the workshop needs to be performed by the project team, project manager, appropriate specialty groups and appropriate stakeholders. The Cost and Risk QC Checklist provided in Table 4 should be used by the Project Manager to insure that the project team is ready for the workshop. When the workshop is convened most people should be familiar with and have had an opportunity to comment on the scope, schedule and cost estimate that the project team has developed and that will be the subject of review and analysis at the CRA or CEVP workshop. At the discretion of the CREM office, Regional Risk Manager, or the Project Manager, the workshop may be postponed if the Cost and Risk QC Checklist items are not all satisfactorily completed.

DURING AND AFTER WORKSHOP:

1. A reasonability check on the preliminary draft results, including charts, needs to be performed by Project Manager, appropriate project team members and specialty groups.
2. The Project Team, Risk Lead and Cost Lead work together to deliver useful products that can be acted on to improve project control through management of project cost and schedule risks. All members are equally important and must work cooperatively to achieve this objective. The Cost and Risk Leads complete the Quality Control checklist for the workshop.
3. Risk and Cost Elicitors coordinate and assist each other to make certain information is properly defined and coordinated during the workshop.
4. The modelers must carefully review the model to insure the information from the workshop is properly represented. The model logic must be described in the report and results presented to the Project Team and CREM.
5. Throughout the analysis, the risk elicitor works with the Project Team, WSDOT subject matter specialists and external SMEs to make certain the risk information is correctly captured for use in the analysis.
6. Throughout the analysis, the cost lead works with the Project Team, WSDOT subject matter specialists and external SMEs to make certain the cost information is correctly captured for use in the analysis.
7. Review of Analysis/Report by Project Team and CREM.

Table 4 Cost and Risk QC Checklist

Cost and Risk Quality Control Checklist	
Cost Lead Review	
1	❑ The “BASIS OF ESTIMATE” has been completed.
2	❑ All Project Team backup available has been reviewed and incorporated.
3	❑ The estimate scope has been validated with the CEVP workshop scope.
4	❑ All unit costs have been validated by professional judgment and/or historical cost information.
5	❑ All spreadsheet formulas have been reviewed and totals have been cross-checked.
6	❑ All costs and durations have been allocated to flowchart activities.
7	❑ Contingencies have been sufficiently removed from the base cost estimate and the inclusion in the risk estimate has been verified.
8	❑ All design allowances have been validated and allowances with large variation have been transferred to the risk estimate.
9	❑ All markup amounts have been verified and confirmed appropriate.
10	❑ All estimate assumptions and clarifications have been documented.
11	❑ Base uncertainty has been assessed and documented.
Risk Lead Review	
1	❑ The workshop process has been presented to the workshop team.
2	❑ Project Team Issues and Concerns have all been explored.
3	❑ Consensus on initial risk identification list has been achieved.
4	❑ Focus on key risks. Minor issues have been filtered out by consistent screening criteria.
5	❑ Remaining risks (threats and opportunities) are quantified in terms of likelihood and consequences.
6	❑ Potential risk mitigation measures have been captured.
7	❑ Contingencies and allowances have been coordinated with Cost Team.
8	❑ Cost Lead has verified that risks are not included in the base cost estimate (no double counting).
9	❑ All issues, impacts, likelihoods and mitigation measures are documented consistently.
10	❑ All assumptions and clarifications have been documented.
11	❑ Team consensus has been reached on all risk items.
12	❑ All risk estimate backup has been documented (date, page number, and estimator’s name).

Cautions

CEVP is iterative in nature and represents a "snapshot in time" for that project for the known conditions at that point.

CEVP normally deals with identifiable and quantifiable project-type risks – i.e. those events that can occur in planning, design, bidding, construction and changed conditions.

CEVP could also consider the larger, more difficult risks – political and management continuity and "acts of God" that can have very high impact in cost and schedule on large programs – but at this point, these risks are not generally included.
This is an area for review and development – in particular how to characterize such events in a useful manner for better management of the projects. All exclusions and assumptions need to be clearly documented in the workshop report.

It is good to remember that risk based estimating, as in CRA/CEVP workshops, does not provide an "answer book" with all uncertainty removed from the project. Risk based estimating and consideration of project uncertainty and project risk does not add costs to a project –it reveals them.

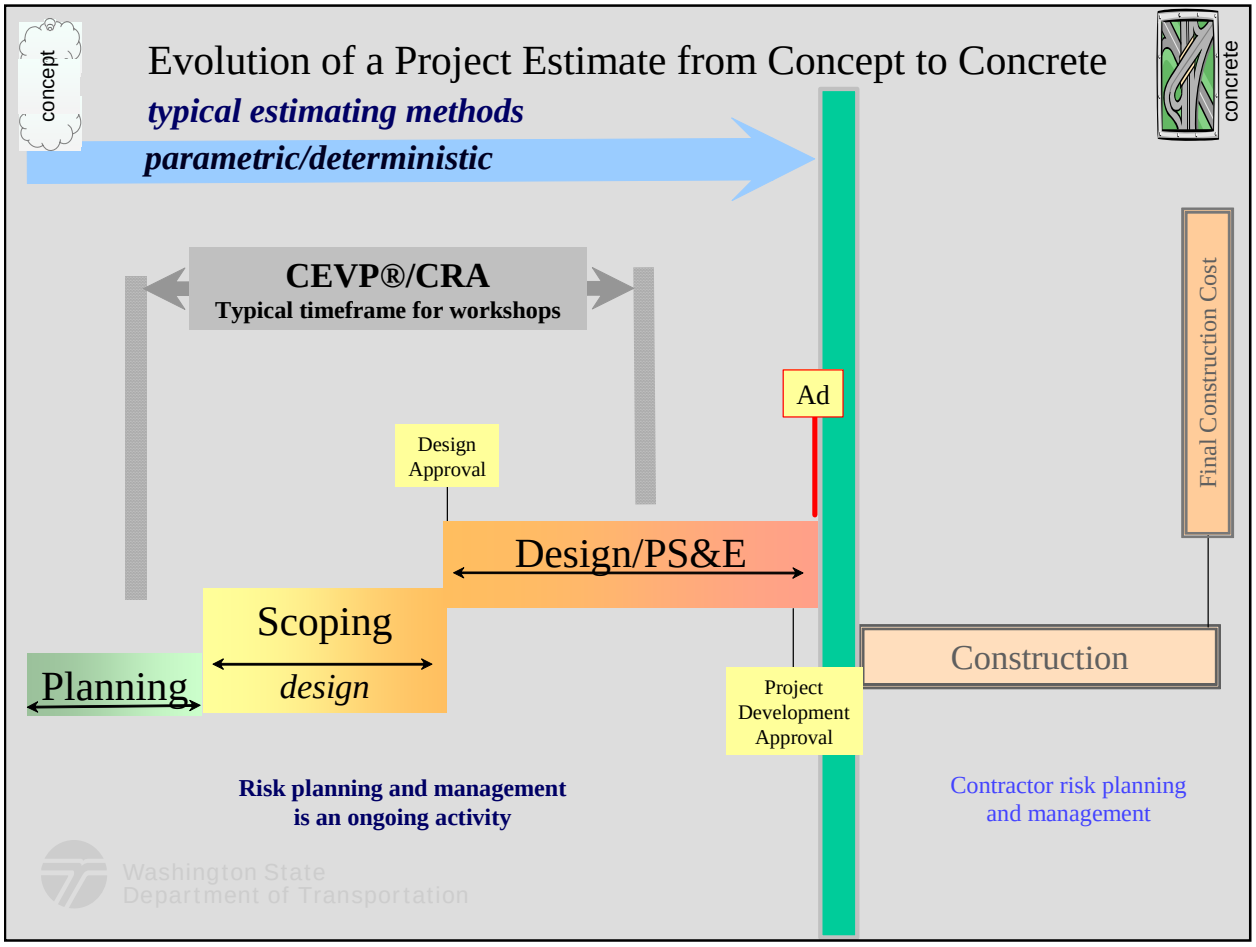
Risk Based estimating is an analysis of data provided by the team. It provides useful information for the risk management element of the overall project management plan. A report is provided that can be used by decision makers and the project team to develop an action plan. The resulting workshop report is information for decision makers to act on- it is not a decision document… it is an ***information document*** for decision makers.

"We may not be able to get certainty, but we can get probability…" CS Lewis

Appendix 1: Project Manager & Project Team - Duties
(Cost Risk Estimating Management)

Project teams typically look to the CRA/CEVP® workshop process as a tool to help improve the accuracy, consistency, and confidence in their project cost and schedule estimates; this process also helps project managers and team with their project risk management efforts, a required component of all project management plans. During this collaborative process uncertainty within a project is identified and quantified. Project schedules and cost estimates are owned by the project teams. Development of risk based estimates through the CRA/CEVP® workshop process is a collaborative effort between the project team, experts in cost and risk analysis, and external subject matter experts.

Workshops are usually held early in project development (from late-planning to early PS&E). Risk Management is an ongoing project management activity and the project manager and project team should continue to pro-actively manage risk up until advertising the contract. Continuing risk management and risk assessment should look at the knowledge gained through the workshop process and pay particular attention to evaluating sequence of construction activities and scheduling through completion of the PS&E.



Project schedules and cost estimates are owned by the project teams, and must be updated regularly, this may involve conducting workshops periodically (typically a workshop every one to two years or so). The workshop effort begins with a request from the project team. The process focuses on the project team for input of primary information and of course the project team utilizes the workshop results, as they deem appropriate, to more effectively manage their projects. The two main elements of an estimate are: *Base Cost* – which represents the cost if the project materializes as planned; and *Risk Events* – a combination of the probability of an uncertain event and its consequences. A positive consequence presents an *opportunity*; a negative consequence poses a *threat*; note that risk events are separate from variability that is inherent in the base.

CEVP®

Generally, CEVP® follows the seven steps process outlined below:

1. Selecting the Project and Method
2. Structuring the Project Team Effort
3. Defining and Evaluating the Base
4. Assess Uncertainty and Risk
5. Quantifying Uncertainty in the Project Cost and Schedule
6. Applying Probabilistic Analysis and Documentation
7. Implementing Performance measurement by the Project Team

After the probabilistic analysis is complete, the results are then interpreted, documented and reported to the project team. Standard results include total project cost and schedule distributions both in terms of current dollars and year of expenditure dollars. The resultant distributions or ranges have specific probability characteristics and are reported as percentage values.

Statement of Purpose for CEVP®/CRA Workshops

Provide the Project Manager and Project Team with actionable information that can be used to shift the odds in favor of project success. Provide a useful, sound, and objective analysis and report that the Project Team will own and act upon to improve, as well as to validate/confirm their project cost and/or schedule.

The risk management performance can be measured by comparing “pre-mitigated” to “post-mitigated” results, then identify risk responses to ascertain the amount of risk relief to be accomplished through risk management efforts.

The process provides a tool for the project team to evaluate the quality and completeness of the current Project Estimate. It is intended to increase confidence in the project cost and schedule forecasts and to identify areas of uncertainty.

The workshop process is not intended to “recreate the wheel,” or second-guess the Project Team, it is not a substitute for other necessary Project Management functions such as project control and value engineering.

Typical applications of results:	
• Presentation of cost estimate range • Project assessment and management • Risk Management • Value Engineering	• Integrated Project/Program Mgmt. • Design/Build and Other Applications • Communications • Financial Management

Risk based estimating, such as CRA/CEVP®, does not provide an "answer book" with all uncertainty removed from the project. Probability, not certainty, is the outcome from the workshop process.

The CRA/CEVP® workshop effort is an analysis of data provided by the team in collaboration with subject matter experts and cost and risk experts. It provides useful information for risk management and is an integral part of the overall project management plan. The project team owns the workshop report and results to help them develop a plan of action to respond to the identified risks. The report resulting from the CEVP analysis is not a decision document… it is an information document for decision-makers.

Project Status Prior to CRA/CEVP Workshop

1. Provide plans and documents that describe the scope, schedule, and cost estimate of the project. The project manager needs to approve of the project management plan, including scope, schedule and cost estimate prior to the workshop. In addition all key contributors need to confirm and accept the estimate that is being presented for analysis in the workshop. The information presented by the project team should not be a surprise to the specialty groups and stakeholders involved in the project.
2. Describe the level of project maturity (i.e. percentage of design completion).
3. Describe the character and timeframe of the project and issues of concern.

Remain mindful of the overall workshop objectives, which are:

1. *Review and/or validate base cost estimates.*
2. *Identification of uncertainties and elicitation of risks in a risk register.*
3. *Characterization of uncertainties and risk.*

In order to improve the quality of our Cost Risk Assessment and CEVP workshops and effectively use the subject matter experts at the workshops, the project manager and project team do the following:

- Submit CRA/CEVP Workshop Request Form at least 8 weeks prior to the workshop (note: UCO requires request 12 weeks in advance).
- The following documents should be submitted 2 weeks prior to the workshop:
    - Updated Project Management Plan (including Risk Management Plan)
    - Current project schedule to be used in the workshop
    - Current estimate file with assumptions and basis of estimate
    - Current Project Summary (and detailed project scope)

The items above need to be completed and turned in early so that workshop participants can learn the basic elements of the project, and begin review of key items of the cost estimate. Project estimate review and risk assessment are the main workshop topics.

Project Team Responsibilities and Requirements

The project team needs to make available, for the majority of the workshop, key people who can represent the Project in areas essential to the Project Objectives. This includes:

- Project Management (provide project context and relationship with stakeholders);
- Engineering (design and construction)
- Cost Estimating
- Scheduling
- Environmental permits, processes and mitigation

The Project Manager is to insure the availability of project team members who can speak to the issues raised in the workshop and are familiar with the documentation.

The Project Team must be prepared to identify applicable risk elements (global and project specific), the interrelationships of the risks, and the characterization of the risks in terms of likelihood and impacts. If the Project Team is interested in pricing the project for different delivery methods, e.g., Design-Bid-Build vs Design-Build, they need to be prepared to discuss this.

The Project Team, working collaboratively with the workshop team, should be prepared to discuss and determine:

- Exclusions
  - Funding
  - Programmatic Issues
  - Others
- Adequate Subject Matter Expert participation
- Authority to “debias” the input
- The optimal process balance between effort and accuracy; level of analytical detail and- how to handle dependence, correlations, and distributions.
- The probabilistic risk-based integrated cost and schedule modeling needs.
- Global vs project specific risks and other uncertainties
- Treatment of base uncertainties.

Items Required from the Project Team Prior to the Workshop

- Project Team Organizational Chart.
- Project Team Contact Information.
- Project Vicinity Map, informational documents, aerial photos, et al.
- Project Definition Documents and Design Criteria used.
- Summary or overview of Project Plan(s) that indicate the project elements at the type, size, and location level. This may include concept plans, cross-sections, illustrations, public information documents, memorandums of understanding, geotech info, etc.
- If there are multiple alternatives there needs to be a description of status and relationships sufficient to understand the options and to plan the workshop priorities.
- The Basis of Cost Estimate including estimating assumptions, qualifications, exclusions, programmatic issues, and constraints.
- Current Estimates (unit prices, parametric estimates, combination…), including an overall "project/program rollup estimate". Please note the base year of the estimate.
- A preliminary listing of risks and the Project Team's issues of concern.
- A preliminary project flowchart showing key tasks and relationships from current status through completion of construction and open to traffic.
- Current Design and construction schedule, including description of how durations were determined and an explanation of the construction sequencing strategy.
- **Estimated durations and costs associated with completion of Preliminary Engineering:**
  - Mapping and Surveys
  - Engineering and Design
  - Geotechnical Investigation
  - Environmental Process and Permitting
  - Environmental Mitigation Design (including Administrative costs)
  - Hazmat Remediation Design
  - Structures
  - Hydraulics
  - All other relevant areas for the subject project
- **Estimated durations and costs associated with completion of Right-Of-Way:**
  - Real Estate Services
  - Right-Of-Way Acquisition Services (includes administrative costs)
  - Access Management
  - Right-of-Way property costs
  - All other relevant areas for the subject project
- **Estimated durations and costs associated with Construction:**
  - Construction Engineering
  - Construction cost of project
  - Lump sum items (i.e. weigh station, maintenance facility/equipment, Park & Ride lot, etc.)
  - Utility relocations
  - Hazmat Remediation
  - Environmental mitigation (cost to construct)
  - Allowances for miscellaneous add-ons (lighting, signing, striping, SC&DI, etc.) with explanation as to what items are covered and percentage to be used, and why.
  - All other relevant areas for the subject project.

Appendix 2: Risk Lead(s) - Duties

(Cost Risk Estimating Management)

Notes for Risk Lead(s)

Description of Work:

The risk lead(s) participate in a peer-level review or due diligence analysis on the scope, schedule and cost estimate for various projects to evaluate quality and completeness, including anticipated risk and uncertainty in the projected cost and schedule.
The risk lead:

- Leads the risk portion of the process including risk elicitation and [2]**project flowchart development** for modeling.
- Keep flowchart practical; it should be a simple but complete representation of the project schedule, it is the 'backbone' of the analysis and can be thought of as an abstract of the project schedule.
- Participates in cost validation or review and risk uncertainty workshops for selected projects.
- Conducts prep sessions, followup meetings, and/or rerun sessions as necessary.
- Provides reports and presentations documenting workshops.
- Provides reports using report guide/table of contents.
- Develops or implements workshops on topics such as project definition, and risk indentification and management.

These functions are critical to WSDOT's success in delivering projects on-time and on-budget. It is anticipated that Cost Risk Assessment/CEVP reviews for each project can be accomplished in a reasonable timeframe, including a 1-5 day concentrated workshop. WSDOT personnel with aid of multiple specialty groups will coordinate CRA/CEVP. Work may include the documentation of the viability of assumptions made regarding project's configuration, scope, schedule, character, and, through risk analysis, the potential impact of risk events that may occur. The project may include creating reports documenting information determined or discovered.

Risk workshops vary based on project needs, but include risk identification, probabilistic risk assessment, development of management strategies, a probabilistic look at the effectiveness of management strategies, and other variants. Consistent methodology for probabilistic risk assessments must be used by the risk lead.

The Risk Lead plays a vital role to insure the analysis is a sound and objective analysis. It is also imperative that the analysis process and results are clear and usable by the project team. The process, as documented, must include the underlying assumptions and constraints of the analysis in a manner that is easily comprehended by the project team who will have to communicate the result of the workshop to others. The report should "tell the story" of the project scope, schedule and cost estimate.

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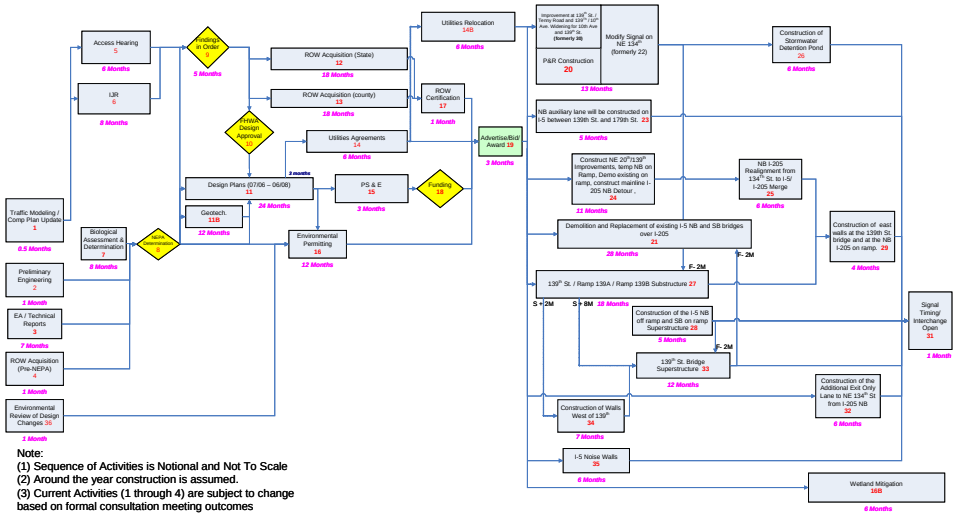
[2] Flowcharts should as simple as possible but still represent the project activities in a realistic manner with proper sequence and durations (see Figure A2-1 on the following page).



FLOWCHART

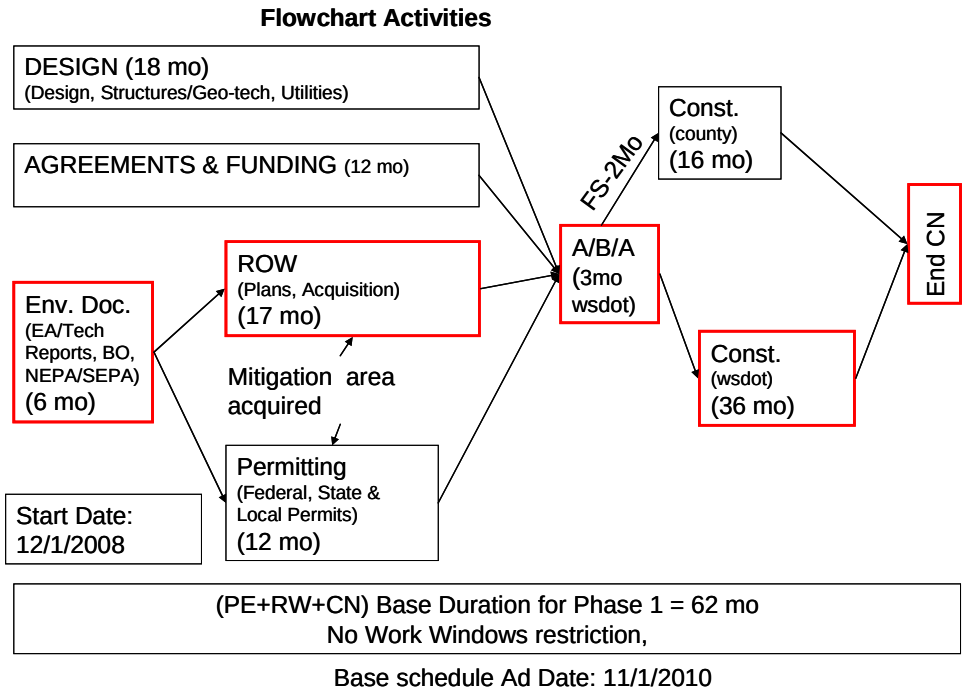


Figure A2-1 Flowchart Examples

Notice the two flowcharts in Figure A2-1 above, they are for the same project however one is simple and easy to follow while the other one is more complex. They both meet the needs for risk modeling however one is much easier to work with –remember more activities does not always mean more clarity.

Appendix 3: Cost Lead - Duties

(Cost Risk Estimating Management)

Special Notes for the Cost Lead

Description

The cost lead will participate and lead portions of a Cost Estimate Validation Process (CEVP) or Cost Risk Assessment (CRA) workshop for the project. Work includes workshop participation, leadership and facilitation, preparation, pre-workshop meetings, documentation, follow up, reconciliation of workshop results, management consulting, technical report writing, process evaluation and communication, and meeting requests to rerun models or assess new scenarios for the project. Travel to and from workshop and/or project locations.

Duties

1. Provide support for the workshop for the project. Assist with the workshop process by taking primary responsibility for:
2. Leading the Review and validation of the project team's estimate,
3. Supporting the project team in the development of the base cost estimate,
4. Supporting the project team in making any adjustments to the base estimate as a result of the review,
5. Support the development of the risk register proposing cost and schedule risk items to deal with risks and opportunities that are identified as part of the cost and schedule review,
6. Review the project team's work to distribute the base costs against the activities identified in the flow chart,
7. Work collaboratively with the project team to review and validate the final cost estimate to be used in the model. Confirm concurrence of the validated estimate with the project team and subject matter experts.
8. Leading the Review and critique of the project team's schedule.

Deliverables:

The Cost Lead will;

1. Provide Comments and validation of the project base estimate,
2. Work with the project team's estimator to develop base cost breakdowns for flowchart activities of the project for use in the risk modeling as soon as possible during or immediately following the workshop,
3. Provide a written report on the Base Cost review and validation and schedule review for inclusion in the risk analysis workshop report to the project office and CREM Team due within one week following the end of workshop or earlier if required and agreed to at the workshop.

Typical cost questions to be asked by the cost lead and the SME's

- Have you completed the Project Estimate Basis form? What is the basis of the estimate?
- How current is it? When was it updated?
- Do unit prices correlate to similar scope projects in the area? Are they truly comparable?
- Does the current scope of the work match the scope that the estimate is base on?
- Does the estimate include engineering, engineering services during construction, Construction management services?
- What is the stage of the design?
- What is the accuracy of the survey data?
- What field investigations have been done, existing conditions analysis?
- What geotechnical work has been done to date? Is there data from past projects in the area?
- Cuts and Fills: What has been assumed for reuse, import, export and disposal, temporary stockpiling, haul distances, location of imported materials?
- Assumptions on compaction? Seasonal variability?
- Assumptions on stability of cuts, sheeting, retaining walls, slope protection during construction?
- Dewatering requirements, perched water tables, and maintenance of excavations during construction, treatment of dewatering to meet permits?
- ROW: How current are surveys and estimates of costs? Partial or full parcels?
- Temporary Utilities, staging areas, parking storage and lay down?
- Knowledge of utilities in project area, relocation requirements, ability to isolate and shutdown, are replacements need prior to isolation, can replacement be installed at proper elevation?
- Erosion protection?
- Special conditions: extraordinary staffing requirements, night work, stop times due to fish wildlife issues, noise limits, and dust control?
- What has been assumed for overhead, insurance, bonding, project management, safety, QC community liaison, trailers, utilities, parking home office overhead, and profit?
- Assumptions for material availability? Backfill, sheeting, piles, concrete, rebar access for delivery, double handling requirements?
- Production rates assumed? Is this work similar to other work done in area?
- Assumptions for Maintenance of traffic, staging of construction, needed temporary barriers, ramps bridges, supports, technology.
- Estimated mitigation, noise walls, Stormwater detention ponds wetlands?
- What contingencies are built into the estimate?
- Has a change order allowance been built into the estimate?

Typical schedule questions:

- How long have similar projects taken?
- How many $/month average and peak would have to be spent to meet the schedule?
- What season is it expected that the Notice To Proceed (NTP) will be issued? Will certain months be lost due to the start date?
- Has mobilization and demobilization time been included in the schedule? How many workers are assumed to be working on the project at the peak of construction?
- Does the construction phasing and traffic management plan match the schedule assumptions?
- How many concurrent work areas are assumed? Are there crews available to staff all of those areas?
- What are the assumed production rates for each of the major elements, earthwork, foundations, piers, beams deck, sub-base, base, paving etc.?
- If the NTP is issued as planned can the landscaping be completed in the required season for the specified plantings?

Tips

1. The project team owns the estimate; let the project team establish what they want out of the process.

2. Don’t get bogged down into details, keep the discussion relevant to the overall size of the project (i.e. don’t get hung up on a $100,000 item on a $50,000,000 project).

3. The project team is under pressure to make spot decisions, take the pressure off, and try to keep it light. The objective is to produce a sound and objective analysis that results in a realistic and accurate range for the cost and schedule forecasts.

Base Cost Assessment

Estimating is a maturation process that follows the project development. Therefore there is always a story behind the estimate; it is rarely a straight forward linear process. It is imperative that you understand how the estimate was generated. Take the time to have the project team explain the history of the estimating process. Also, while the project team talks through how the estimate was generated they are mentally checking that the process is correct. The following is step by step guide through the assessment process;

1) **Confirm Cost Matches Scope**
   Gain a comprehensive understanding of the project scope, limits, major items of work such as structures, construction staging, phases, etc. during the project team presentation. Validate that the scope description, drawings, and estimate match in terms of work items. Use the expertise of the team to validate the design elements (e.g. if there is a curved bridge has the team assumed steel girders and factored that into the unit price).

2) **Confirm Unit Prices are Valid**
   Based on experience, bid tab data, and recent projects in the area validate unit prices. Per square foot of bridge deck is usually contentious, foundation type; superstructure type and geometry are the major factors. This also includes confirming tax rate which varies by county, the per acre cost for right of way, mobilization markup, and engineering markup. Bid histories are useful but not the final answer, especially if bid histories are more than 3 months old; in such cases care and judgment must be used to ascertain the appropriate and valid current unit prices.

3) **Identify Contingency (internal & external)**
   Strip out the contingency in the base cost estimate. This is obvious when contingency appears as an explicit line item in the estimate. There can also be contingency hidden within the line items, such as inflated unit prices, rounding up of quantities, etc. This a judgment call based on discussions with the estimator.

4) **Split Estimate to Match Flowchart**
   The estimate needs to be cut apart to match the flowchart boxes. This is typically, environmental cost, preliminary engineering, PSE, ROW and construction. This needs to be closely coordinated with the risk group and confirmed by the workshop participants (project team, cost-risk team, and subject matter experts).

5) **Determine Risk Costs in collaboration with the Risk Team**
   Generate risk items and determine costs (this occurs in the workshop).This should be a high level estimating effort. If this becomes voluminous, consider ways to divide and conquer. It is imperative that the cost and risk scope items match- and that there is no overlap of costs and risks, nor are there any holes.

Appendix 4: Subject Matter Experts (SME) - Duties
(Cost Risk Estimating Management)

Cost Risk Estimating Management is a program created and developed to better estimate transportation projects. The program provides the framework for two comparable processes "Cost Estimating Validation Process" (CEVP) and "Cost Risk Assessment" (CRA.) These processes involve intensive collaborative workshops where transportation projects are examined by teams of top engineers, risk managers, Internal and External Subject Matter Experts from local and national private firms and public agencies and from WSDOT specialty groups with the Project Team.

External and/or Internal Subject Matter Expert participate in **peer-level** systematic project review, or due-diligence analysis, and risk assessment to identify and describe cost and schedule risks based on the information at hand. The review process examines how risks can be lowered and the project cost and schedule vulnerability can be reduced.

The Subject Matter Expert should have extensive expertise in his/her specialty area. In addition to the technical expertize the SME is expected to provide guidence and assistance on defining the cost and schedule of the projects activities related to his/her expertize. While the SMEs should focus on their area of expertise it is expected that the SMEs provide input on one or more of the following risk categories: Management; Environmental; Third Party; Design; Construction Cost estimating and cost control, Construction planning and phasing, Construction implementation; Construction claims and disputes; Real Estate and Right-of-Way, Operation & Maintenance and Safety.

The SME should understand that Risk Management could require a negative frame of mind but once identified, risks should be managed positively, so that the risks are addressed in the best possible way to minimize their influence on a project.

The SME should understand that Risk Assessment does not need to be exact to be useful, particularly during the early stage of a project. Risks and opportunities go hand in hand and their analysis should have equal consideration. Much of the power of CEVP and CRA workshops lies in the rigorous disciplined approach and the ability of team members to focus collectively, both inwardly and outwardly on a broad range of topics. The SME should…

- provide objective input in his/her field and cooperate with all team members by crossing conventional boundaries.
- have an open attitude to change by encouraging team and individuals' creative thinking.
- stay aligned to the workshop process and focus on fulfilling the ultimate workshop mission; projects delivered on time and on budget.
- be familiar with the WSDOT process for CRA and CEVP® workshops, including the policy statement, common assumptions, and other guidance.
- have a clear understanding of the specific terminology used during workshops such as: allowances, contingency, base cost, cost uncertainty, schedule uncertainty, risk, opportunity, etc.

In addition to active participation in the workshops the SME may be asked to provide documentation of the viability of assumptions made regarding the project's configuration, scope, schedule, cost estimate, and the potential impact of risk events that may occur.

The SME may be asked to participate in a follow-up or rerun session as requested; and provide reports and/or presentations documenting their work.

The SMEs and the Project Team members would strive to produce a clear and concise product (CEVP or CRA report) that would help the decision maker with sound and objective analysis in order to make informed decisions.

Note: It is preferred to have at least one SME with estimating experience from a "contractor's" perspective; that SME would participate with the Cost lead in the review and critique of the project team estimates and schedule and that this take place if possible between the project briefing/flowchart development session and the actual workshop.

Appendix 5: Region CRA Coordinator - Duties

Cost Risk Estimating Management

Region CRA Coordinators help accomplish the CRA/CEVP® program in accordance with department policy and guidelines. It is expected that region coordinators will promote and help advance the effective use of CRA/CEVP® workshops in their region and that project managers and teams use the workshop results to actively manage risk. Project teams know the details of their project; the cost-risk team knows the workshop process, modeling, and the goals of the effort, and its limitations. The Region CRA Coordinator should be familiar with both and can play an important role in the risk assessment process and serve as a bridge between the project team and cost-risk team.

Specific duties include:

1. Identify the need for CRA-CEVP® workshops for region projects (work with project offices) estimate workshop for the upcoming 12 months.
2. Establish approximate timeframe for CRA-CEVP® workshops (with as much advance notice as practical, discuss with project offices).
3. Review workshop request forms for completeness:
    - Make sure all information is provided.
    - Make sure project office is setting up WOA with appropriate Group Numbers, prior to the workshop.
4. Work with project office to make sure there is an appropriate location for the workshop (adequate size and space), other helpful meeting items.
5. Be familiar with the CRA/CEVP® workshop process.
6. Be familiar with the CREM website, it is frequently updated and occasionally additional material is posted: http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/default.htm
7. Help identify training needs and take advantage of training opportunities as they arise (cost estimating class; risk based estimating class)
8. Prepare to serve as workshop leader/coordinator for some workshops in your region.
9. Advocate, within your region, participation in CRA/CEVP® workshops as opportunities arise. For example in order to have independent specialty group representation it may be possible, on occasion, to request a person from a neighboring region to provide subject matter expertise.
10. Advocate pro-active risk response actions that are documented in the project risk management plan.
11. Assist in making sure that feedback from workshops is provided using the post-workshop evaluation form.
12. Maintain records of CRA/CEVP® accomplishments within the Region. Including involvement of workshop participants; key risks identified and mitigation strategies implemented. The effectiveness of the risk assessment and mitigation efforts.
13. Reporting needs of regions.
14. Attend training.

CRA Coordinator – "How-to" (Example walk-through of a typical project):

- Meet with the project team.
  - Determine upcoming projects that will require a risk-based estimating workshop. Work with the team early to help them identify, well in advance (8 weeks lead time or more), appropriate timing for a workshop – these target dates can be entered into the project work schedule.
  - Advise the project team to include risk management (activities) in their project schedule – this includes: Risk Planning, Risk Identification, Qualitative Risk Analysis, Quantitative Risk Analysis, Risk Response Planning, Monitoring and Control.

- Once a timeframe for a workshop is established take the following steps:
  1. Go to CREM website and download a workshop request form (http://www.wsdot.wa.gov/Projects/ProjectMgmt/RiskAssessment/) ;
  2. Work with the project team to make sure the form is completed in its entirety, during this time check Outlook Calendar "WSDOT re VERA" to determine dates that may be available for workshops and include this information in the workshop request form.
  3. Meet with Area Engineer or Project Development Engineer and design team to give an overview of the workshop process.
  4. Work with the Cost Risk Estimating Management (CREM) team to determine appropriate cost and risk leads, and subject matter experts, help complete the participation matrix.
  5. Determine who will send invitations to workshop participants – often the region will invite region and project team, and CREM Workshop Coordinator will invite others (Cost Lead, Risk Leads, SMEs, HQ representatives, etc.)
  6. Continue to communicate/coordinate to make sure workshop materials are being made ready and available by the project team to the Cost-Risk team and Subject Matter Experts. Follow-up with certain workshop participants to ensure their participation in the process is well timed and appropriate.
  7. Attend prep sessions and workshops.
  8. Post-workshop: follow-up with CREM workshop coordinator and other as appropriate to make sure action items are being communicated and follow-up on them to make sure they are progressing. Help tie up any remaining loose-ends from the workshop. Make sure the risk register properly documents the risks discussed at the workshop (particularly the larger risks).

Specific things the Region Coordinator can do to enhance the process:

- Advise the project team that the project scope, schedule and estimate need to be current for the workshop. Estimates should be well organized and easy to follow and should align with the flowchart that is drafted at the prep session. Estimator should have backup notebook, calculations, and assumptions available for ready-rapid retrieval of information if needed.
- Assist with coordinating advance elicitation between the project team and risk leads.
- Work with the CREM workshop coordinator to help develop an effective agenda (participants in the workshop will know what to expect and when to attend).
- Advocate for early geotechnical explorations, and other specialty work as appropriate, for the subject project.

Appendix 6: Notes for Risk Modelers (considerations for modeling)

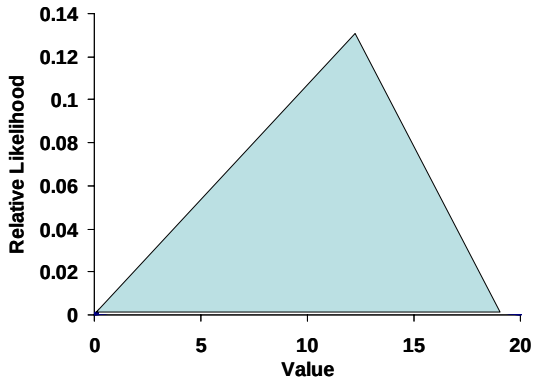
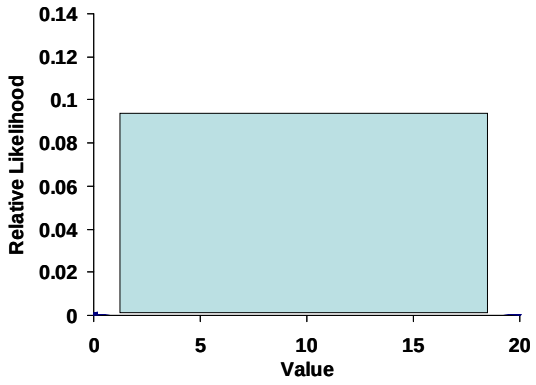
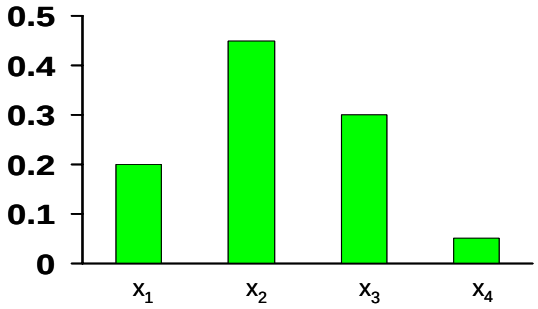
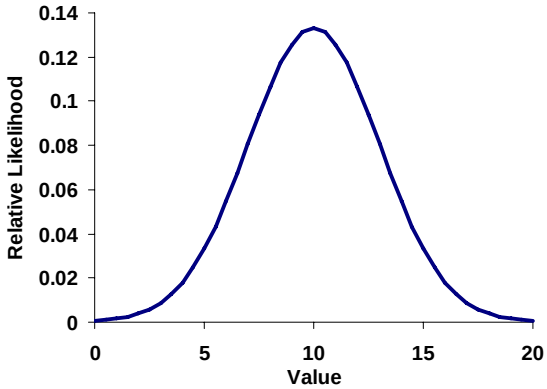
Triangular Distribution	Uniform Distribution
	
A Triangular distribution is a continuous distribution representing a three-point estimate. This is one of the most common and widely used distributions in risk modeling. It is common to assume that there is a chance that the min and max values will be exceeded (5/95, 10/90, etc.) these percentiles may change to represent different levels of uncertainty in the estimate.	A uniform distribution is a continuous distribution where only the maximum and minimum values can be estimated. This distribution is used when there is considerable uncertainty over the duration of an activity or cost impact of a risk event and hence a "most likely" value cannot be estimated.
Multi-Point Discrete Distribution	**Continuous Curve Distribution**
	
X_1 = 20% X_2 = 45% X_3 = 30% X_4 = 5% **<u>Multi-point discrete distribution</u>**: In some cases a risk element can only take particular values (i.e. is not continuous) or used to approximate a continuous distribution.	Three points are defined (high (max, low (min) and best guess); then a continuous distribution (such as Pert or other) is used to characterize the potential risk impact. Although these can provide a realistic representation of uncertainty these curves are hard to define and so should only be used when there is sound, documented information on the variability of a particular risk element. It is common to assume that there is a chance that the min and max values will be exceeded (5/95, 10/90, etc.) these percentiles may change to represent different levels of uncertainty in the estimate.

Figure A6-1 Some common distributions for risk events

Distributions to Consider for Quantifying Risk

When characterizing risks during workshops many elicitors and workshop participants may be more comfortable using simple distributions or multi-point discrete distributions to characterize uncertainties. The Risk Lead (elicitor) should determine the risk characterization that meets the need of the risk elicited and fits the group dynamics of a particular workshop membership. The distributions are representations of the "range and shape" of uncertainty. Elicitors may elicit ranges of information (min/max; low/high) and shape of information (symmetric; skewed). Consider this: Simulations are useful to the extent they reflect reality. Cost and/or duration (schedule) are conceptually continuous random variables and should be modeled In way that simulates this nature – this can be accomplished through continuous distributions or approximated with a discrete representation as depicted above.

There are two parts to the risk, which define the risk register:

1. PROBABILITY OF OCCURRENCE - What is the estimated likelihood of this event occurring?
2. IMPACT – If the event occurs what is the impact in terms of cost and/or schedule? This typically requires only 3 inputs from the expert, minimum, maximum and (most likely or best-guess); as depicted in Figure 6A-1 previously, the uniform distribution is used when only the minimum and maximum values can be estimated.

Interdependencies and/or Correlations Between Random Variables

Interdependencies between two (or more) base uncertainties cost and durations, risk events, and/or their impacts in an analysis can occur due to a variety of conditions. The uncertainties may be:

1. mutually exclusive;
2. conditionally dependent in terms of likelihood, but independent in terms of impact;
3. correlated (a common case here is cost and duration for a given risk event).

Items 1 and 2 can easily be modeled with analysis logic. Correlation can be modeled statistically or the relationship among correlated events can be described in terms of conditional probability networks. The conditional probability "event tree" has been used successfully in WSDOT and other transportation oriented risk evaluations.

Typical Model Settings

Consider the following settings:

1. 5,000 iterations (typical).
2. Latin-hypercube sampling.

Directives for Implementing the Response actions to major risks

(Items for the Project Team to Review and take action)

A critical and useful output of the risk analysis for the Project Team is the ranked risks indicating the risks, in a prioritized order, that most significantly affect project objectives. This information provides a roadmap to the risks that have the most promise for benefiting the project through pro-active efforts to respond to the risks.

The more significant risks, sometimes termed “candidates for mitigation”, are what are useful from a Monte Carlo simulation. It identifies those risks that are most responsible for variation in the bottom-line (cost or schedule) as determined from the modeling.

An effective way to present the risks that have the largest potential impact to the cost or the schedule is via “regression sensitivity” chart (i.e. “Tornado diagram”), depicting the “candidates for mitigation” order of importance.