Project Risk Analysis (with Pertmaster)

AACE Toronto Section

October 2, 2008

Brought to you by:

Emerald Associates

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  - Primavera Premier Solution Provider
  - Pertmaster Solutions Partner for Canada
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  - Nexen
  - Petro-Chemical
    - Agrium
    - Nova Chemicals
  - Electrical
    - Bruce Power
    - OPG
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    - Manitoba Hydro
    - Transalta
    - ENMAX
  - Government
    - Milwaukee Metropolitan Sewerage District
    - Capital Health Authority
  - Transportation
    - CPRail
  - Contractors
    - Ledcor
    - Flint
    - Stuart Olson
    - Redpath
    - Genivar
  - Engineering
    - Wardrop
    - VECO
    - Bantrel
    - Fluor
    - Jacobs
    - Worley Parsons/Colt

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Agenda

- Why & How to Conduct Risk Analysis
- Risk Theory
- Pertmaster Application
- Real World Case Study

"The advantage of not planning is that failure is not preceded by long periods of depression, worry and anxiety." - Anonymous

Why is Schedule Risk Analysis Suddenly So Popular?

Because

- Common Platforms
- Common Coding
- Central Databases
  Have now made it possible to produce meaningful roll-ups and powerful, useable results

*But really because of -*
Results like these

Uncertain spend curves – by period
Why is this Suddenly so Important?

Because new US (SOx) and Canadian (MI-52-109) legislation means CEO’s and CFO’s must sign off personally that:-

- All controls are in place and working
- That there are no known, unstated, factors that could affect the financial position of the company.

And accounting methods are poor at predicting future risks from current commitments that could reflect on the financial statements.
How Does Risk Analysis Answer the Need?

1. Most existing software does static spreadsheet analysis without the dimension of time.
2. These spreadsheets are often created by accountants who tend to be focused on actual records. Even Earned Value is backward focused.
3. Pertmaster starts from the resource loaded schedule created by the project staff.
4. Schedules start from current actuals and look forward.
5. Such a schedule is rolling forward & constantly evolving as new events occur, exposures are evaluated and actual results received.
6. Thus the source data is the actual detailed data created and used by the people closest to the project.

But….

The Other Side of the Coin

1. This is schedule based analysis so a weak schedule means an even weaker risk analysis.
2. However, it should reflect time, productivity & costs.
3. Perfect schedules are rare so it is a matter of deciding if the weaknesses are critical.
4. The risk process is fundamentally qualitative so don’t get too hung up on theoretical quantitative procedures.
5. A slick report based on garbage is just toxic garbage.
So how do we get meaningful results?

PertMaster Risk Methodology

- **Schedule Review**
  - Risk Ready State
  - Review for logic & errors
- **Risk Identification**
  - Estimate Uncertainty
  - Risk Events: Risk Register
- **Develop Risk Model**
  - Map Risks to Activities
- **Preliminary Analysis & Review**
  - Impacted Risk Plan
  - Monte Carlo simulation
- **Final Model & Report**
  - Risk Event plan
  - Mitigation planning

Based on: PMBOK Chapter 11, APM PRAM Guide, AS/NZ S4360
1 Interviews

- Prepare
  - Focus on critical or near critical sequences.
  - Think about things not scheduled but impacting.
  - Identify people to interview in each sector.
  - Prepare a bullet point check list for each.

- Interview
  - One-on-one is most effective
  - Don’t lead them, listen and prompt from the bullet points.
  - Most important to them is what affects them most; it may not be important to the project

2 Interviews

- A Recent Example
- From Interview Sheets, Write up Interviews –
  - Catch the essence only
  - Identify risk categories
  - Sort comments

<table>
<thead>
<tr>
<th>PBMM</th>
<th>Time</th>
<th>Person</th>
<th>Company</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.20</td>
<td>0.15</td>
<td>12/27/2007</td>
<td>12/27/2007</td>
<td>Staff Engineer (Engineering Div.)</td>
</tr>
</tbody>
</table>

1. Quality of ERPS’s submittals. The first intake review was held just before Christmas and was rejected. It was just a bunch of economics with uncorrected error data. This spells trouble and is against the policy of quality cuts at the 30% Review. Preliminary Share Drawings at the 30% review and Verified Share Drawings at the 30% Review.

2. Engineering Scope Challenges: the new process was something new to the engineer who was used to being on the construction with both hands in the software and look at the edges. This change in culture could cause delays in the approval process until it settled down.

3. Shortening the Review Process: the scope in the ERPS are being combined with EPICs. He told that scenario or later this was going to result in engineering errors.

4. Shortage of Engineering Manpower: the schedule is showing a peak of 10 Engineering work packages per month. This is clearly impossible. 32 to 40 is more like the maximum. However, there is clearly room for negotiation but there is currently no table listing the ones that can be delayed.

5. Delays to Vendor Bills: 4X vendors are experiencing delays in issuing drawings. This is partly because the vendor response time was stretched out slightly at the 3rd place.

<table>
<thead>
<tr>
<th>PBMM</th>
<th>Time</th>
<th>Person</th>
<th>Company</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.20</td>
<td>0.15</td>
<td>12/27/2007</td>
<td>12/27/2007</td>
<td>Commissioning and Startup</td>
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</table>

1. The priority sequence for systems commissioning has not been established and will be set until the end of January. Currently, 100 systems have been identified. Since construction priorities are different these commissioning periods could be some Out of Synchronization if the furnaces are not down which is likely if parts are late.

2. War Components: the system MIF and NIF could be turned over a little later than the rest. Turn A could be somewhat delayed as Turn E although same in length is common and there is some communality in both red and the front stream. It would slow things down as the necessary work is not yet established and interfaces and permits would be delayed. There are no visible pressure vessels so this delay due to delays would not be significant.
3. Quantify the Risks

- Take the risks identified and relate them to the schedule and quantify the impact.
- Determine whether these risks are uncertainty or risk event.

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Type of Risk</th>
<th>Impact</th>
<th>Probability</th>
<th>Duration</th>
<th>Person</th>
<th>Impact</th>
<th>Note</th>
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<td>Missing Project M.T.</td>
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<td>Peng Stud Charge</td>
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<tr>
<td>3</td>
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<td>Event</td>
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<tr>
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<td>30%</td>
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</tr>
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<td>5</td>
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<td>Critical</td>
<td>High</td>
<td>30%</td>
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<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>Changes with ESS's</td>
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<td>30%</td>
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<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>7</td>
<td>Changes with ESS's</td>
<td>Event</td>
<td>Critical</td>
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</tr>
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<td>High</td>
<td>30%</td>
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<td>N/A</td>
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<td>High</td>
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<tr>
<td>12</td>
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<td>Critical</td>
<td>High</td>
<td>30%</td>
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<td>Yes</td>
<td>N/A</td>
</tr>
</tbody>
</table>

4. Build the Model

- Build the risk model.
5. Review & Understand the Results

6. Develop Mitigation Strategies
7. Implement Changes

A risk model is a living document
It is important to update the risks and models frequently to obtain best results
Make this part of your project management methodology
Don’t be a “seagull”!

8. Repeat
An introduction to schedule risk analysis theory

Overview of traditional CPM

- Predicts single completion date and cost
- Uses single values for activity durations and costs
- Does not take uncertainty into account
**CPM with schedule risk analysis**

- Quantifies probability of completing project on time and budget
- Uses estimates for durations and costs
- Takes uncertainty into account to predict a realistic end date

**Monte Carlo (Latin Hypercube) Simulation**

- Triangle divided up into equal segments
- One segment randomly selected for each iteration
- Skew impacts distribution of results
- Reveal hidden critical paths

<table>
<thead>
<tr>
<th>Iteration</th>
<th>Min</th>
<th>Likely</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10  days</td>
<td>11  days</td>
<td>17  days</td>
</tr>
<tr>
<td>2</td>
<td>9   days</td>
<td>11  days</td>
<td>17  days</td>
</tr>
<tr>
<td>3</td>
<td>14  days</td>
<td>15  days</td>
<td>20  days</td>
</tr>
<tr>
<td>4</td>
<td>17  days</td>
<td>18  days</td>
<td>24  days</td>
</tr>
<tr>
<td>5</td>
<td>10  days</td>
<td>12  days</td>
<td>16  days</td>
</tr>
<tr>
<td>6</td>
<td>14  days</td>
<td>15  days</td>
<td>20  days</td>
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<tr>
<td>7</td>
<td>13  days</td>
<td>14  days</td>
<td>19  days</td>
</tr>
<tr>
<td>8</td>
<td>7   days</td>
<td>8   days</td>
<td>13  days</td>
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<tr>
<td>9</td>
<td>10  days</td>
<td>12  days</td>
<td>17  days</td>
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<td>10</td>
<td>12  days</td>
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<tr>
<td>11</td>
<td>10  days</td>
<td>15  days</td>
<td>20  days</td>
</tr>
</tbody>
</table>
Better estimates for completion dates

- Single-Path Schedule
- CPM schedule finishes on December 10, relies on combinations of durations that equal 70 days

Likelihood of the 10th December?

Exercise: Find out chance of meeting 10th December
Why is there only a 18% chance?

- Distributions are skewed – most likely is nearer to minimum than maximum

```
      30
     /  \
    /    \
  20     50
```

- There is a greater chance an activity will take more time rather than less time to complete.

Effect of skewed distributions

- What would be the chance of completing the project on time if each distribution was symmetrical?

  50%

- Therefore: With skewed distributions the chance of hitting a schedule end date will be less than 50%
Effect of parallel paths

- This project also completes on December 10
- Is it more or less risky than single path?
- Likelihood of December 10th finish?

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Description</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>0019</td>
<td>Start</td>
<td>0</td>
<td>04-Sep-08</td>
</tr>
<tr>
<td>0020</td>
<td>Design Unit 1</td>
<td>30</td>
<td>04-Sep-08</td>
</tr>
<tr>
<td>0030</td>
<td>Build Unit 1</td>
<td>40</td>
<td>10-Oct-08</td>
</tr>
<tr>
<td>0040</td>
<td>Design Unit 2</td>
<td>30</td>
<td>04-Sep-08</td>
</tr>
<tr>
<td>0050</td>
<td>Build Unit 2</td>
<td>40</td>
<td>10-Oct-08</td>
</tr>
<tr>
<td>0060</td>
<td>Finish</td>
<td>0</td>
<td>10-Dec-08</td>
</tr>
</tbody>
</table>

More risky...Merge Bias Effect
Combined effect of skew and parallel paths

Skewed Distributions + Parallel Paths = Typically less than 20% chance of hitting completion date

Why run a quantitative analysis?

- To help create more realistic schedules
- To improve awareness of project risk and uncertainty
- To identify schedule assumptions
- Communication: Develop a better understanding of the schedule amongst the project team
Running a quantitative risk analysis

Checking the schedule

- Before considering a risk analysis, check the quality of the schedule
  - Reports | Schedule
  - Check Report

- Produces a report in your browser
  - Can be summary or full report
  - Content can be customized
  - Can be “badged”
Schedule Checker

- Checks schedule quality
  - Constraints
  - Open-ended tasks
  - Start to Finish links
  - Negative lags
  - Positive lags
  - Long lags
  - Broken logic
  - Calendars on lags
  - Link on summary tasks (MS Project)

Aim: Reflect reality

Run Analysis

- What is the chance of completing our project on time?
Understanding Project Drivers

- The critical path is useful...
  - Determines the earliest the project can finish
  - Delay on the critical path delays the project
  - The path that most deserves risk management
- Duration Sensitivity
  - Shows how closely correlated changes in one activity are to changes in the overall project
- Criticality Index...
  - During the risk analysis, the number of times an activity was critical is recorded
  - The percentage of iterations each activity was critical = Criticality Index
- Cruciality
  - Product of Sensitivity and Criticality
Exercise: Criticality Index (1 of 1)

Unit 1 no longer critical but has more uncertainty (company has not made this unit type before)

- Unit 2 is on the Traditional Critical Path should we concentrate on Unit 2?

Criticality Index Shows Unit 1 more risky!

- Risk Analysis shows we should focus on Unit 1
- Traditional CPM can “Mask” Risks!
Criticality/Sensitivity/Cruciality

- Criticality identifies activities that are likely to be on the critical path given the uncertainty in the schedule.
- Sensitivity relates activity changes to overall schedule changes

Therefore...

- Reduce durations and/or uncertainty on activities with a high sensitivity/cruciality to improve the chance of completing the project on time.
- High Cruciality: If task is delayed, project is delayed.
- Focus on the tasks with high cruciality index first.

Revising Estimates

- If the contract has already been signed, we need to improve chances of meeting the contracted date
- The tornado helps us:
  - Risk | Tornado Graph

  ![Tornado Graph]

  New Store
  Details: Sensitivity
  - CD13: Order and receive computer systems (44%)
  - CD10: Obtain bank loan (16%)
  - C14 - Motor and premises (18%)
  - D13 - Install and test computer systems (24%)
  - G00: Research completion (2%)
  - G11 - Research market (12%)
  - G14 - Create business plan (7%)
  - G16: Task staff (5%)
  - G22 - Locate premises (16%)
  - G28: Organize lease (8%)
Revising Estimates

- As Refurbish Premises is the biggest driver to the project duration, this is the best place to mitigate the risk.
- We can reduce its worst case by obtaining a guarantee from the contractor.
  - Change Maximum Duration

Revising Estimates

- Analysis now shows new top driver

New Store
Duration Sensitivity

- E010 - Advertisement for staff: 37%
- C040 - Refurbish premises: 29%
- E040 - Train staff: 15%
- B030 - Locate premises: 14%
- D020 - Install and test computer systems: 14%
- E010 - Hire staff: 14%
- B030 - Research market: 14%
- E020 - Organise local: 14%
- C030 - Move in: 0%
Questions

- Questions?
- Time Check
- Real Life Example