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Using Advanced GoldSim Features to Support Project Performance Modeling

GOLDSIM USER CONFERENCE 2018 \ SEATTLE, WA

September 12, 2018

AGENDA

- About me
- Project risk analysis & simulation
- Some useful GoldSim elements and features
- A few considerations
- Conclusions

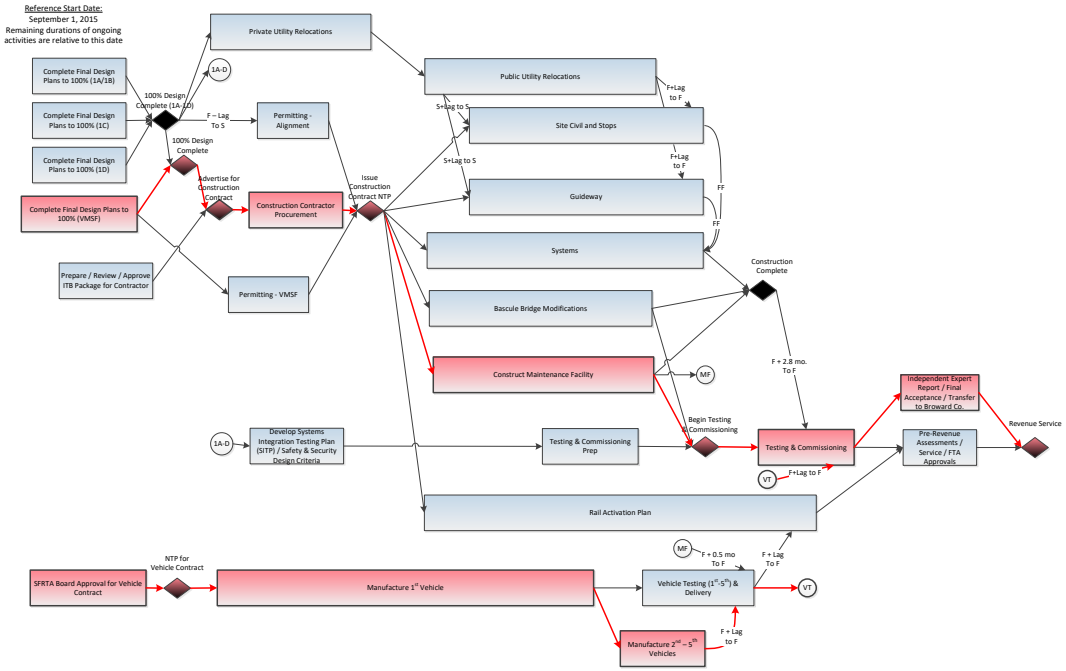
Project Risk Analysis & Simulation: Applications

- Public infrastructure
  - Transportation
  - Utilities
  - Buildings
  - Waste management
  - Etc.

- Private ventures
  - Facilities
  - Product development
  - Software
  - Etc.

How do we model a project?

- Sequence of activities, defined by predecessor-successor relationships
- Key milestones and objectives
- Possible decision points
- Resource expenditure (e.g., cost)
- Risks



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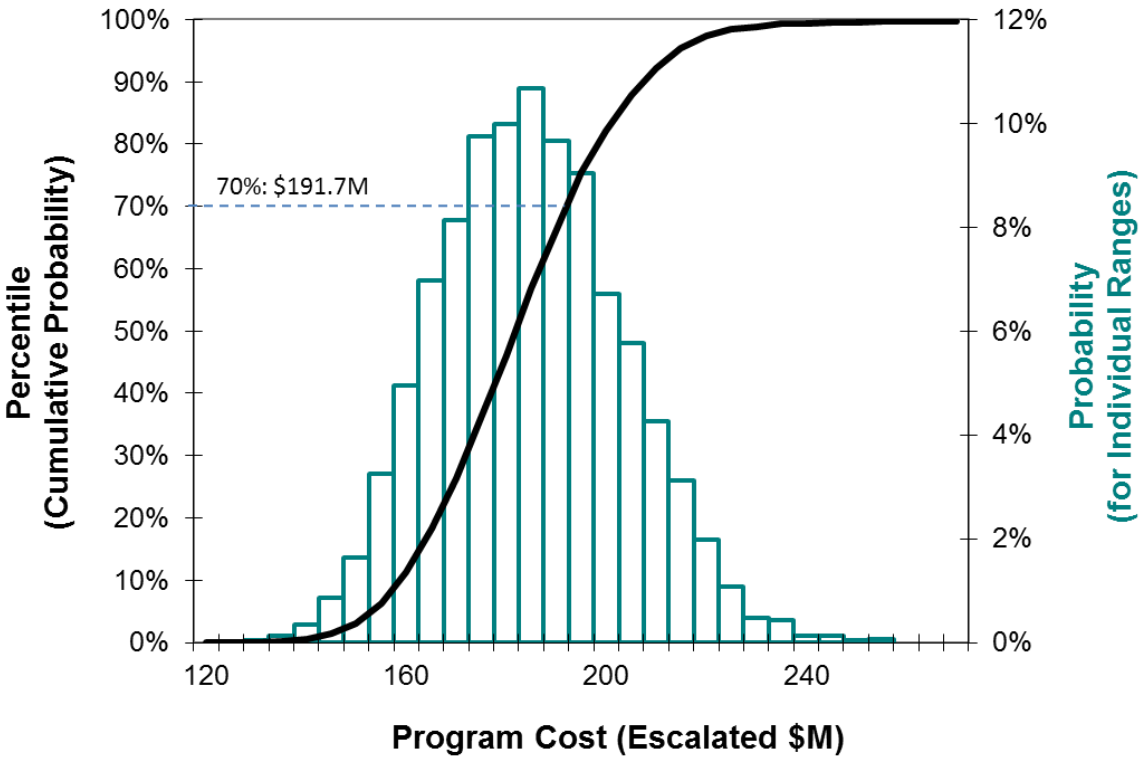
Project Risk Analysis & Simulation: Uses/Objectives

- Budget establishment or validation (e.g., based on percentile cost)
- Risk-based scheduling
- Strategic/program planning
- Selection of preferred alternative
- Scenario evaluation (e.g., re: timing of funding availability)
- Go/No Go Decisions
- Risk management



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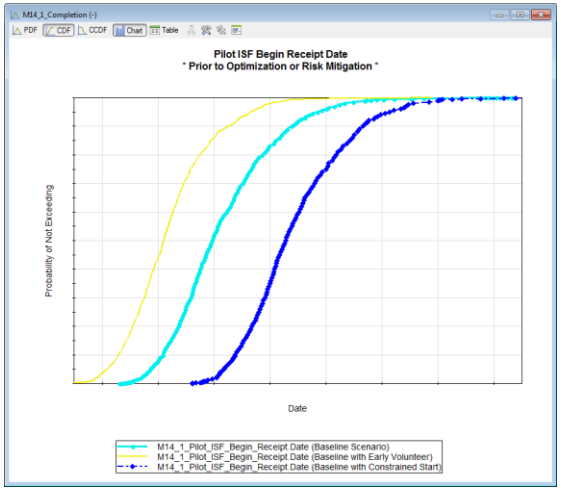
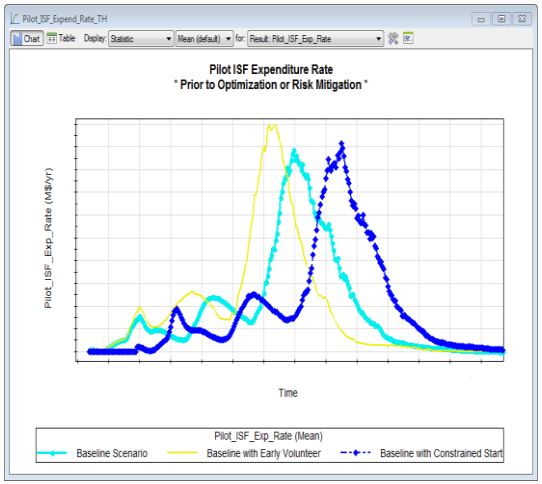
Project Model Inputs

- Activity costs and durations
- Logistics (e.g., inventories, shipment rates, etc.)
- Other project metric descriptors, as appropriate (e.g., environmental impacts, etc.)
- Estimating uncertainties associated with the above, including correlations
- Resource limitations / constraints (e.g., annual funding caps)
- Risks to project metrics, including potential impacts and probability of occurrence

Project Risk Analysis & Simulation: Outputs

- Probability distribution of cumulative cost
- Probability distributions of milestone completion dates
- Expenditure rates / cash flow
- Sensitivity of input uncertainties and risk events on key outputs
- Probability of activities and milestones being on critical path
- Comparison of alternative scenario performance
- Probability of failure





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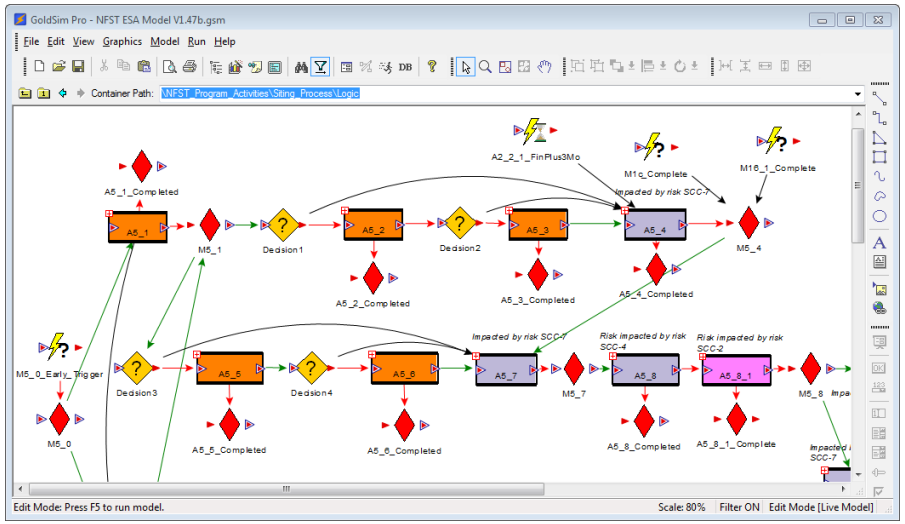
Some Useful GoldSim Capabilities for Model Construction

- Event-driven models (no basic timesteps)
- Conditional containers to represent activities
- Milestone elements to track start and completion dates
- Decision elements to handle branching logic
- Allocator elements to assign available funding
- Correlation Matrices



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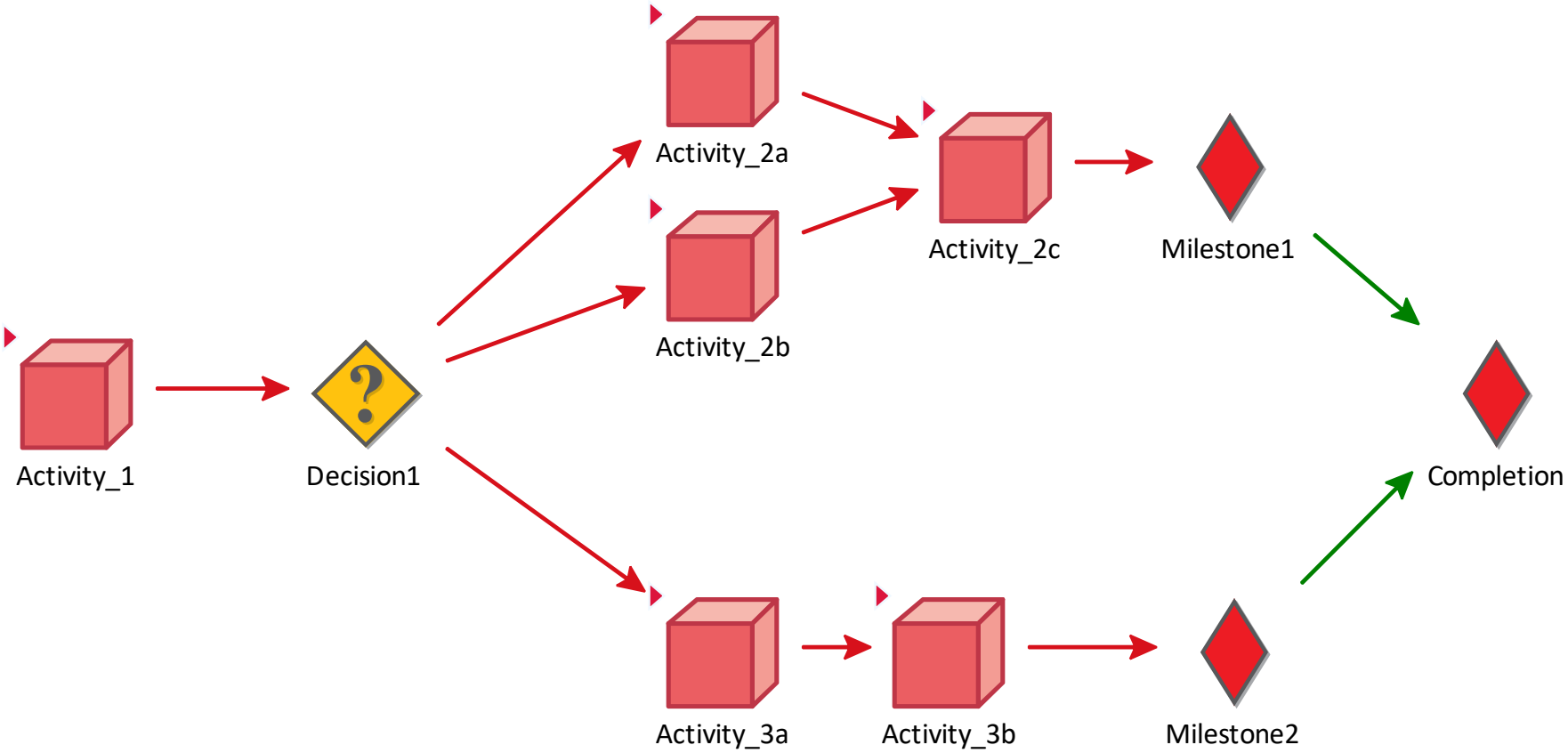
Project Model Structure Example



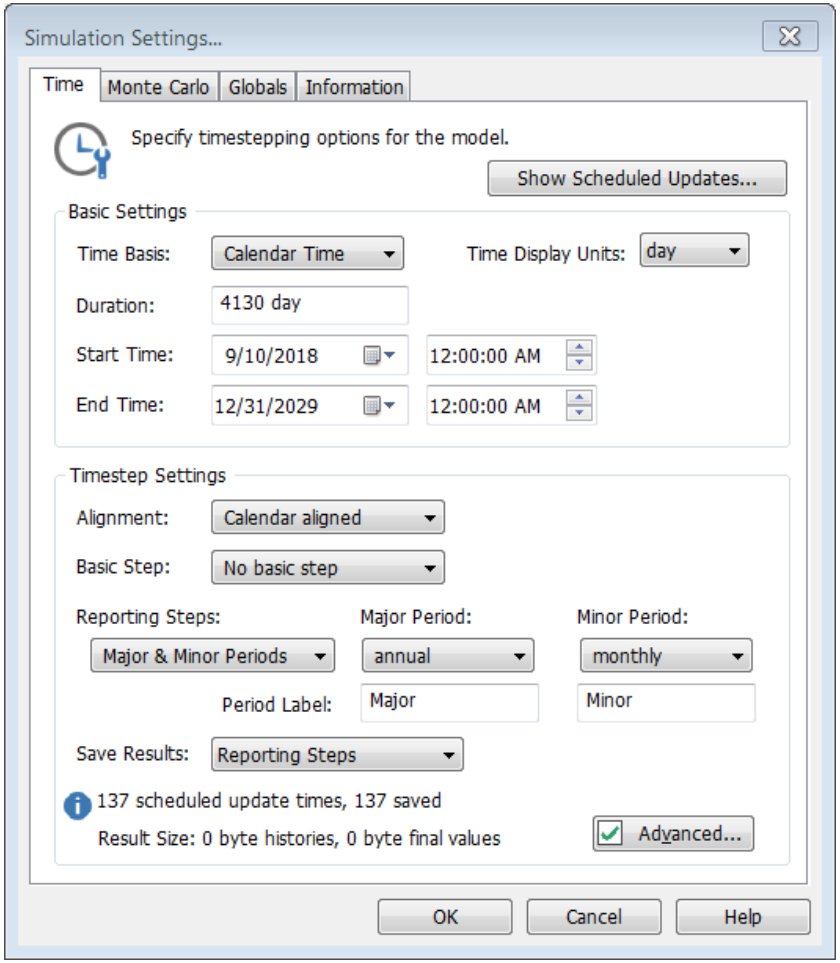
Event-Driven Models

Model only updates when something "happens" (e.g., activity starts or finishes, event occurs).

Calculations (e.g., spend rates) are assumed to be uniform between updates.

This is efficient and reduces simulation time, but can result in loss of accuracy if triggers not set up carefully.

- For example, should avoid use of "On True" triggering because the model will not necessarily update immediately upon the condition being met.



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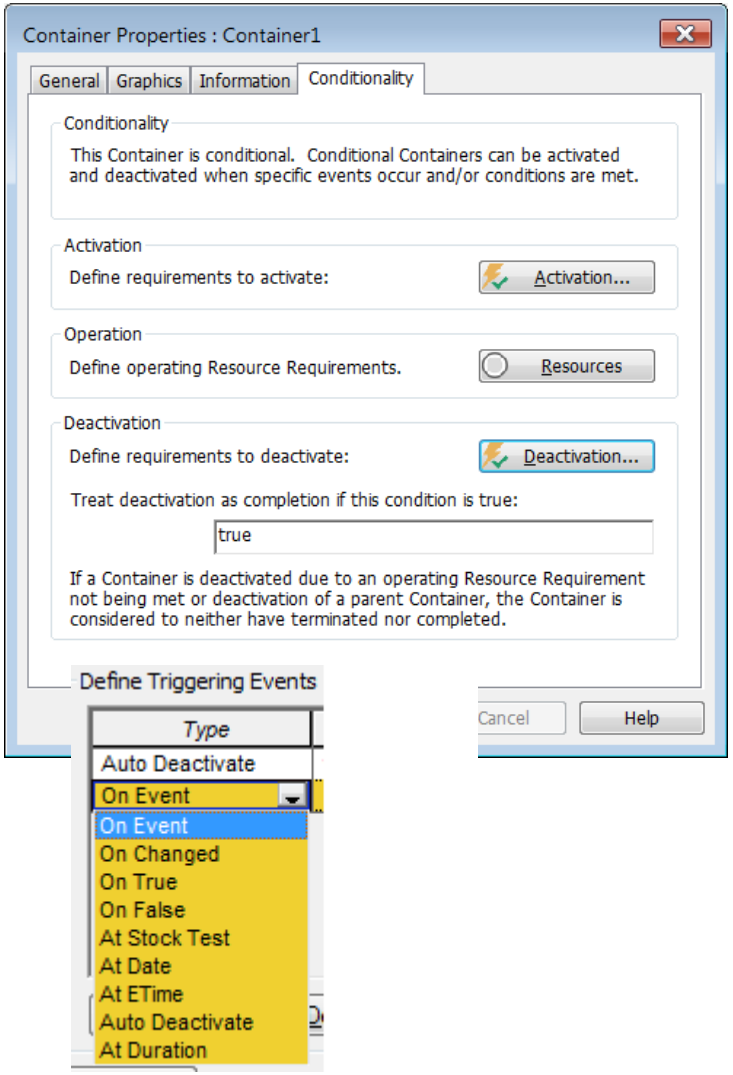
Use of Conditional Containers

Use of triggers to represent the activity's activation and completion

Useful triggering mechanisms include:

- On Event: for completion events of predecessor activities
- At Duration: for specified or internally-calculated duration
- At Stock Test: for decrementing "work remaining" approach
- At Date: for specified (future) date



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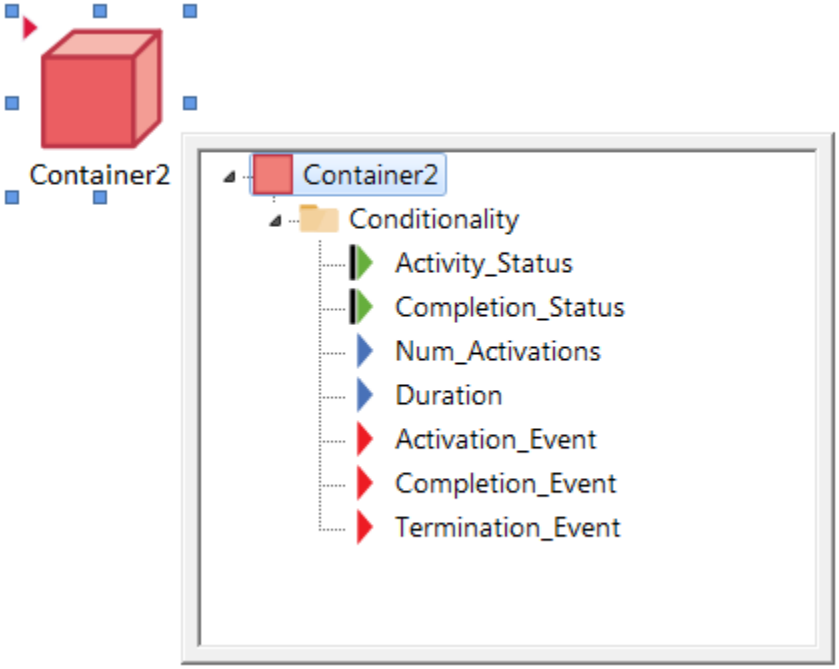
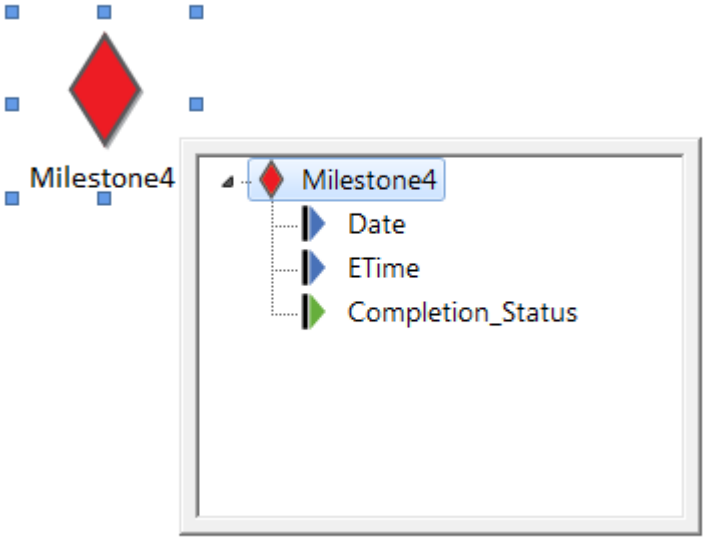
Conditional Container Event-Driven Triggering

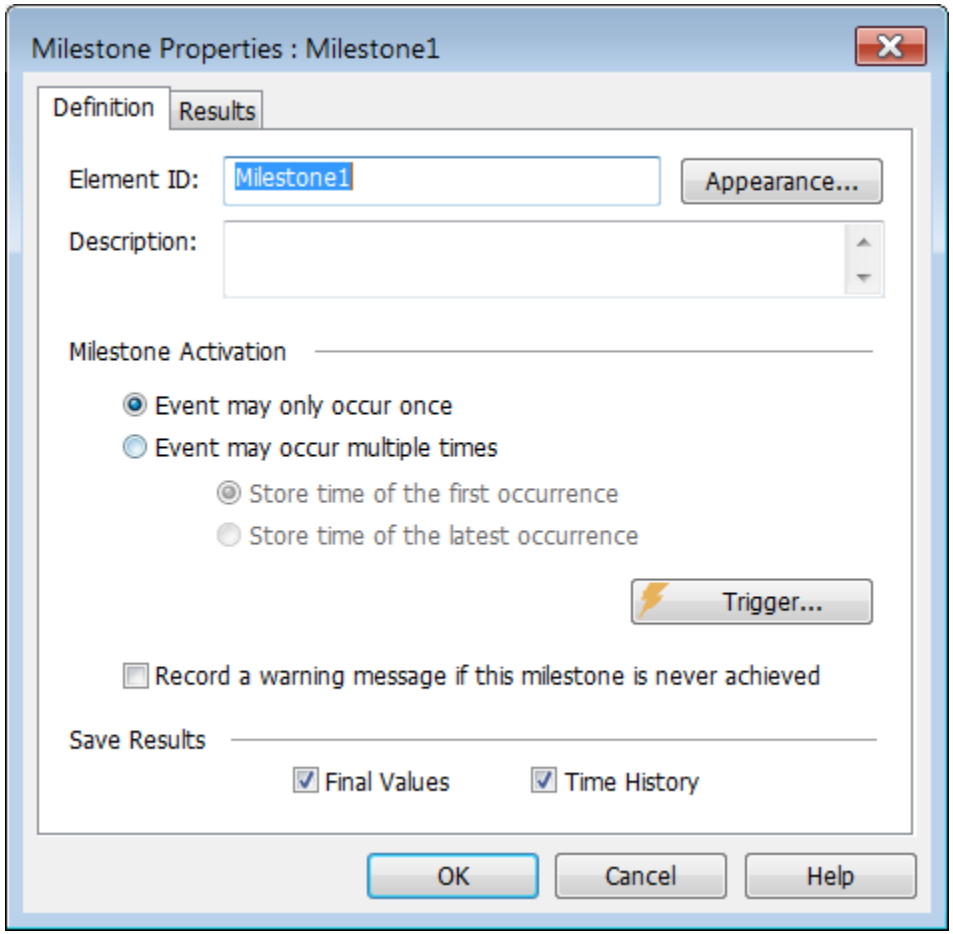
Conditional containers produce additional outputs, including several events that can be used to trigger activation and/or deactivation of successor containers.



Milestone Elements

- Useful for recording achievement dates
- Standard triggering mechanisms are available





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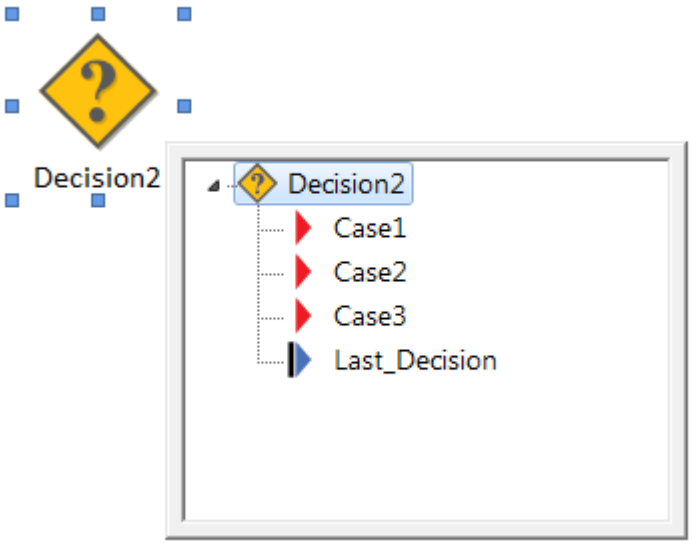
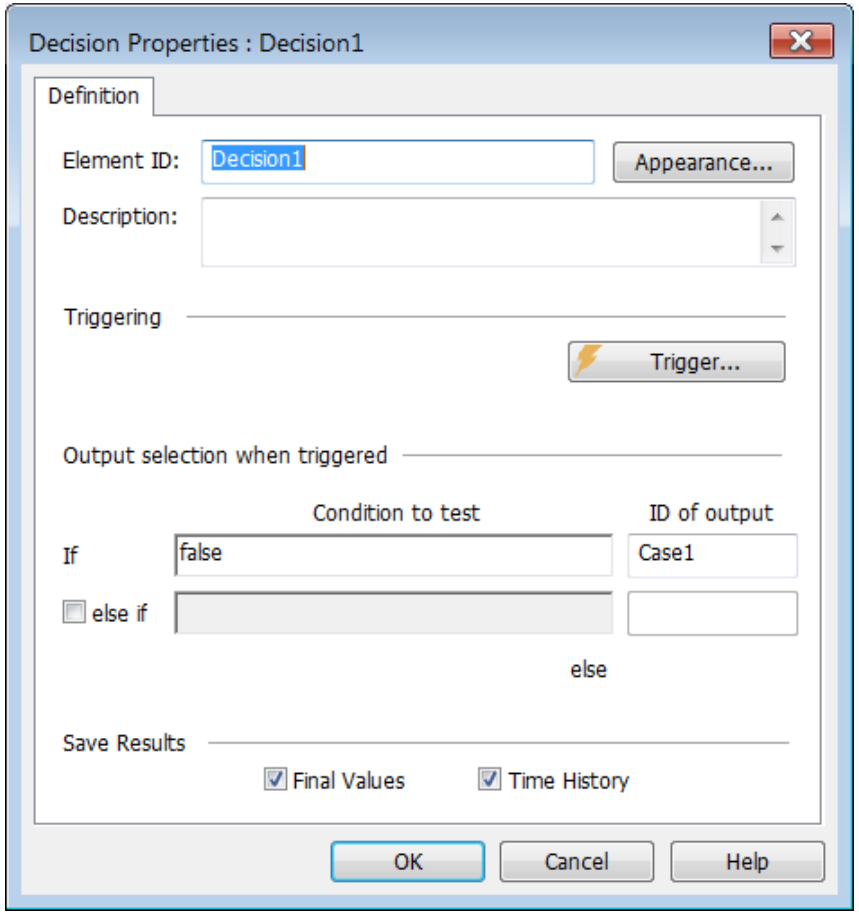
Decision Elements

- Useful for triggering subsequent logic based on a condition that can be tested
- Triggers events (up to 3) based on test condition
- Standard triggering methods apply





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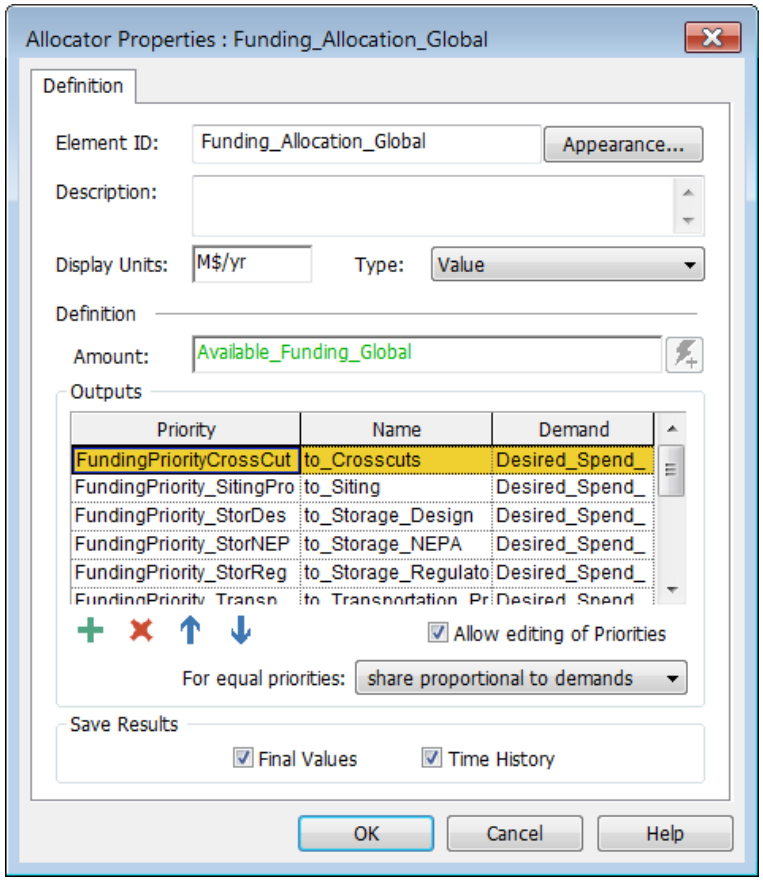
Allocator Elements for Resource Distribution

Can be used to allocate available funding (or resources) among activities or groups of activities based upon user-specified priorities.

Requires:

- Available amount
- Desired amount for each allocation group
- Priority for each allocation group



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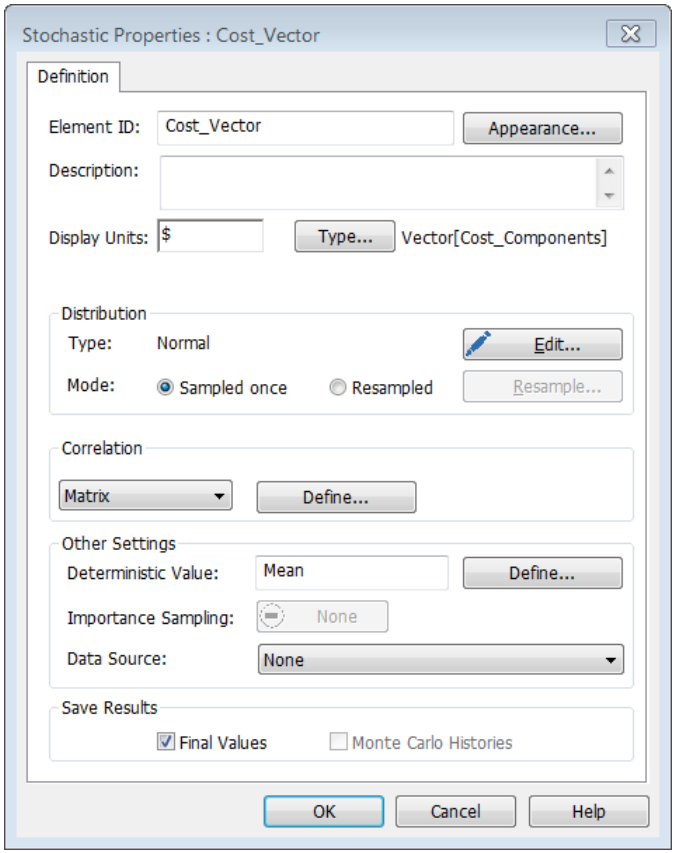
Correlation Matrices

Can be used to define correlation coefficients among groups of inputs (e.g., activity costs or cost components).

- Stochastic inputs grouped into a vector
- GoldSim will ensure that the matrix is internally consistent



Correlation Algorithm: Copula: Gaussian

	1	2	3	4	5
1	1	0.5	0.5	0.5	0.9
2	0.5	1	0.5	0.5	0.5
3	0.5	0.5	1	0.5	0.5
4	0.5	0.5	0.5	1	0.5
5	0.9	0.5	0.5	0.5	1

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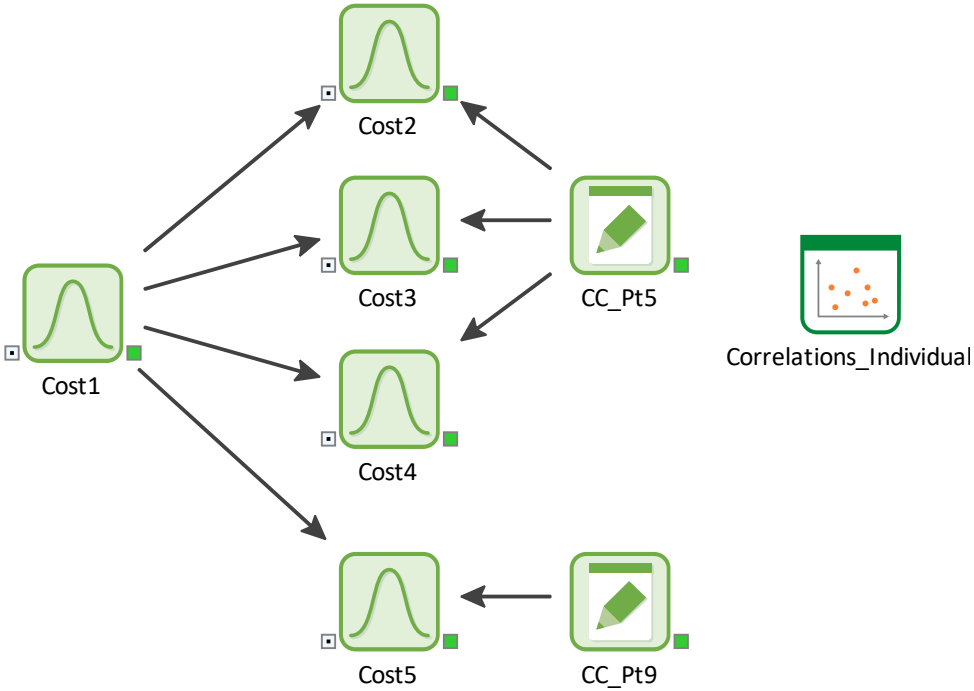
Correlation Matrices: Example

Correlation Matrix

Pairwise Correlation



Correlation Matrices: Example

Correlation Matrix Results

Correlations_Matrix

2D Chart | 3D Chart | Table | Correlations | Sensitivity | Use Ranks

	Cost_Vector[1]	Cost_Vector[2]	Cost_Vector[3]	Cost_Vector[4]	Cost_Vector[5]
Cost_	1	0.505	0.501	0.510	0.901
Cost_	0.505	1	0.511	0.502	0.508
Cost_	0.501	0.511	1	0.499	0.501
Cost_	0.510	0.502	0.499	1	0.505
Cost_	0.901	0.508	0.501	0.505	1

Pairwise Correlation Results

Correlations_Individual

2D Chart | 3D Chart | Table | Correlations | Sensitivity | Use Ranks

	Cost1	Cost2	Cost3	Cost4	Cost5
Cost1	1	0.502	0.506	0.515	0.901
Cost2	0.502	1	0.253	0.252	0.453
Cost3	0.506	0.253	1	0.252	0.454
Cost4	0.515	0.252	0.252	1	0.461
Cost5	0.901	0.453	0.454	0.461	1

Some Useful GoldSim Features for Output Evaluation

- Scenario Manager

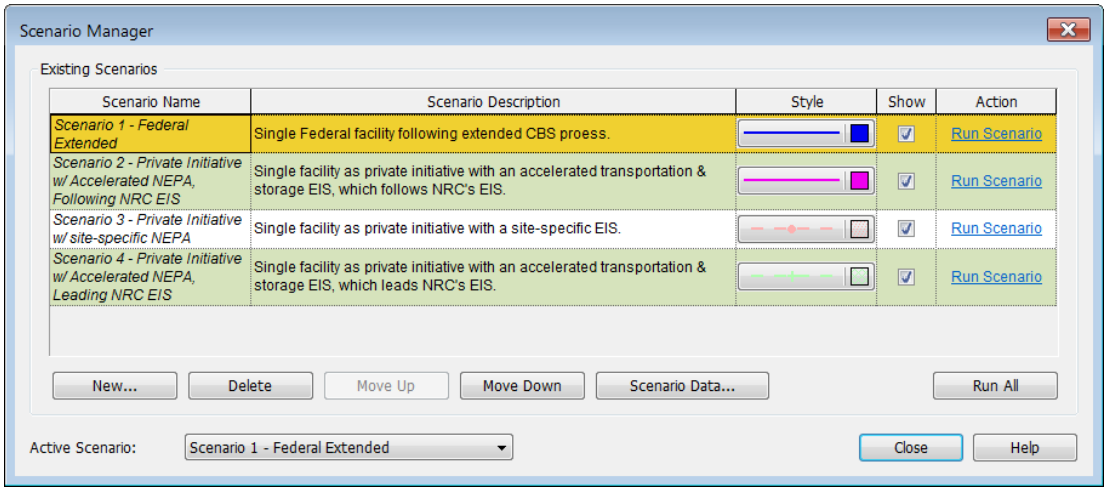
- Sensitivity Analysis

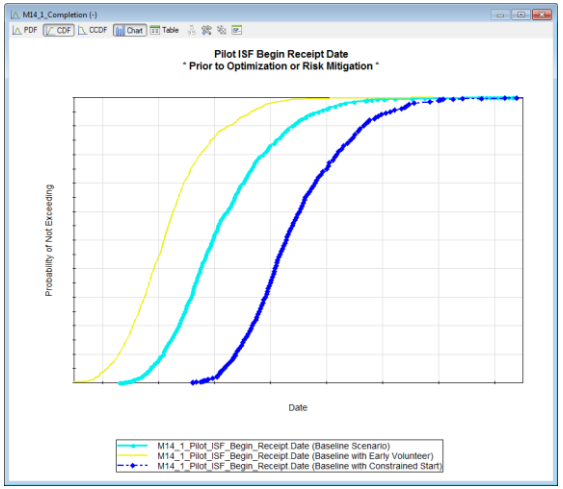
Scenario Manager

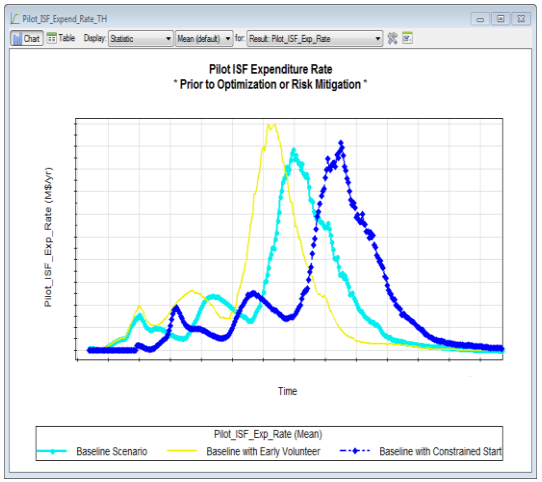
Allows for comparison of alternative scenarios within a single simulation.

For example:

- Funding scenarios
- Design alternatives
- Delivery methods
- Project development strategies







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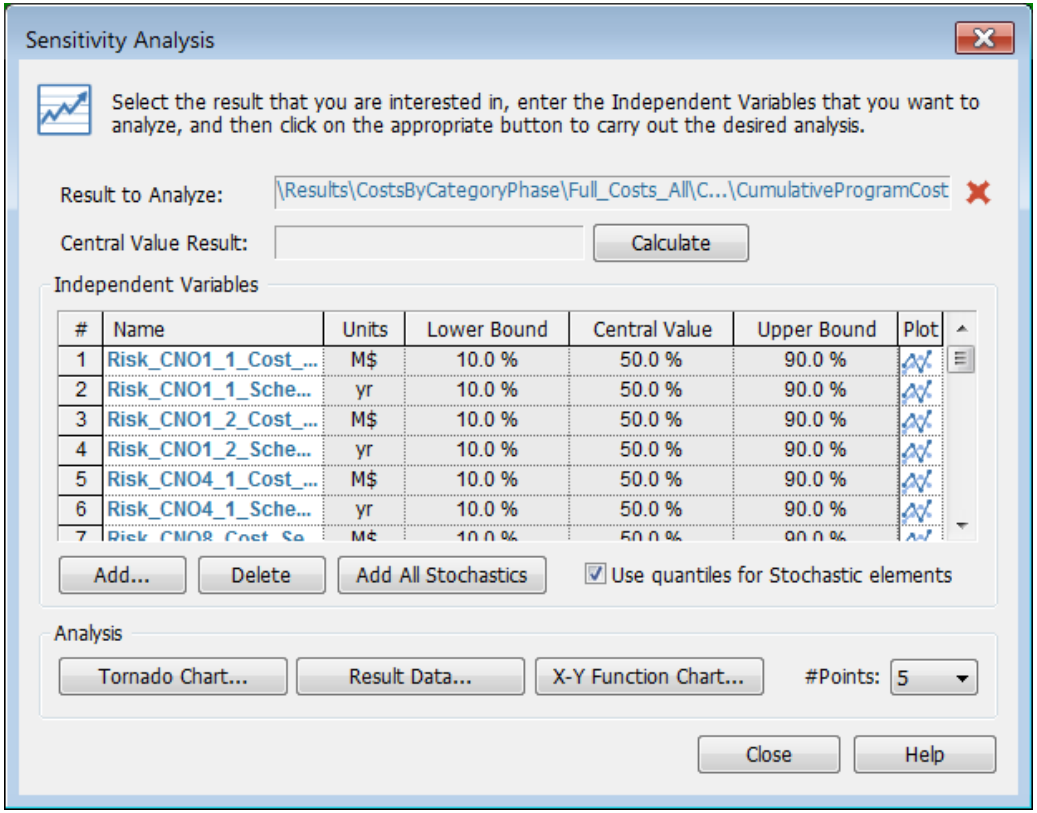
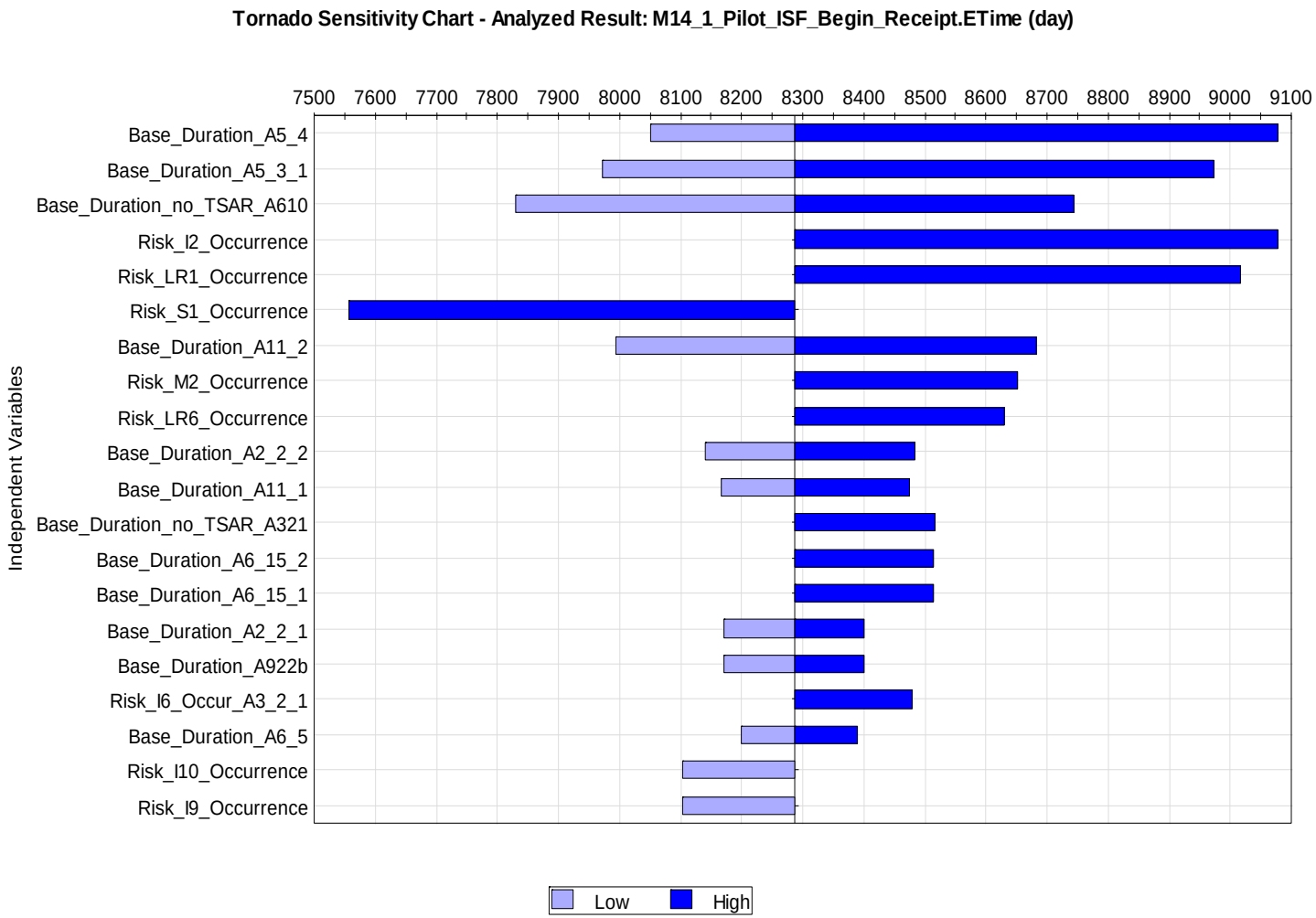
Sensitivity Analysis

Selected inputs are independently varied over their range of potential values (e.g., 10th to 90th percentiles for stochastic inputs)



The value of a specified dependent variable (e.g., milestone completion date) is recorded with each variation.

Sensitivity Analysis



What Works Well? (1 of 3)

- GoldSim provides a great deal of flexibility to address complex modeling situations (e.g., risks, branching logic, decision rules, etc.) and allows the developing of custom decision support models free of constraints introduced by commercial scheduling products.

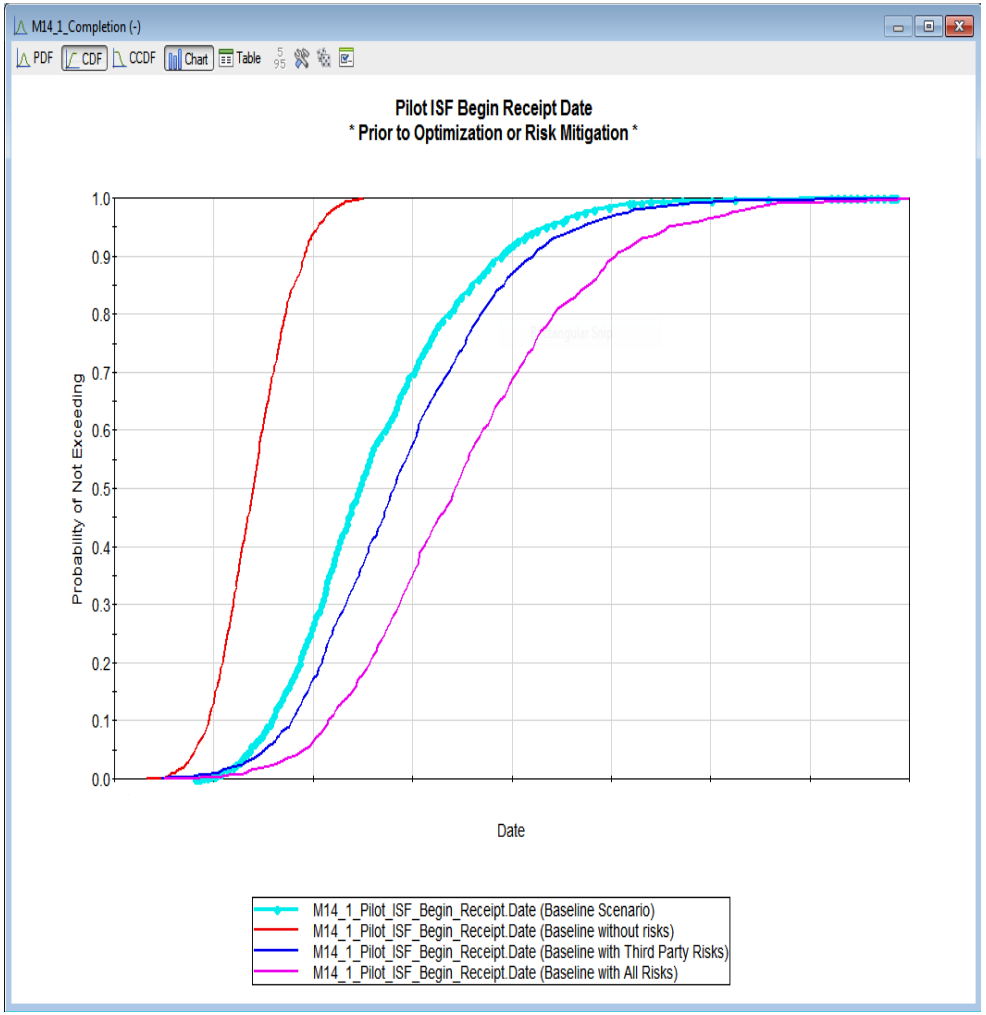
- Dashboards to develop custom user interface.

- GoldSim's output capabilities facilitate powerful, interactive discussions with decision makers.

What Works Well? (2 of 3)

- The GoldSim scenario manager provides an excellent tool for easy comparison of alternative scenarios or strategies (e.g., funding constraints, schedule acceleration, design alternatives, etc.).

- Reporting periods support cost reporting (e.g., by fiscal year).



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What Works Well? (3 of 3)

- The GoldSim sensitivity analysis capability is useful to determine the relative significance of stochastic inputs (particularly with respect to the nonlinear schedule results); however, careful structuring is required to achieve maximum benefit.

- GoldSim' s modular framework allows for relatively rapid model development once the basic building block structure is established.

What are the Challenges? (1 of 2)

- GoldSim does not offer a “canned” solution for project simulation, and a solid understanding of GoldSim’s triggering methods is necessary.
- Calculation of critical path has to be done manually because GoldSim doesn’t record the element responsible for a triggering action.
  - *This is a potential area for software enhancement.*
- Project models typically involve a large volume of input data (e.g., costs, durations, risks, etc.).
  - *Carefully-structured input spreadsheets (with associated spreadsheet elements) can alleviate the data management challenges.*
  - *Selective saving of results (particularly time histories) can help manage file size.*

What are the Challenges? (2 of 2)

- Handling correlations among a large number of probabilistic inputs requires careful consideration.
  - *GoldSim provides mechanisms to address correlations (including correlation matrices), but careful thought should be given to this topic when developing model inputs and designing the structure.*

- The logic can be complex and difficult to verify.
  - *Recommend performing independent, deterministic, calculations of schedule and cost (e.g., in a separate spreadsheet) for comparison with model results.*

Conclusions

- GoldSim provides a powerful environment for simulation of complex projects.
- Particularly suitable for projects requiring key decisions to be made despite significant uncertainty related to cost, schedule, or other key metrics, branched logic, and multiple alternatives.
- GoldSim particularly shines in situations where the model can be used as an interactive demonstration tool.
- Such models tend to be complex and the modeler will be presented with challenges related to data management and probabilistic calculations, but GoldSim provides tools to overcome these challenges

Questions?

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