Outline

- Risk Concepts
- Risk Management Techniques
- Sample Application
Concepts

- **Risk:** The possibility of suffering loss (or harm) and the impact that loss has on the involved party. Risk can be characterized in terms of its Severity where
  - Severity = Likelihood of Occurrence x Magnitude of the Impact
- **Opportunity:** The possibility of realizing a favorable outcome and the impact this outcome has on the involved party. Opportunity is positive risk and can be identified and managed in a similar way.
- **Uncertainty:** “The gap between the information required to estimate an outcome and the information already possessed by the decision maker.” (CII 1989)
- **Risk Analysis:** The process of identifying risk factors and the quantification of those factors (estimating likelihood and magnitude of impacts).
- **Risk Mitigation:** The process of developing a plan to respond or deal with risk on a project.
Why do you need risk analysis

- Minimize management by crisis
- Minimize surprises and problems
- Increase probability of project success
- Better handle on true costs and schedules by properly estimating contingencies...

![Graph showing conceptual estimates for different project types]
So what is risk analysis & management?

- An orderly way of studying and analyzing the project. More than simply designing it...
- Clear understanding of the project objectives, all alternatives, and all issues that need to be considered during the design and construction...
- A comprehensive understanding of all stakeholder issues, a probing of internal experts and review of similar projects...

When should it be done?
Characteristics of risk events

Risk is generally:

- “Magnitude dependent”.
  - The greater the payoff, the more the risk is acceptable...

- “Value based”.
  - Everyone sees risks differently. Everyone has a different tolerance level for risk...

- “Time dependent”.
  - Risk is a future event, time affects its perception. What is seen today as a risk may not be tomorrow...
More Characteristics

- For risk to be an issue, the event and/or its outcome must be associated with a certain degree of uncertainty (the possibility).
- In practice it is virtually impossible to avoid all risks.
- Risks can be reduced and sometimes transferred (e.g. through contracts, financial agreements, concessions, insurance policies).
Process of Risk Management

Generally involves the following steps:

- Preparation for risk analysis
- Risk Identification
- Risk Analysis
- Risk Response
- Risk Control
- Close down
Risk Identification

Risk Factor Definition:
- Identify every possible event or issue that may cause harm to the project (from the organization’s viewpoint).
- Risk factors can be stated in the form:
  - “…… may happen during the execution of …. which may impact ……”
  - “If …… occurs, then an impact to ….. will be realized.”
  - e.g. “If the lay-down area is not optimized then productivity will be too low.”
  - e.g. “Segmental liners may not be available prior to construction thus delaying project”

So, how do we do this?
- A number of approaches can be used including:
  - Standard Checklists
  - Comparison to other projects
  - Expert Interviews
  - Facilitated brainstorming sessions
  - Delphi Technique
Risk Analysis

Tools used:
- Decision trees
- Expected value (severity, contingency)
- Questionnaires
- Life Cycle Cost Analysis
- Financial measures
- Computer simulation
  - Range estimating
  - Schedule analysis

Qualitative
- Using a subjective assessment of “low, Medium, High”... or color code the various risk factors.

Quantitative
- Assign probabilities or likelihood to the various factors and a value for the impact then identify severity for each factor.
An approach for conducting risk management

Evaluate risk factors as follows:

- Assess each factor and its impact if it occurs
- Determine the likelihood of the factor being encountered (e.g. Table 1.)
- Determine the magnitude of the impact if the factor is encountered (e.g. Table 2.)
- Determine the overall impact of the factor by multiplying likelihood (ii) by magnitude (iii).
- Interpret the score of (iv) (e.g. Table 3.)
Sample Applications

- Risk Analysis for projects in Edmonton - **Risk Identification, and quantification**, and **Contingency derivation**...

- **Range estimating to quantify uncertainty with estimate**
Risk Response

- Decide on the actions to be taken in response to residual risks (where the overall impact exceeds the risk threshold). Actions can include:
  - Reduce uncertainty by obtaining more information. (This generally leads to a re-evaluation of the likelihood or impact.)
  - Eliminate or avoid the risk factor through means such as a partial or complete re-design, a different strategy or method etc.
  - Transfer the risk element by contracting out affect work.
  - Insure against the occurrence of the factor (generally difficult in self insured organizations such as the City).
  - Abort the project if the risk is intolerable and no other means can be undertaken to mitigate its damages.
- Plan response to residual risks
- Communicate mitigating strategy and response plan to risk review team.
Risk Management

- Develop and implement a risk strategy through integration with mainstream management.
- Manage the agreed risk mitigation initiatives.
- Revise plan periodically (e.g. at each phase of the project life-cycle) to reflect changes in conditions, information or as a result of the undertaken response.
- Report changes.
Sample risk management plan

Like any other plan, should outline what is to be done, who is responsible for it, when to do it and other pertinent information. Use of programs may help.

Examples are wide varied, can be straight forward or fairly integrated with the overall project management process. See sample
Close Down

Assess investment outcome
- Consider results of investment against original objectives
- Compare risk impacts with those anticipated

Review Risk Analysis Process
- Assess effectiveness of process and its application
- Draw lessons for future investments
- Propose improvements to process
- Communicate results
# Table 1: Likelihood

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Explanation</th>
<th>Probability</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Likely</td>
<td>Almost certain that it will happen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td>more than 50-50 chance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somewhat likely</td>
<td>less than 50-50 chance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unlikely</td>
<td>small likelihood but could well happen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very unlikely</td>
<td>not expected to happen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremely unlikely</td>
<td>just possible but would be very surprising</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are set by the corporation and used for all projects.
Table 2. Magnitude

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Explanation</th>
<th>Dollar impact</th>
<th>Value to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disastrous</td>
<td>The impact is totally unacceptable to the organization.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>Serious threat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substantial</td>
<td>Considerably affects cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>Moderately affects costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal</td>
<td>Small effect on costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negligible</td>
<td>Trivial effect on costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are set by the corporation and used for all projects.
<table>
<thead>
<tr>
<th>Total severity score</th>
<th>Category</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intolerable</td>
<td>Must eliminate or transfer risk</td>
</tr>
<tr>
<td></td>
<td>Critical/Undesirable</td>
<td>Avoid or transfer risk</td>
</tr>
<tr>
<td></td>
<td>Serious</td>
<td>Attempt to avoid or transfer, be proactive in managing risk.</td>
</tr>
<tr>
<td></td>
<td>Important</td>
<td>Accept manage proactively</td>
</tr>
<tr>
<td></td>
<td>Acceptable</td>
<td>Accept and manage risk</td>
</tr>
<tr>
<td></td>
<td>Negligible</td>
<td>Can be ignored but should be managed</td>
</tr>
</tbody>
</table>
Range Estimating Algorithm

1. Divide the project into manageable components (e.g. line items or work packages).
2. Identify the uncertain components (those that effect the bottom line.)
3. For each of the uncertain components estimate the variability using a statistical distribution (e.g. triangular).
4. Generate random numbers and transform them to the appropriate distribution.
5. Find the project cost on this iteration as the sum of all components (including those that do not vary).
6. Repeat steps 1-5 a large number of times.
7. When done construct the cumulative distribution function and calculate all relevant statistics to perform risk analysis.
Sample Range Estimating Application for Tunneling

- Estimators prepared the estimate breakdown and preliminary estimate
- Program Manager decides to perform a range estimate to
  - determine the probability of achieving this estimate
  - derive a value to use for project contingency
## Sample Range Estimating Application for Tunneling

<table>
<thead>
<tr>
<th>Item (1)</th>
<th>Description</th>
<th>Unit (3)</th>
<th>Quantity (4)</th>
<th>Optimistic (5)</th>
<th>Most Likely (6)</th>
<th>Pessimistic (7)</th>
<th>Mean (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Removal Shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Excavate by Drilling (11m)</td>
<td>Each</td>
<td>1</td>
<td>15000</td>
<td>30000</td>
<td>45000</td>
<td>30000</td>
</tr>
<tr>
<td>22</td>
<td>Excavate by Hand</td>
<td>Vert m</td>
<td>18</td>
<td>3000</td>
<td>4300</td>
<td>7500</td>
<td>4933.333</td>
</tr>
<tr>
<td>25</td>
<td>Form &amp; Pour Drop Structure (included in Tunnel)</td>
<td>Each</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>26</td>
<td>Build 1200 mm AMH/1200 mm DMH &amp; Backfill</td>
<td>Vert m</td>
<td>23</td>
<td>1600</td>
<td>2300</td>
<td>3500</td>
<td>2466.67</td>
</tr>
<tr>
<td>3</td>
<td>Tunnel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Build Undercut &amp; Drop Structure</td>
<td>Each</td>
<td>1</td>
<td>437369</td>
<td></td>
<td>437369</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Build Removal Undercut</td>
<td>Each</td>
<td>1</td>
<td>47425</td>
<td></td>
<td>47425</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Tunnel using segments</td>
<td>Lin m</td>
<td>2298</td>
<td>1200</td>
<td>1500</td>
<td>3000</td>
<td>1900</td>
</tr>
<tr>
<td>4</td>
<td>Build 1200 mm AMH (4 locations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Excavate by drilling (12m)</td>
<td>Each</td>
<td>4</td>
<td>5500</td>
<td>11000</td>
<td>16500</td>
<td>11000</td>
</tr>
<tr>
<td>42</td>
<td>Excavate by Hand</td>
<td>Vert m</td>
<td>79.8</td>
<td>2100</td>
<td>3000</td>
<td>4500</td>
<td>3200</td>
</tr>
<tr>
<td>45</td>
<td>Form &amp; Pour Base Connection</td>
<td>Each</td>
<td>4</td>
<td>21959</td>
<td></td>
<td>21959</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Build 1200mm AMH &amp; Backfill Shaft</td>
<td>Vert m</td>
<td>114</td>
<td>700</td>
<td>1000</td>
<td>1300</td>
<td>1000</td>
</tr>
</tbody>
</table>

Range for Unit costs
Simphony Range Estimating Template
Output Statistics – Range Estimating

The image displays a software interface with statistical data. The graphs show the total cost of linked work packages for all runs, with data points indicating cost distribution across different variables.
Distribution for Subtotal/J26

Cumulative Density Function (CDF) for the tunnel range estimate

Prob of Value <= X-axis Value

Values in Thousands

If Cost = $4,700,217 then probability of cost underrun = 20%

If Cost = $6,373,368 then probability of cost underrun = 80%
### Risk Control Main

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty associated with land acquisition</td>
<td>Early negotiations with land owners in conceptual design stage. Negotiate agreement in practice with all parties. Early buy-in from stakeholders. Communicate with landowners throughout the process. Timely purchase or expropriation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity</th>
<th>Likelihood</th>
<th>Magnitude</th>
<th>Risk Significant?</th>
<th>Calculated Action: From Average</th>
<th>Acceptable - Accept and manage</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.00</td>
<td>15.00</td>
<td>10.00</td>
<td>No</td>
<td>ID</td>
<td>ID</td>
</tr>
</tbody>
</table>

### Alternative And It's Tasks And Assignments

**Alternative**

1. Conduct one-on-one meetings with all affected stakeholders in the concept planning study to get early buy-in from stakeholders and to obtain agreement in principle.

2. Ensure required property is purchased or expropriated before finalizing detailed design phase.

**Assignee Name**
- Streets Engineering Branch
- Each Department as it pertains
- PB - Systems planning section
- Frank Vanderlaan
- Mike Marlow
- Michael Chibuk
- Hassan Sheikh

**% Completed**
- 0%

**Required Date of Completion**
- 9/15/00

**Followup Date**
- 9/15/00

**Date Completed**
- 0

### Form View

Form View