Using Risk Drivers and Integrating Cost/Schedule Risk Analysis with Acumen RISK

Acumen Summit, Houston TX
October 1, 2013
David T. Hulett, Ph.D.
Hulett & Associates, LLC
Agenda

• Simple schedule with uncertainty
• Correlation with uncertainty
• Probabilistic event – recovery from test failure
• Risk Register provides the Risk Drivers
• Risk Drivers on one or several activities
• Cost Risk
• Integrating cost risk and schedule risk
Simple Schedule in Primavera P6
Adjust the Uncertainty Ranges

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Min</th>
<th>Most Likely</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Conservative</td>
<td>Triangle</td>
<td>80%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>Conservative</td>
<td>Triangle</td>
<td>85%</td>
<td>100%</td>
<td>105%</td>
</tr>
<tr>
<td>Realistic</td>
<td>Triangle</td>
<td>90%</td>
<td>100%</td>
<td>110%</td>
</tr>
<tr>
<td>Aggressive</td>
<td>Triangle</td>
<td>95%</td>
<td>110%</td>
<td>125%</td>
</tr>
<tr>
<td>Very Aggressive</td>
<td>Triangle</td>
<td>100%</td>
<td>120%</td>
<td>150%</td>
</tr>
</tbody>
</table>

The default values can be edited. Notice that for “Aggressive” and “Very Aggressive” we suggest that the Most Likely durations are **NOT** the same as in the schedule, but are 10% and 20% longer, respectively.
Adding Uncertainty to Schedule

Decided that the schedule durations as estimated are “aggressive”
The Effect of Correlation with Uncertainty
Add a Probabilistic Activity

Input an estimated schedule duration. Acumen RISK allows this to happen with some probability <100, including 0%
It is 30% Likely that We will Fail the Test

<table>
<thead>
<tr>
<th>Description</th>
<th>Remaining...</th>
<th>Duration Uncertainty</th>
<th>Type</th>
<th>%</th>
<th>CLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENRISK</td>
<td>ACUMENRISK</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACUMENRISK</td>
<td>ACUMEN RISK Case Study</td>
<td>199</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1000 Start</td>
<td>0</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1010 Design</td>
<td>50</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1020 Build</td>
<td>100</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1030 Test</td>
<td>25</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1040 Recover from Failing the Test</td>
<td>25</td>
<td></td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z1000 Finish</td>
<td>0</td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Could create a bi-modal Distribution

The “shoulder” of the cumulative distribution is at 70%, the probability that we pass the test the first time
Compare the two results

Impact at P80 of test failure
Getting to Risk Drivers
The Risk Register Template

Schedule Impacts in Percentage of Schedule RDUR

The Red / Yellow / Green regions of the 5x5 matrix are configurable
Add Risk Drivers Using the Risk Register

Using the definitions from the Risk Matrix Template. Impacts are adjusted because they apply to the activity durations, not to the overall schedule.
Assign Risk Drivers to Activities

In this case each activity has just one risk assigned. These risks have a *probability* at the mid-range and *impact* as a uniform distribution between Min Duration and Max Duration impact in the Risk Register.
Activity Design Duration shows “Spike”

Spike represents the risk’s not happening. Probability for Design Risk is “High” between 50% and 75%. This translates to 62.5% happening, 37.5% not happening, so in 3,750 of 10,000 iterations the 50-day remaining duration is deemed / simulated as accurate.
Schedule date is 2/22/2014. Here the 80th percentile is 4/17/14, two months late with 3 assigned risk events and no uncertainty.
Add a Risk Driver that is Assigned to Multiple Activities

### Risk Register

<table>
<thead>
<tr>
<th>Risk</th>
<th>Enabled</th>
<th>Mapped</th>
<th>ID</th>
<th>Type</th>
<th>Name</th>
<th>Probability</th>
<th>Schedule</th>
<th>Cost</th>
<th>Score</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Design productivity may be low</td>
<td>High</td>
<td>Medium</td>
<td>Negligible</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Construction supervision may be ...</td>
<td>Medium</td>
<td>Medium</td>
<td>Negligible</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Testing may be unpredictable</td>
<td>Medium</td>
<td>Very High</td>
<td>Negligible</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Communication between partners...</td>
<td>High</td>
<td>Medium</td>
<td>Negligible</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

### Mapping

<table>
<thead>
<tr>
<th>R...</th>
<th>Activity</th>
<th>Event</th>
<th>Min Prob.</th>
<th>Max Prob.</th>
<th>Min Durati</th>
<th>Max Durati</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>A1010: Design</td>
<td>Communication between partners...</td>
<td>50 %</td>
<td>75 %</td>
<td>25 %</td>
<td>50 %</td>
<td></td>
</tr>
<tr>
<td>×</td>
<td>A1020: Build</td>
<td>Communication between partners...</td>
<td>50 %</td>
<td>75 %</td>
<td>25 %</td>
<td>50 %</td>
<td></td>
</tr>
<tr>
<td>×</td>
<td>A1030: Test</td>
<td>Communication between partners...</td>
<td>50 %</td>
<td>75 %</td>
<td>25 %</td>
<td>50 %</td>
<td></td>
</tr>
<tr>
<td>×</td>
<td>A1010: Design</td>
<td>Design productivity may be low</td>
<td>50 %</td>
<td>75 %</td>
<td>25 %</td>
<td>50 %</td>
<td></td>
</tr>
<tr>
<td>×</td>
<td>A1030: Test</td>
<td>Testing may be unpredictable</td>
<td>25 %</td>
<td>50 %</td>
<td>75 %</td>
<td>100 %</td>
<td></td>
</tr>
</tbody>
</table>

Communication between partners affects all of the project tasks.
With the Partner Communication Risk the P-80 is 6/13/2014, Adds 2 months
Adding the Partner Communication Risk adds 57 days at the P-80
Add Uncertainty to the Risk Drivers

Aggressive Uncertainty has been moderated to 95% - 105% - 115% since it does not have to represent the risk events that have now been entered separately.
Adding Uncertainty to the Schedule adds 16 Days at P-80
Risks & Uncertainty that Drive each of the Activities’ Durations

ACUMENRISK Uncertainty and Risk Events (No Mitigation)
Schedule Contribution™ (Children) for ACUMENRISK - ACUMEN RISK Case Study

Risk Exposure at P80: 126d

A1020 - Build
- 7d
- 35d
- 21d
- 63d

A1010 - Design
- 4d
- 18d
- 17d
- 39d

A1030 - Test
- 2d
- 9d
- 13d
- 24d

Legend:
- Logic
- Uncertainty
- R4: Communication between partners lacking
- R3: Testing may be unpredictable
- R1: Design productivity may be low
- R2: Construction supervision may be lacking
Adding Cost Estimate to the Analysis

We have:
- 3 time-dependent (labor) resources and
- 2 time-independent (materials, equipment) resources
- Total cost = $320,000 (without padding for risk)
Add Uncertainty to the Cost Elements

We could add Risk Drivers to these Cost elements as well.
Base cost is $320,000. With 95%-105%-115% uncertainty the P-80 is $341,000
Cost – Schedule Scatter with NO EFFECT of Schedule Risk on Cost Risk

Unless time can drive cost of time-dependent (labor-type) resources the cost and finish dates are not related. In other words, without integrating schedule and cost risk we are missing the standard wisdom that “time is money” and we UNDERESTIMATE cost risk.
### Integrated Cost Schedule Risk Analysis – Add Schedule Risk to Cost

<table>
<thead>
<tr>
<th>Description</th>
<th>Remaining Cost</th>
<th>Cost Uncertainty</th>
<th>Type</th>
<th>%</th>
<th>CLT</th>
<th>Activity Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2013 Case Study</strong></td>
<td><strong>2013 Case Study</strong></td>
<td>$320,000</td>
<td>[Green]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Total Cost</td>
<td>$320,000</td>
<td>[Yellow]</td>
<td>100%</td>
<td></td>
<td>ACUMENRISK</td>
</tr>
<tr>
<td>10</td>
<td>Indirect Cost</td>
<td>$45,000</td>
<td>[Red]</td>
<td>100%</td>
<td></td>
<td>A1010</td>
</tr>
<tr>
<td>20</td>
<td>Design Engineering</td>
<td>$40,000</td>
<td>[Red]</td>
<td>100%</td>
<td></td>
<td>A1020</td>
</tr>
<tr>
<td>30</td>
<td>Construction Labor</td>
<td>$120,000</td>
<td>[Red]</td>
<td>100%</td>
<td></td>
<td>A1030</td>
</tr>
<tr>
<td>40</td>
<td>Testing Labor</td>
<td>$25,000</td>
<td>[Red]</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Raw Materials</td>
<td>$40,000</td>
<td>[Red]</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Installed Equipment</td>
<td>$50,000</td>
<td>[Red]</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Schedule Risk affects Cost Risk:
- Design schedule risk affects Design Labor cost
- Build schedule risk affects Construction Labor cost
- Testing schedule risk affects Testing Labor cost
- Total Schedule Risk affects Indirect Costs (overhead, Project Management)

Procured Materials and Equipment costs are uncertain but not because of schedule risk.
Base cost is $320,000. With uncertainty the P-80 is $341,000. Adding schedule risk to the Labor resources the P-80 is $508,000, for a total cost contingency of $188,000. Schedule risk adds $167,000 by itself in this case.
Schedule Risk is an Important Driver of Cost Risk, Should not be Ignored
In addition to greater cost risk, allowing schedule risk to drive the cost of Labor resources creates correlation between dates and cost.
Cost – Schedule
Joint Confidence Level @ 70%

The boundary describes combinations of cost (for budget) and dates (for schedule) where there is a 70% chance of meeting BOTH.
Summary

• Simple schedule with uncertainty
• Correlation with uncertainty
• Probabilistic event – recovery from test failure
• Risk Register provides the Risk Drivers
• Risk Drivers on one or several activities
• Cost Risk
• Integrating cost risk and schedule risk
Contact information:
David T. Hulett, Ph.D.
Hulett & Associates, LLC
Los Angeles, CA
David.hulett@projectrisk.com
www.projectrisk.com
(310) 476-7699

Copyright 2013 David T. Hulett