Defining Risk

• Risk is
  – the undesirable events, their chances of occurring and
    their consequences.
• Some risk can be identified before the project
  starts, whereas some others cannot be imagined.
• Risks can have negative effect on the main
  objectives of the project:
  – cost, schedule and performance (quality)

Risk Planning

• Risk Planning involves
  – Identification of risks.
  – Analysis and assessment of risks.
  – Contingency planning.
• One advantage of risk planning:
  – Helps project manager to take risks when there is a
    potential advantage.

Risk Information

• For each risk the following information must be
  developed
  – The event forming the risk.
  – All outcomes of the event.
  – The magnitude (severity) of the event’s impact.
  – Probability of the event occurring.
  – The time(s) at which the event might occur.

Example:
– Activity ‘A’ might take twice as long.,
– Outcomes: project delayed, cost increased, a critical
  resource will be overburdened for some time.
– Magnitudes: delay could be anywhere between 5% to
  10% of total planned project duration. Total project
  cost can go up by 4%.
– Chances: 10% probability estimated.

Managing Risk – Identification of Risks

• Identification of risks:
  – The entire management team should be involved.
  – First focus on macro risks that might affect the
    entire project. Some useful questions:
    • Are the core competencies of the firm adequate for the
      challenges of the project?
    • What is the degree of novelty in the project?
    – After the macro risks, more specific risks can be
      identified using the WBS.
  – Risks can be classified based on their source

Risk Analysis and Assessment

• Risk analysis attempts to quantify the severity
  of the impact of an identified risk event.
• By doing risk analysis, you can select potential
  risk events that need attention because there is a
  high chance of occurrence and/or large impact.
• Developing a “Risk Assessment Matrix” is a
  useful first step.
**Risk Analysis and Assessment**

- Risk assessment matrix for “switching to a new e-mail software.”

<table>
<thead>
<tr>
<th>Risk event</th>
<th>Chance - LMH</th>
<th>Severity - LMH</th>
<th>Detection difficulty - LMH</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>System freezing</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Startup</td>
</tr>
<tr>
<td>User complaint</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Post-installation</td>
</tr>
<tr>
<td>Hardware failure</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Installation</td>
</tr>
</tbody>
</table>

- Assessments could either be subjective or quantitative.

**Semi-quantitative Scenario Analysis**

- Obtain three estimates (the team members must be 90% confident that the three estimates will be accurate):
  - Baseline duration: there is 50% chance of project being complete in this time.
  - Best-case duration: there is 10% chance of project being complete in this time.
  - Worst-case duration: there is 90% chance of project being complete in this time.
- Once the three estimates are made, it would be very useful to:
  - Graph the three schedules
  - Document time estimates, costs and assumptions

**Probabilistic Risk Analysis Techniques**

- Decision trees to assess alternative courses of action, using expected value criterion.
  - Covered in OPSM 632 Management Science
- Monte Carlo simulation
  - Covered in OPSM 633 Business Simulation
  - Some applications:
    - NPV calculations with statistical variations.
    - PERT simulation to identify project schedule risk.

**Sensitivity Analysis**

- Sensitivity Analysis:
  - Main idea: see the effect of changing values for project parameters on the outcomes.
  - For example:
    - Effect of changing project durations on total project time.
    - Effect of changing certain cost categories (or variables that affect cost) on total project cost.
  - Easily done by Monte Carlo simulation.

**Establishing Contingency Reserves**

- Because plans seldom materialize as estimated, it is common practice to have a contingency funds.
  - These should be agreed upon before the project starts.
- The amount typically depends on the uncertainty and risk of schedule and cost estimates.
  - A low risk project might have a contingency reserve of 1 to 2% of the total cost.
  - This percentage might be up to 20% in high risk projects.

**Responding to Risk**

- After a risk is identified and assessed there are four types of actions:
  - Reduce risk:
    - In software development parallel innovation processes are used in case one fails.
  - Transfer risk
    - Passing risk to another party (almost always results in paying a premium).
    - Examples: fixed price contracts; insurance.
Responding to Risk

- Retain risk
  - Some very large risks (e.g. earthquake) cannot be reduced or retained. The chances are quite low so you accept it.
  - Sometimes you accept the risk and place a budget reserve for it, in case it materializes.
  - Sometimes you just ignore the risk.
- Share risk
  - Allocate portions of risk to different parties.
  - Example: Airbus R&D is done by several countries.

Managing Risk – Schedule Risks

- Use of slack
  - Recall that total slack is shared by multiple activities.
  - A manager should not use the slack available for his activity irresponsibly. It may be needed by activities later on the path.
  - Managing slack can reduce schedule risks!
    - Incentive systems to report early completion of activities?

Responding to Risk

- Contingency planning
  - Without a contingency plan, a manager cannot react to a risk event quickly. This results in
    - Panic
    - Crisis mismanagement
    - Acceptance of first solution suggested.
- Conditions for activating (or triggering) a contingency plan must be decided and documented.

Managing Risk – Schedule Risks

- Compressed project schedule
  - Increases the number of critical paths.
  - The more the number of critical (or near critical) paths, the higher the chance of a late project.
    - Much harder to manage and control a large number of critical activities.

<table>
<thead>
<tr>
<th>Risk event</th>
<th>Accept, reduce, share, transfer</th>
<th>Contingency plan</th>
<th>Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>System freezing</td>
<td>Reduce</td>
<td>Reinstall OS</td>
<td>Frozen for 1 hr</td>
</tr>
<tr>
<td>User complaint</td>
<td>Reduce</td>
<td>Increase staff</td>
<td>Call from top</td>
</tr>
<tr>
<td>Hardware failure</td>
<td>Transfer</td>
<td>Order different brand</td>
<td>Replacement doesn't work</td>
</tr>
</tbody>
</table>

Use a supplier with a warranty
Managing Risk – Cost Risks

- Most cost risks are due to errors in schedule and technical estimates.
- Other issues: exchange rate and inflation risks.
- An objective of minimizing net present value of costs would make a late-start schedule more attractive.
  - This would reduce slacks and increase schedule risks.

Example: Cost Risk Analysis

- File: CostEstimating.xls
- Using Excel’s Data-Subtotal functionality, which creates an outline automatically.
- @RISK for performing simulation.

Example: Cost Risk Analysis

- Some questions:
  - Will the contingency funds be enough?
  - What is the expected cost of the project?

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Minimum</th>
<th>$69,361,820.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>$82,174,300.00</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>$74,655,740.00</td>
<td></td>
</tr>
<tr>
<td>Std Dev</td>
<td>$2,570,983.00</td>
<td></td>
</tr>
</tbody>
</table>

Example: Schedule Risk Analysis

- Filename: CriticalPath.xls
- We will determine the probability distribution for the project duration and probability of each activity being on the critical path for the following project network.
Example: Schedule Risk Analysis

The yellow line gives the estimated probability of each activity being on the critical path.

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Example: Schedule Risk Analysis

The yellow line gives the estimated probability of each activity being on the critical path.

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