@RISK for Project
advanced risk analysis for project management
Presentation Agenda

- Welcome to @RISK for Project
- RPJ Models
- Distribution Choice
- Simulation Results
- Fitting Distributions to Data
- Creating Variables Easily
- Ranking Risks
- Advanced Modelling Concepts
  - Correlation
  - Probabilistic Structures
@RISK for Project

- Monte Carlo simulation add-in to MS Project
- Quantifies the exposure in a schedule by allowing you to specify the variation that exists for key inputs
  - Add-in probability distribution functions
  - Pre-processing risk analysis modelling capabilities
  - Post-processing reports, graphs and statistics
  - Post-processing analyses to assist in evaluating the results
- For each iteration in a simulation @RISK:
  - Uses Monte Carlo techniques to sample representative values from the uncertainties
  - Recalculates the schedule and saves the designated output fields
- @RISK creates graphs and statistical tables to show you the variation in/exposure to your bottom line as well as diagnostic information to determine which uncertainties are key in affecting the bottom line
@RISK Model Window

- Shows the inputs, outputs and @RISK modelling features
  - Can be used to edit properties such as variable names
- Advanced modelling elements can be viewed and created
  - Correlation matrices
  - Probabilistic branching
  - Probabilistic calendars
  - Global Variables

![@RISK Model Definition](image)
Distribution Palette

- Click the “Dist…” button on the define distribution window
  - Discrete distributions in red, continuous in blue
  - The thumbnails indicate the possible characteristics of the distribution
- The discrete distributions (in red) could be used to model whole-day delays
- Vary is a special distribution type that allows percentage changes as parameters
  - This is the most popular choice as it matches the language commonly used in project management (±10% etc.)
  - Calculated from the base value as appearing in the schedule
Defining Distributions

- Once the distribution type has been selected the parameterisation is performed in the Define Distribution Window
- Shows information on the selected distribution
  - The syntax for the distribution
  - Allows the direct selection of parameters
  - Graphs the distribution, which updates as changes are made
  - The distribution can be interrogated for reasonableness via sliding percentile bars on the graph
  - Distribution statistics update as well
- The distribution type can be changed, or the input renamed
@RISK Results Window

- The Results Window allows access to all simulation results
  - Graphs of the outputs (density and cumulative)
  - Basic summary statistics
  - Detailed statistics (includes analysing target values)
  - Simulation data created by @RISK
  - Sensitivity analysis (tornado charts and simulation scenarios)
- Standard Excel reports can also be produced
- Statistics can be placed in the project (critical index etc.)
Reporting Results

- After a simulation is run, there are lots of statistics and charts available!
- The Results Window contains all of the available reports, and will be where you spend most of your time analysing the simulation
  - Reports can also be exported to Excel
- Statistics such as mean duration and critical index can be placed directly into the project table
- The Summary Statistics Report has basic descriptive results for the outputs and inputs
  - Min, Mean, Max, P5 and P95
  - The range from the P5 to P95, number of errors
Need More Detail?

- The Detailed Statistics report contains descriptive statistics for the outputs and inputs, including:
  - Central moments (mean, variance etc.)
  - Every 5\textsuperscript{th} percentile
- There are usually statistics required from a simulation that are unique to each project, such as specific dates or durations or client-specific percentiles
- These can be found in the Target section
  - Find the percentile associated with any value by typing it in a "Target (Value)" row
  - Find the value that has a specified percentile by typing it in a "Target (Perc\%)" row
Graphical Output

- Both cumulative (S-curve) and density (histogram) charts are available
  - Density curves are useful for showing where the bulk of possibilities lie, as well as the nature of the tails
  - Cumulative curves quickly show percentiles, which are harder to read off the density
- The delimiters can be moved to show any two percentiles
Reporting in Excel

- All of the reports generated in @RISK for Project can be exported to Excel
  - The charts can be exported as meta files, or in native Excel format
- Below is a truncated example of the very useful Quick Output Report
  - This is identical to the popular Quick Report in @RISK for Excel
Tornado Charts

- A useful visual and mathematical representation of the important inputs to the model
- The bar lengths are determined by:
  - Regression coefficients (usual)
  - Correlation coefficients
- The regression coefficients rank the inputs by their contribution to the variance of the output
- The correlation coefficients rank the inputs by the strength of the relationship between their observed values and observed values of the output
Scenario Analysis

- A scenario is a tail range, or scenario, of the output
  - The highest 10% of durations
  - Finishing before a certain date, etc.
- This report shows which inputs are the key drivers for these scenarios by finding the inputs that are behaving unusually in these scenarios
- The reported statistic can be:
  - Medians for each input when the output is observed in the scenario of interest
  - Those medians as a percentile of the input population
  - The ratio of the difference between the scenario median and actual median to the standard deviation

<table>
<thead>
<tr>
<th>State</th>
<th>Data</th>
<th>Sens.</th>
<th>Scen.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td>Scenarios</td>
<td>Task/Duration Percentile</td>
<td>Task/Duration Percentile</td>
</tr>
<tr>
<td>1</td>
<td>Subtask 1: Work Item (Dist.1)</td>
<td>85.0%</td>
<td>18.5%</td>
</tr>
<tr>
<td>2</td>
<td>Subtask 2: Work Item (Dist.2)</td>
<td>77.5%</td>
<td>22.9%</td>
</tr>
<tr>
<td>3</td>
<td>Subtask 3: Work Item (Dist.3)</td>
<td>88.2%</td>
<td>22.0%</td>
</tr>
<tr>
<td>4</td>
<td>Subtask 4: Work Item (Dist.4)</td>
<td>78.2%</td>
<td>28.0%</td>
</tr>
</tbody>
</table>
Fitting Distributions to Data

- The same rules, guides and caveats that apply to distribution fitting in @RISK for Excel apply here in RPJ.
- Despite this, using historical data in some manner will always be superior to blanket techniques such as “±10% on everything” which is both fundamentally flawed and unhelpful.
- The data must be pasted into the fit window for RPJ to run the fit in this non-spreadsheet environment.
Parameter Entry Tables

- A very quick method of introducing uncertainty to a schedule
- Extra columns are added to the project table representing the parameters of a distribution (e.g. Minimum, Most Likely, Maximum)
- Can be applied to all or selected tasks
  - Select tasks after clicking Parameter Entry button
- Non-@RISK users can enter parameter values this way
- All entries are simultaneously visible
Risk Categories

- Another quick way of assigning distributions to risks
- Tasks are allocated to a group, each of which is similarly distributed
- A logical way of grouping tasks by risk (e.g. low, medium, high)
- Also user-defined groupings (e.g. interior vs. exterior work)
- The available distributions are:
  - Triangle
  - Uniform
  - Pert
- They are parameterised with percentage or actual changes from the base value
Critical Path Analysis

- The critical path is the sequence of tasks that determines the total time for the project.
  - If the duration of any task in the critical path increases, the total time for the project will increase.
- Under uncertainty, the critical path becomes less definite – a task that is critical in one iteration may not be critical in the next.
  - The critical index is the proportion of the iterations during a simulation in which the task was on the critical path.
- To be able to generate the critical index after a simulation, choose the setting:
Modelling Correlation

- Correlation matrices are created in the model window
  - Click Add
  - Insert the desired number of rows
- Attach inputs to the matrix
  - Large matrixes calculated in Excel can be copied and pasted into the window
  - Coefficients can be inputted directly into the matrix
  - The graph in the corner of the pop-up shows what the selected correlation coefficient represents as a scatter plot of observations of the two variables
Probabilistic Branching

- It is common in projects that some tasks can lead to several distinct tasks, only one of which can occur (e.g. repair a server or replace it)
  - @RISK’s probabilistic branching allows you to model these realistic situations and simulate them
- Select the task you want to branch from then click the probabilistic branching toolbar button
- Enter the tasks to branch to and their likelihood of occurring
If/Then Conditions

- Logic conditions often need to be included in the risk model to accurately represent the impacts of risk
  - @RISK uses If/Then logic rather than the Excel-style If/Then/Else
  - Thus the ‘Else’ is the static value of the task when not simulating
- Select the task you want to apply the condition to and click the If/Then button on the toolbar
- Enter the condition you want to apply—it’s that easy!
Global Variables

- Global variables are used to affect other variables or distribution functions in the risk model.
  - For example, the global variable “weather severity” may be required as an input in several tasks to impact their duration or cost.
- Global variables are created in the Model Window.
- They can be referenced in other risk functions, e.g.

  \[
  \text{Bad Weather Task [Duration]} = \text{RiskNormal(Variable[Weather Severity],2)}
  \]
# Probabilistic Calendar

- Random non-work days can be modelled in calendars with @RISK
  - Examples include industrial action, adverse weather, server downtime etc
- These are generalised affects that will prevent work on a project for a time period
- Specific resource calendars can also have random non-work days

![Probabilistic Calendars](image)

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**Probabilistic Calendars**

<table>
<thead>
<tr>
<th>Range Name</th>
<th>Start Date</th>
<th>End Date</th>
<th>Non-Working Probability %</th>
<th>1 Sample for</th>
<th>Outside Range, Repeat</th>
<th>Outside Range, Repeat Until</th>
<th>Apply to Non-Work Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server downtime</td>
<td>3/2/2007</td>
<td>3/8/2007</td>
<td>10%</td>
<td>Each Day</td>
<td>Each Week</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>
RiskSimtable

- Decision variables are not subject to risk, rather they can be adjusted/selected by the analyst.
- The Simtable function represents these different policy choices for the model and allows us to directly compare the results of each choice.
  - A separate simulation is run for each policy choice, corresponding to the number of arguments in the Simtable function.
- Note carefully the use of "{}" and "," to delimit values.
- Std. Rate = Simtable({100,105,110})
  - Returns the values 100, 105 and 110 in consecutive simulations.