

Quick Tour



BlockSim

VERSION 2024

ReliaSoft

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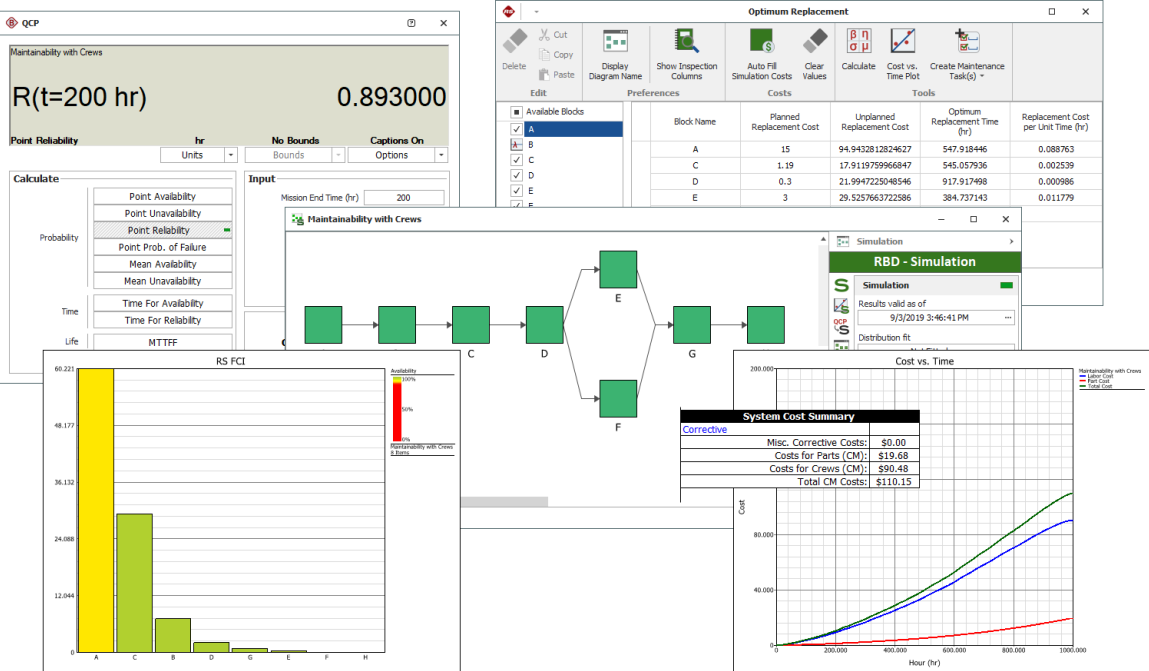
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Quick Tour of BlockSim

BlockSim supports a wide variety of system reliability, availability and related analyses using **reliability block diagrams (RBDs)**, **fault trees (FTA)** and/or **Markov analysis**. It's also packed with tools for related analyses, such as reliability allocation, optimum replacement and inspection, reliability importance measures and throughput analysis. In addition, BlockSim's **event analysis flowcharts** use Monte Carlo simulation to model and analyze even the most complex probabilistic or deterministic scenarios.

You can use this application to answer a wide variety of questions, such as:

- What is the expected reliability of the system? What are the most critical components? What component reliabilities are required to meet the system reliability goal?
- What is the expected availability (uptime) or throughput? Where are the critical components or bottlenecks? What changes are needed to meet the operational goals?
- What is the optimum maintenance strategy? When is the best time for scheduled maintenance? How many spares should we keep on hand? Is crew capacity sufficient?
- How much will it cost to operate the system? How will a change in the design or operating conditions affect costs? Which components are the most costly?
- What is the risk of catastrophic failure? Which components or failure modes pose the greatest risk? How will a change in the design or operating conditions affect safety?
- How does the system perform across different operational phases?
- What is the effect of variability on performance? How will the outcome be affected by changes in specific inputs? What are the probabilities of different possible outcomes?



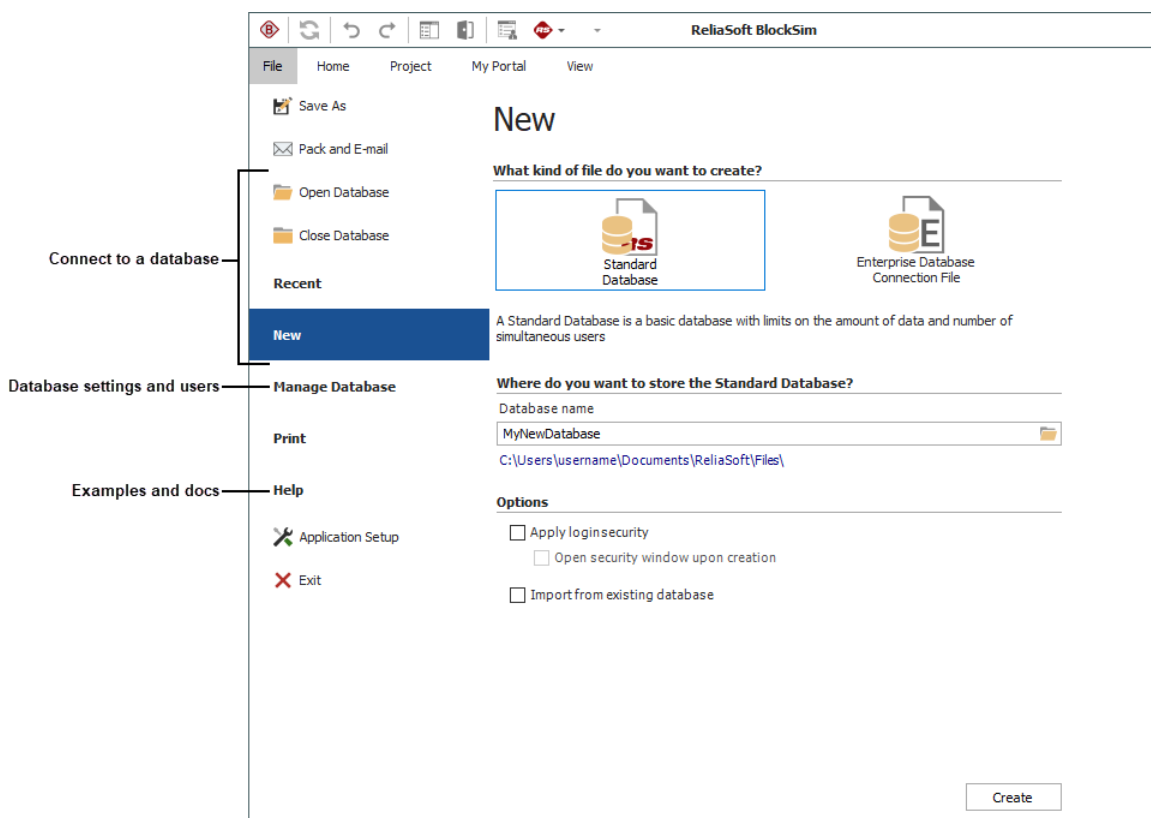
Using Databases and Projects

File Menu

Use commands on the **File** menu (**New**, **Recent** or **Open Database**) to create or open a database.

Each database supports simultaneous access by multiple users. If you have admin permissions, use **File > Manage Database** to control user access and manage configurable settings that apply throughout the database.

Use **File > Help** to access online help and shipped examples.

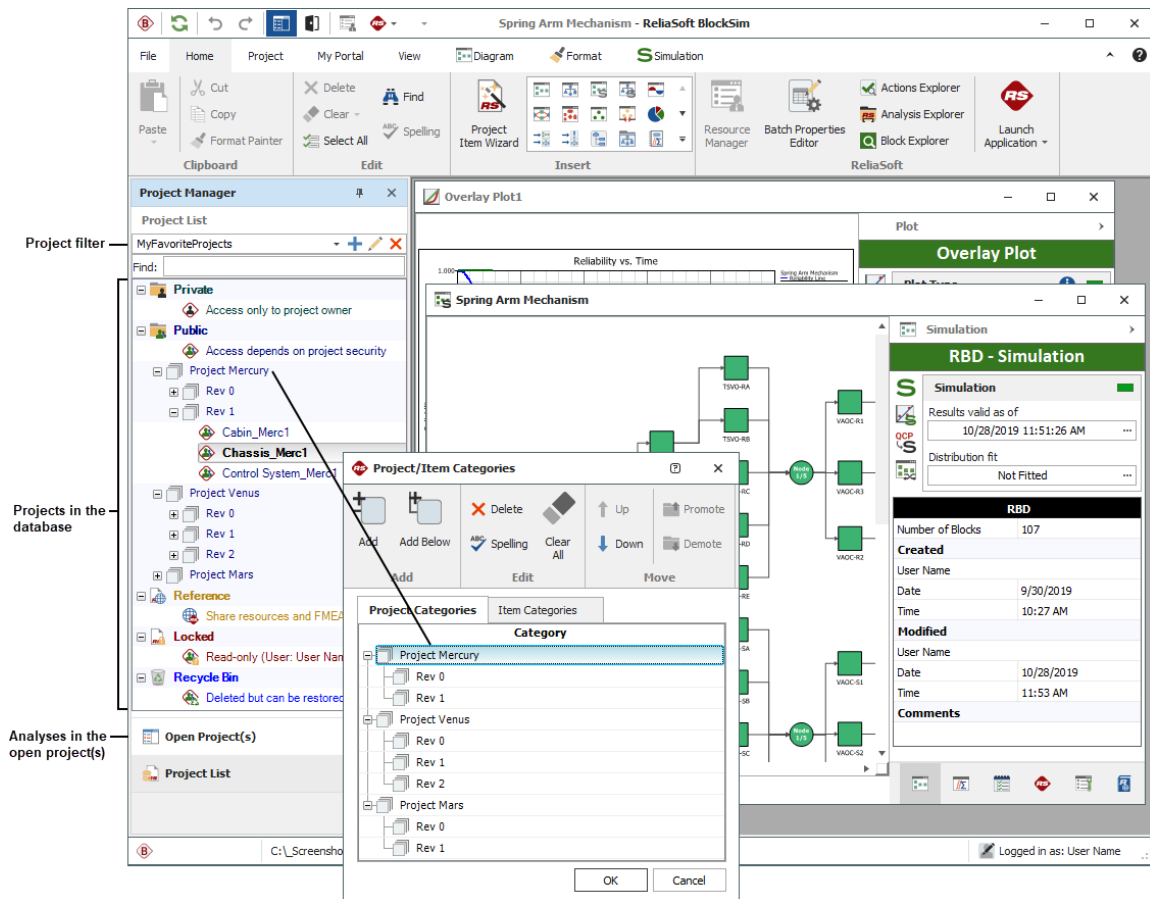


Project List

Each database can contain multiple projects. Use the **project list** to create or open a project.

If you have a lot of projects:

- Use the **project filter** to limit what's displayed.
- Use the **project category** to group projects within the list.



Current Project Explorer

Use the **current project explorer** to create or open analyses and reports.

You can open the same project in any ReliaSoft desktop application. Analyses and reports are visible only in the application(s) that can edit them:

- Life data folios are visible only in Weibull++
- Fault trees are visible only in BlockSim
- FMEAs are visible only in XFMEA/RCM++
- Etc.

Common features such as **resources** and **project attachments** are visible in all ReliaSoft desktop applications.

Using Fault Trees

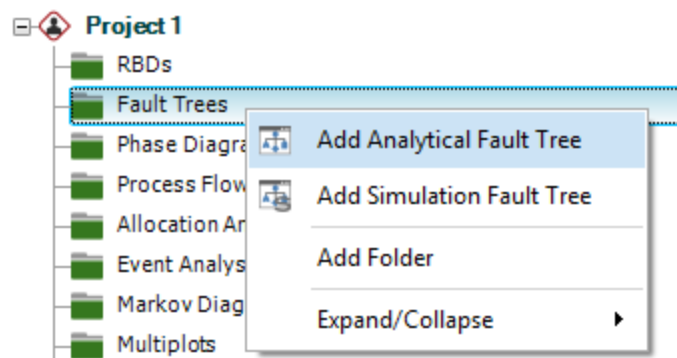
BlockSim's fault trees can be configured as analytical diagrams (which use the exact mathematical solution for the system model but impose limitations on what can be modeled and what results can be obtained) or simulation diagrams (which provide more modeling options and results but must be analyzed with discrete event simulation).

Fault trees and reliability block diagrams (RBDs) can be used together in the same analysis (e.g., a subdiagram block in a fault tree can point to an RBD and vice versa).

The basic steps for using an analytical fault tree are:

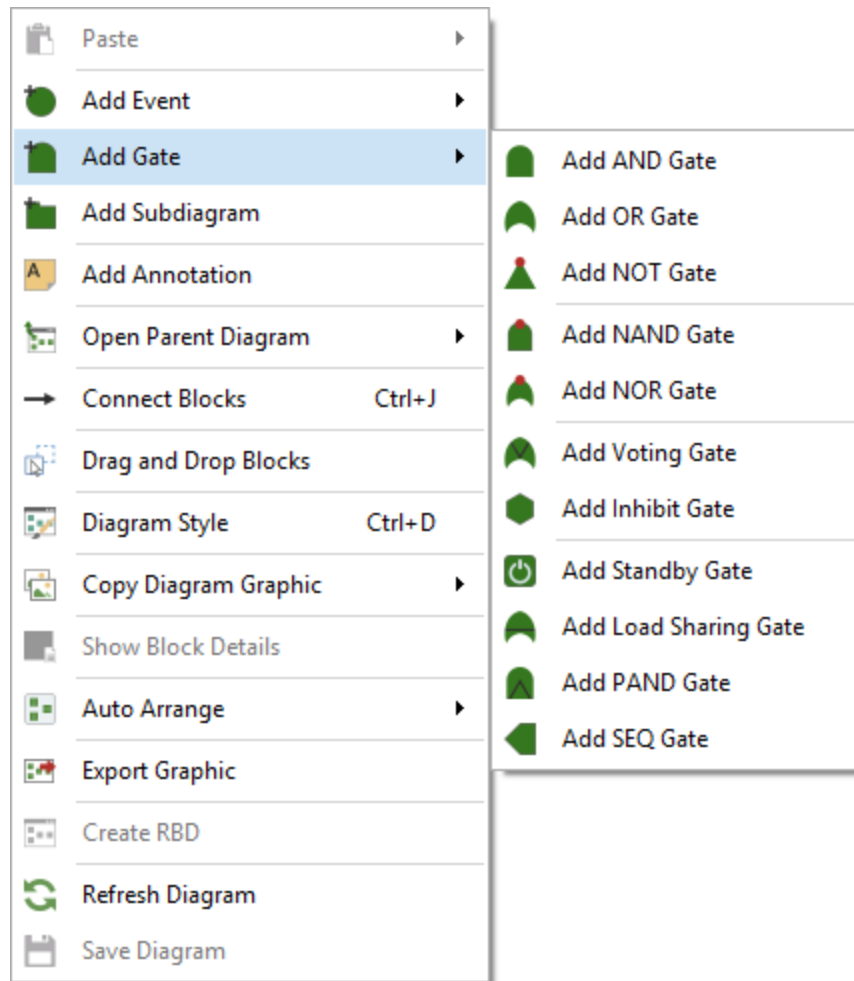
1. Add fault tree diagram

Right-click the Fault Trees folder in the current project explorer and choose **Add Analytical Fault Tree**.



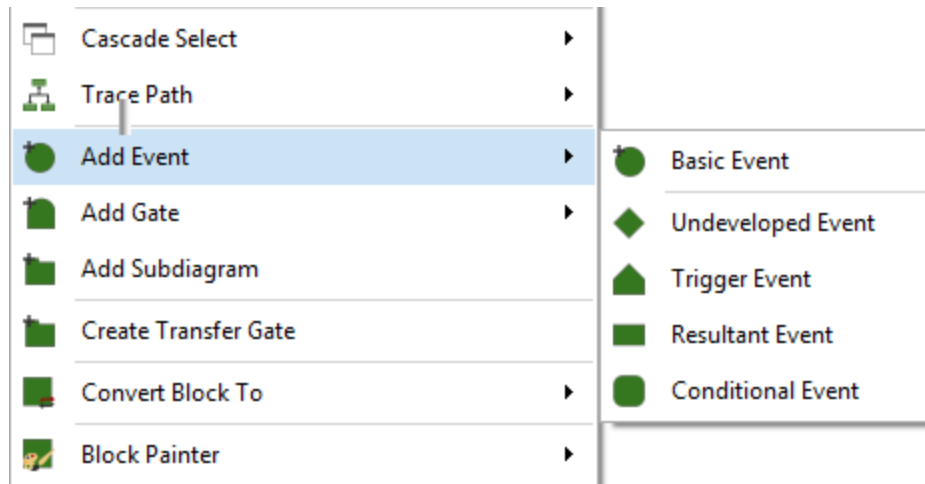
2. Add gates

Right-click inside the diagram and choose the type of gate to add.



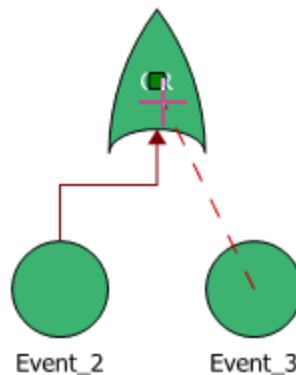
3. Add events

Right-click a gate and choose **Fault Tree > Add Event > [Type of Event]**. When a gate is selected, the event will be added below the gate, already connected.



4. Connect blocks (if applicable)

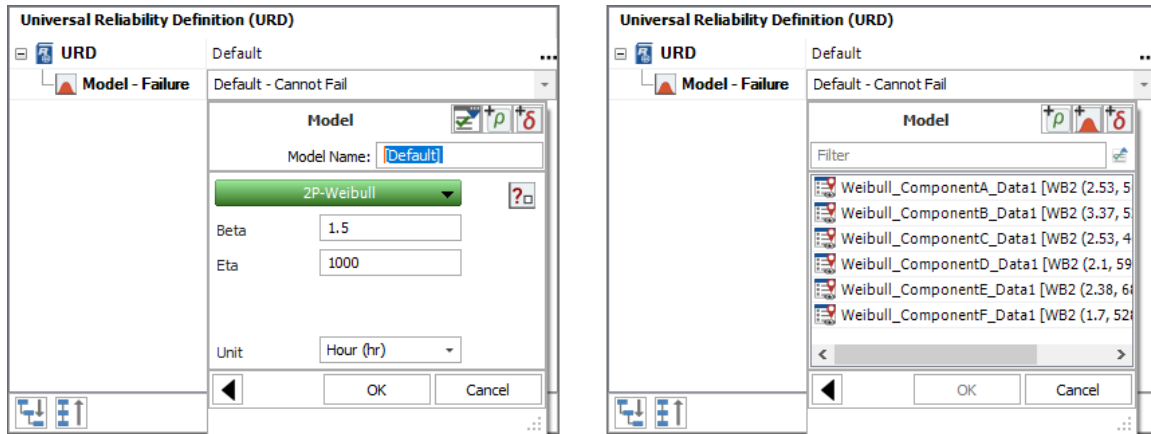
If you need to create a new connection, hold down the **ALT** key, click the source block and drag a line to the destination block.



5. Set block properties

To edit a block's properties, right-click it and choose **Block Properties**. For gate blocks, you can change the name and identifiers. For event blocks, specify any operational and cost properties and use *universal reliability definitions* (URDs) to specify the reliability properties.

- To select an existing URD, click inside the **URD** field.
- To create a new URD, click inside the **Model - Reliability** field and follow the wizard. You can create a new model (left) or select an existing model (right). Existing models may have been manually created, or may have been published from other analyses in BlockSim, Weibull++ or Lambda Predict.

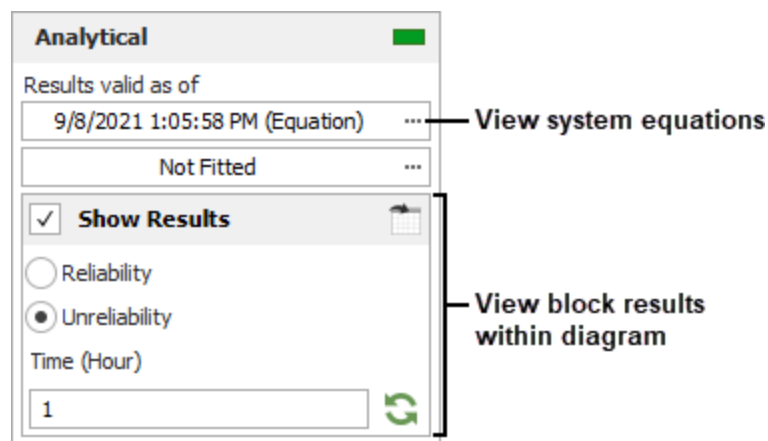


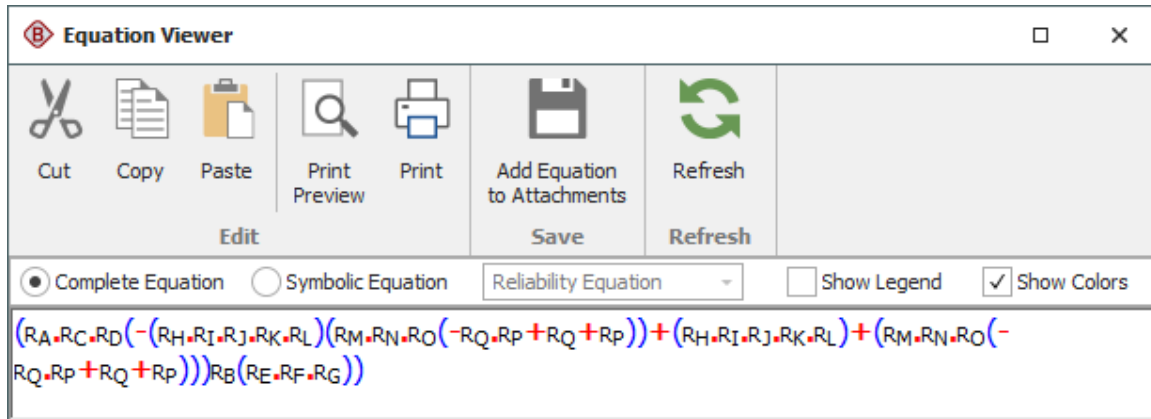
6. Analyze the diagram

Click the **Analyze** icon on the control panel.



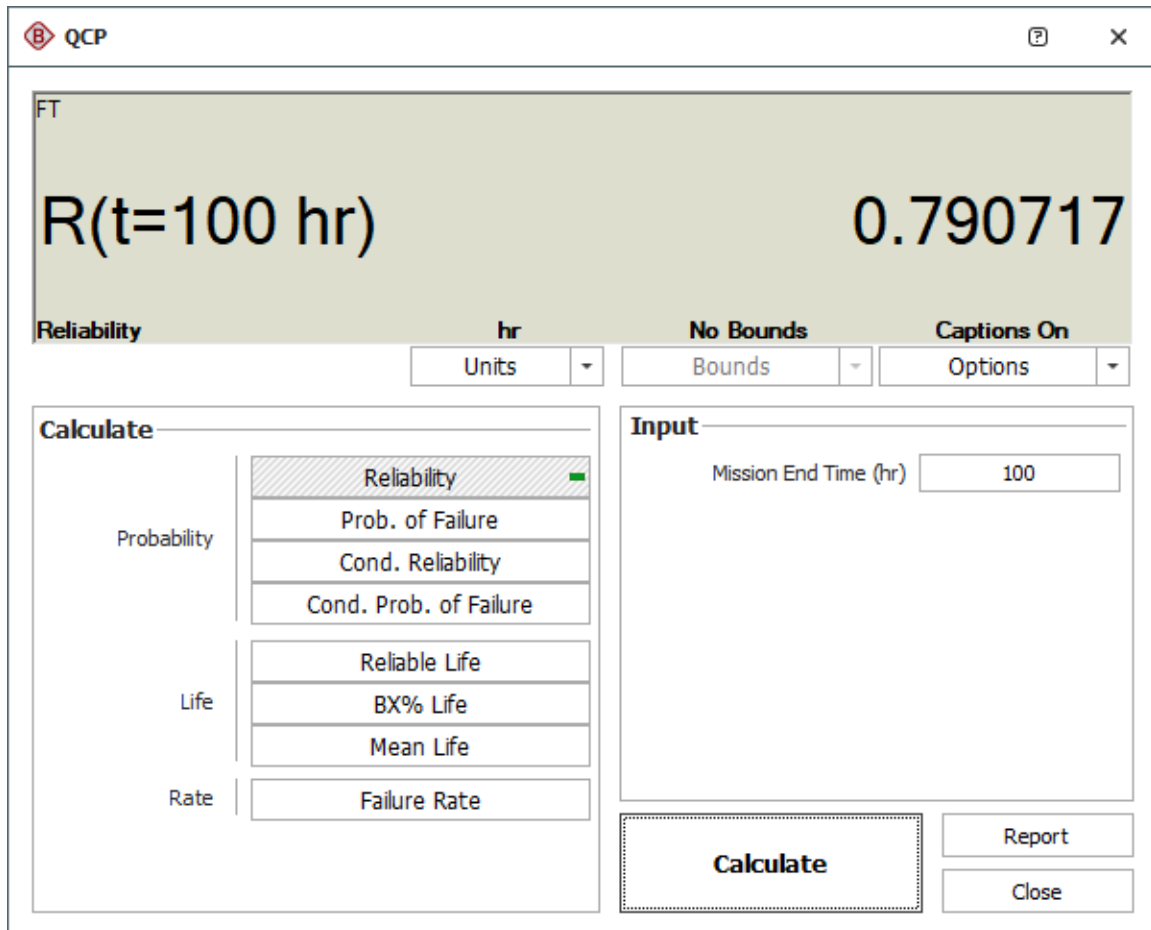
To view the calculated reliability or unreliability at a specific time for each block, select **Show Results** on the control panel and specify the time. To view the algebraic equations for the system reliability, *pdf* and failure rate, click the **Results valid as of** field on the control panel. Note that starting in Version 2022, you have a choice of analysis methods for analytical fault trees; algebraic equations are available only for the Equation analysis type, not for the new Binary Decision Diagram analysis types.





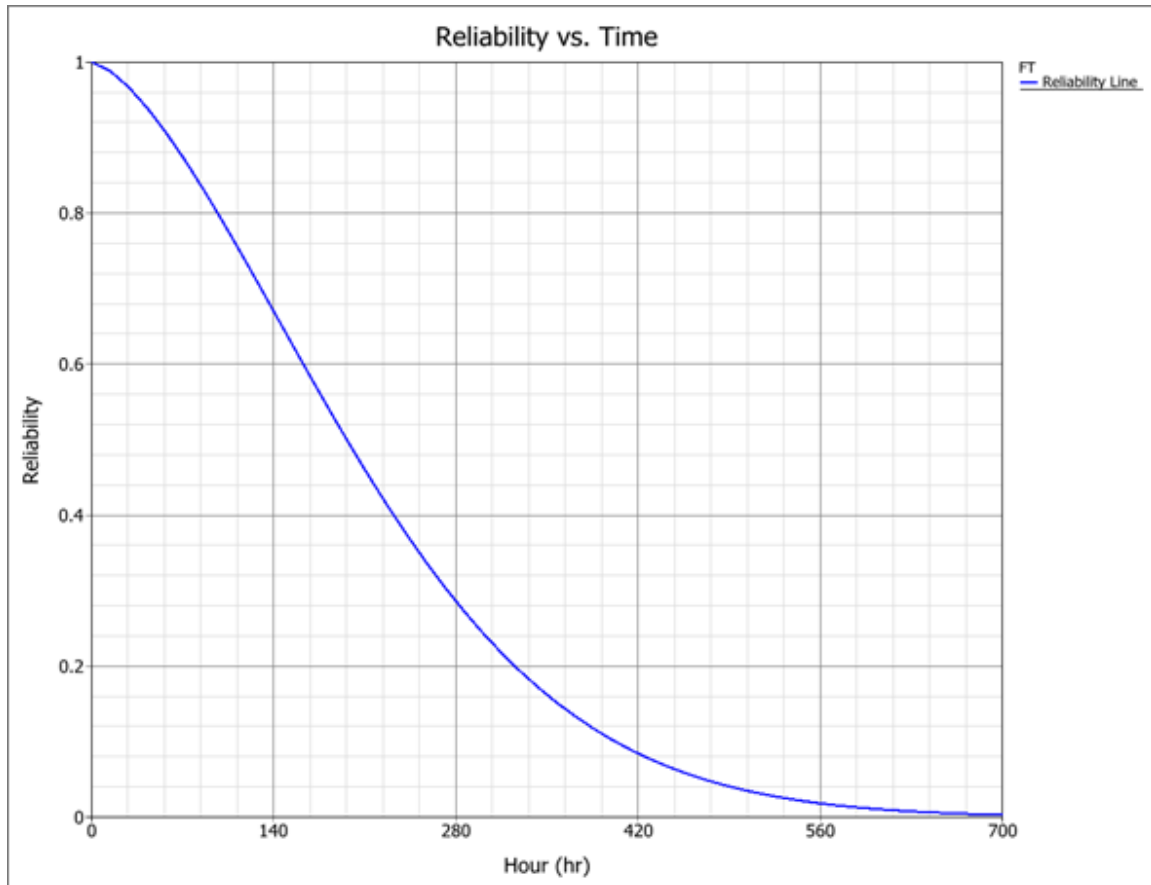
7. Calculate metrics

Click the **QCP** icon on the control panel to open the Quick Calculation Pad.



8. View plots

Click the **Plot** icon on the control panel to open the plot sheet.



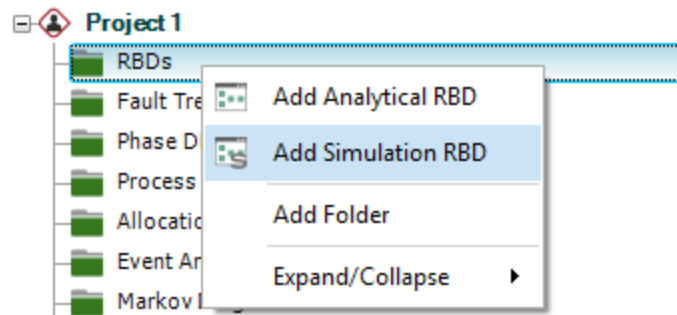
Using Simulation RBDs

A reliability block diagram (RBD) is a graphical representation of how the components of a system are reliability-wise connected. BlockSim's RBDs can be configured as analytical diagrams (which use the exact algebraic equation for the system model but impose limitations on what can be modeled and what results can be obtained) or simulation diagrams (which provide more modeling options and results but must be analyzed with discrete event simulation).

The basic steps for using a simulation RBD are:

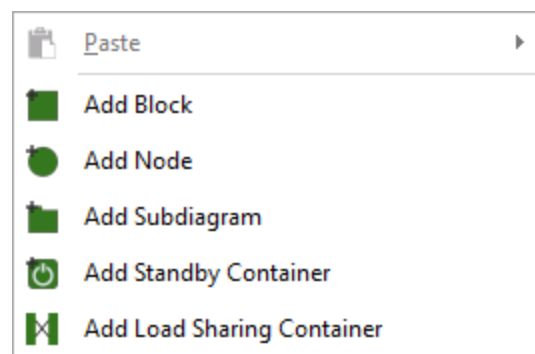
1. Add diagram

Right-click the RBDs folder in the current project explorer and choose **Add Simulation RBD**.



2. Add blocks

Right-click inside the diagram and choose the type of block to add.



3. Connect blocks

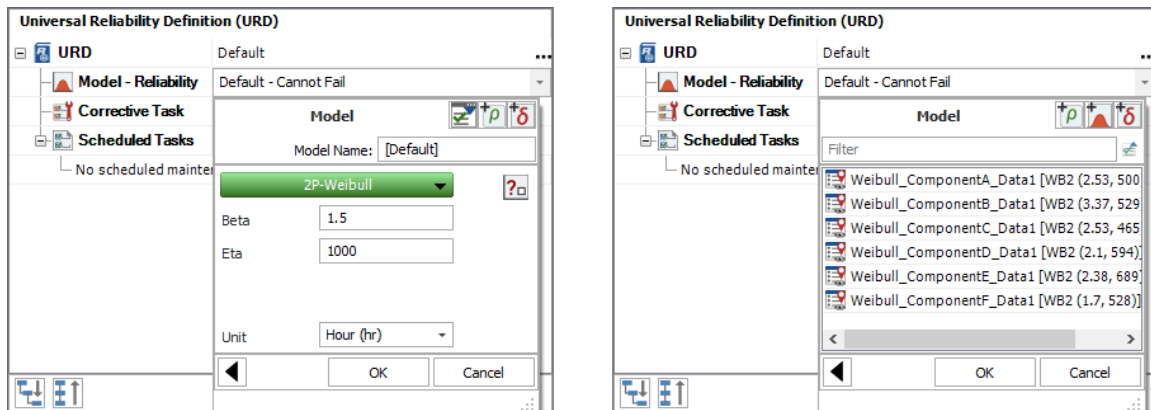
Hold down the **ALT** key, click the source block and drag a line to the destination block.



4. Set block properties

To edit a block's properties, right-click it and choose **Block Properties**. Use a *universal reliability definition* (URD) to specify the reliability properties.

- To select an existing URD, click inside the **URD** field.
- To create a new URD, click inside the **Model - Reliability** field and follow the wizard. You can create a new model (left) or select an existing model (right). Existing models may have been manually created, or may have been published from other analyses in BlockSim, Weibull++ or Lambda Predict.



5. Simulate the diagram

Click the **Simulate** icon on the control panel.



Specify the simulation settings and click **Simulate**.

Maintainability/Availability Simulation

A = 92.812705%

Seed Value 1
Current Sep 03 - 03:46:41
ETC Sep 03 - 03:46:43
Convergence 0.00775162084644776
Resolution 0.01000

Simulation 1000 of 1000

Comparative Options Advanced Options Display Options

Simulation End Time 1000 Hour (hr)

Point Results Every 10 Hour (hr)

Number of Simulations

Number of Simulations 1000

[Analysis Settings](#) Simulate Details Close

6. View the simulation results

From within the Maintainability/Availability Simulation window, click **Details**. If you have closed the window, click the **Results valid as of** field on the control panel.

Simulation

RBD - Simulation

Simulation

Results valid as of
9/3/2019 3:46:41 PM

Distribution fit
Not Fitted

<

7. Calculate metrics

Click the **QCP** icon on the control panel to open the Quick Calculation Pad.



QCP

Diagram1

Am(t=1000) **0.928127**

Mean Availability **hr** **No Bounds** **Captions On**

Units Bounds Options

Calculate

Probability

- Point Availability
- Point Unavailability
- Point Reliability
- Point Prob. of Failure
- Mean Availability**
- Mean Unavailability

Time

- Time For Availability
- Time For Reliability

Life

- MTTF

Input

Mission End Time (hr) 1000

Calculate

Report

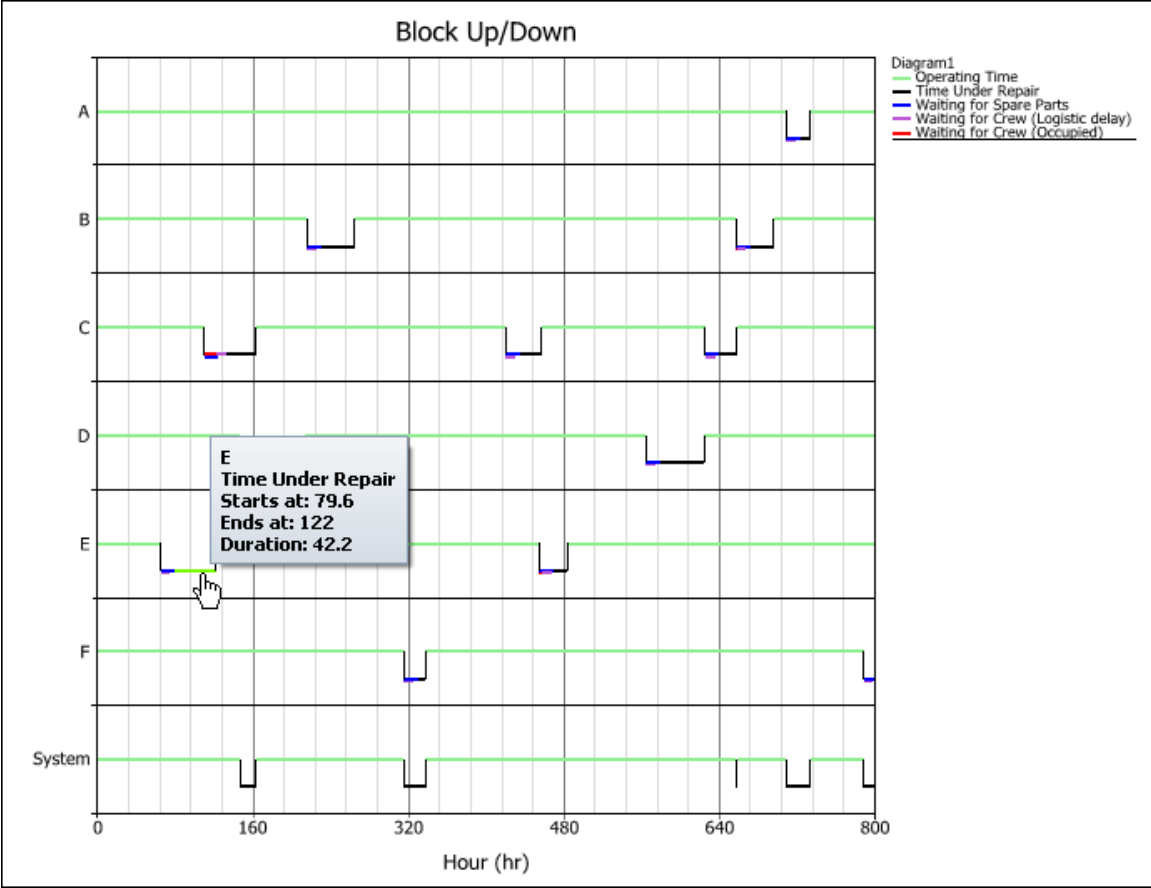
Details

Close

8. View plots

Click the **Plot** icon on the control panel to open the plot sheet.





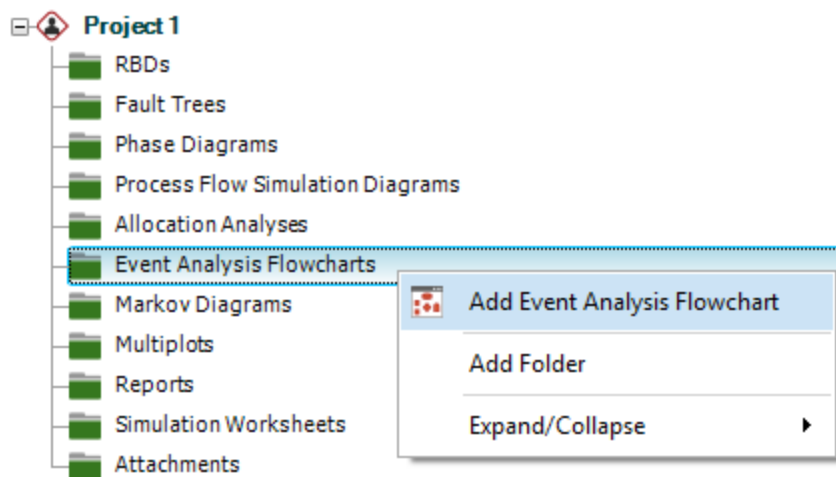
Using Event Analysis Flowcharts

Event analysis flowcharts (formerly RENO flowcharts) are used to build models of probabilistic or deterministic problems, processes or scenarios in order to help you understand and/or quantify them. The flowchart is a graphical representation of the mathematical process of predicting an outcome.

The example that follows demonstrates some of the basic techniques used in working with event analysis flowcharts. This simple flowchart generates failure times for 10 items.

1. Add diagram

Right-click the Event Analysis Flowcharts folder in the current project explorer and choose **Add Event Analysis Flowchart**.



2. Define resources

a. Create a variable

This resource will control the number of items to generate failure times for.

Choose **Home > ReliaSoft > Resource Manager**.

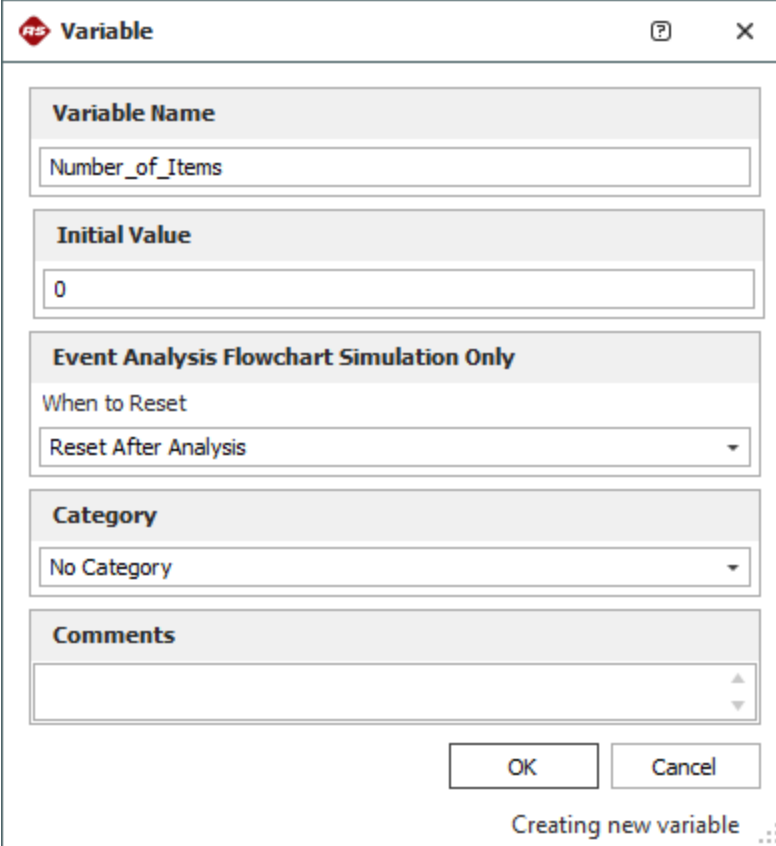


In the Resource Manager, choose **Variables** and then choose **Home > Edit > Add**.

The screenshot shows the 'Resource Manager (Project: Project 1)' window. The left sidebar has a 'Variables' tab selected. The top ribbon has an 'Add' button highlighted with a red box. The main table displays the following data:

Variable Name	Value	When to Reset	Comments	Category
ABC	ABC	ABC	ABC	ABC

Define the variable properties.



The image shows a 'Variable' dialog box with the following fields and options:

- Variable Name:** Number_of_Items
- Initial Value:** 0
- Event Analysis Flowchart Simulation Only:**
 - When to Reset: Reset After Analysis
- Category:** No Category
- Comments:** (Empty text area)

Buttons: OK, Cancel

Creating new variable

- b. Create a model

This resource will define the model used to generate the failure times.

In the Resource Manager, choose **Models** and then choose **Home > Edit > Add**.

Define the model properties.

Model

Model Name
Item_Failure_Distribution

Model Properties

- Model Category**
 - Category: Reliability
- Model Type**
 - Type: Distribution
- Distribution**
 - Distribution: 2P-Weibull
- Parameters and Inputs**
 - Beta: 2.3
 - Eta: 1750
 - Units: Day (day)

OK Cancel

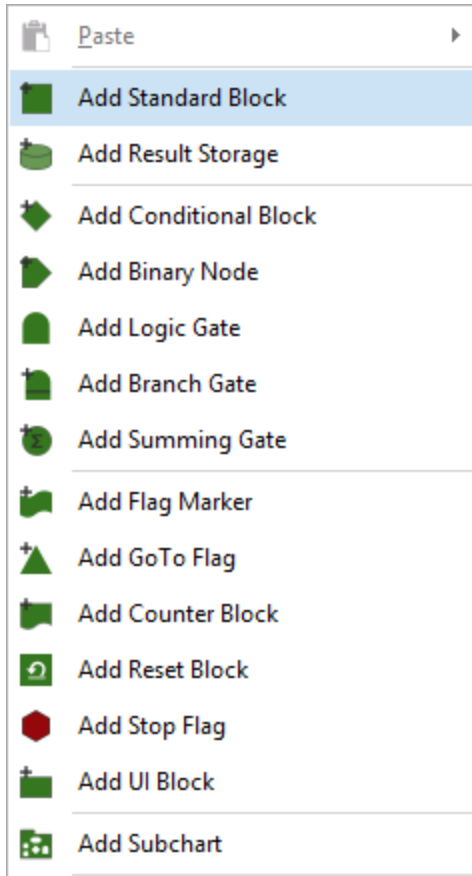
Creating new model

3. Add blocks

- a. Add a standard block (to increment the variable)

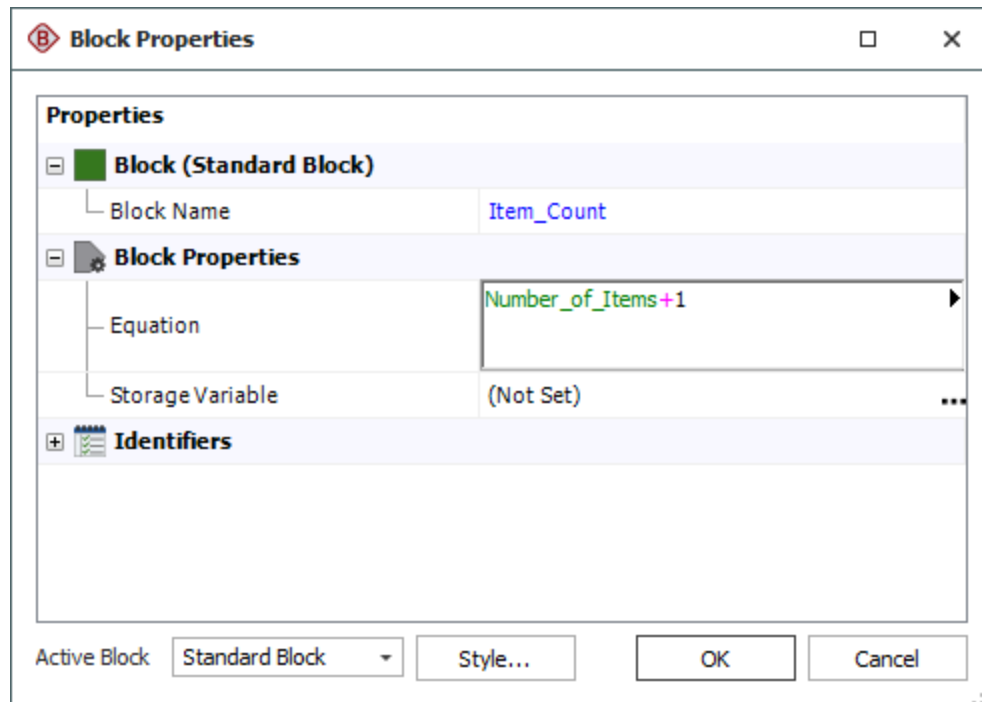
This block will increment the value of the Number_of_Items variable.

Right-click inside the diagram and choose to add a standard block.

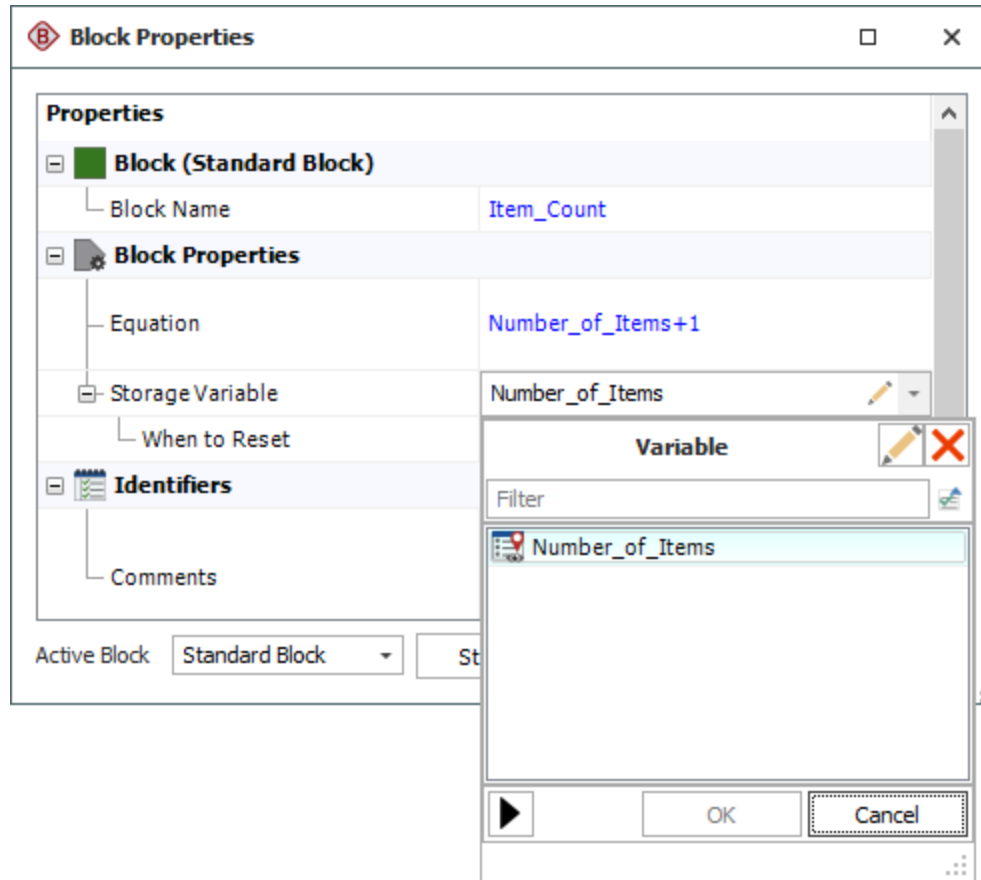


To edit the block's properties, right-click it and choose **Block Properties**.

Click inside the **Equation** field and type **Number_of_Items + 1**.



Click inside the **Storage Variable** field and select the **Number_of_Items** variable.

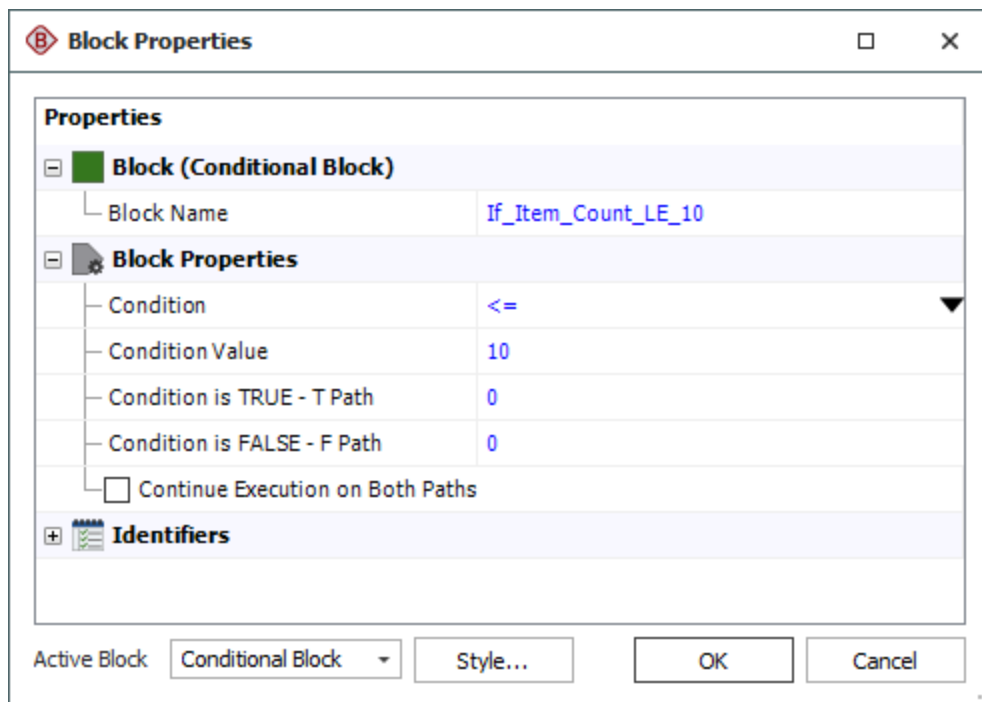


- b. Add a conditional block (i.e., create an IF statement)

This block will determine the simulation path based on whether the item count has reached 10.

Right-click inside the diagram and choose to add a conditional block.

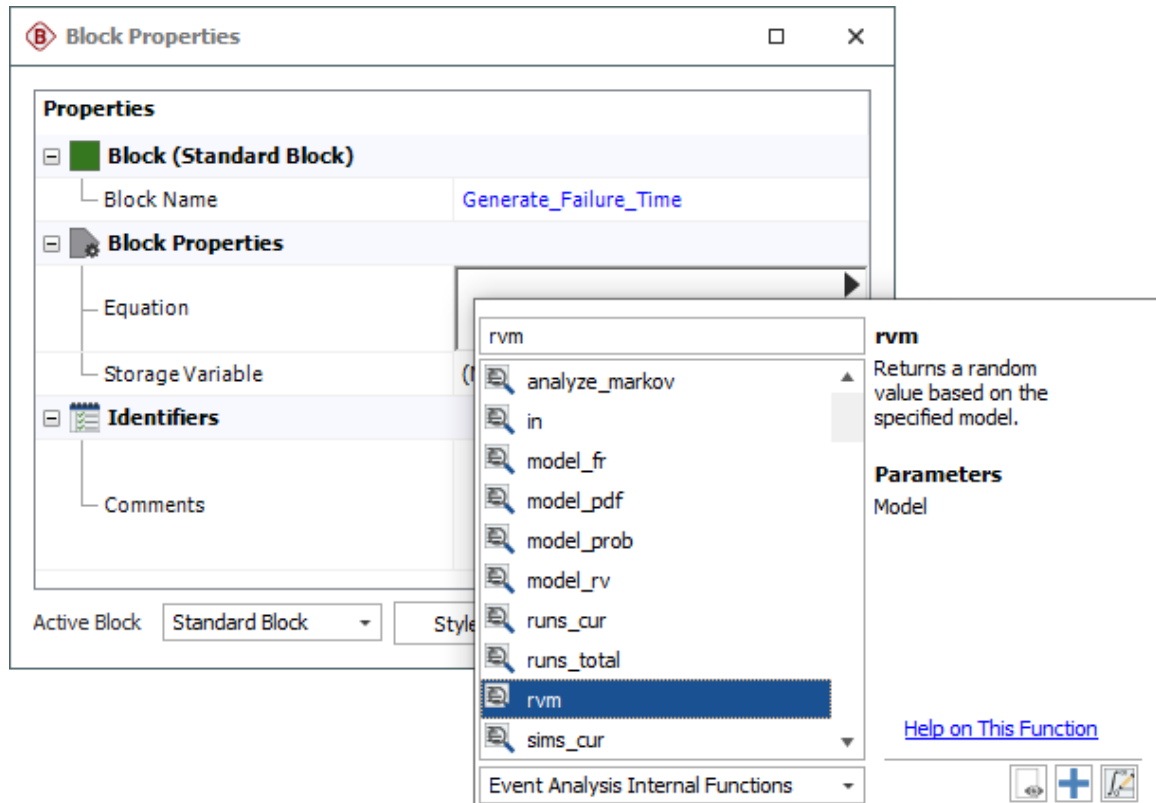
In the block's properties window, specify that if the incoming value is less than or equal to 10, a value of 0 will be passed on the "true" path. Otherwise, a value of 0 will be passed on the "false" path.



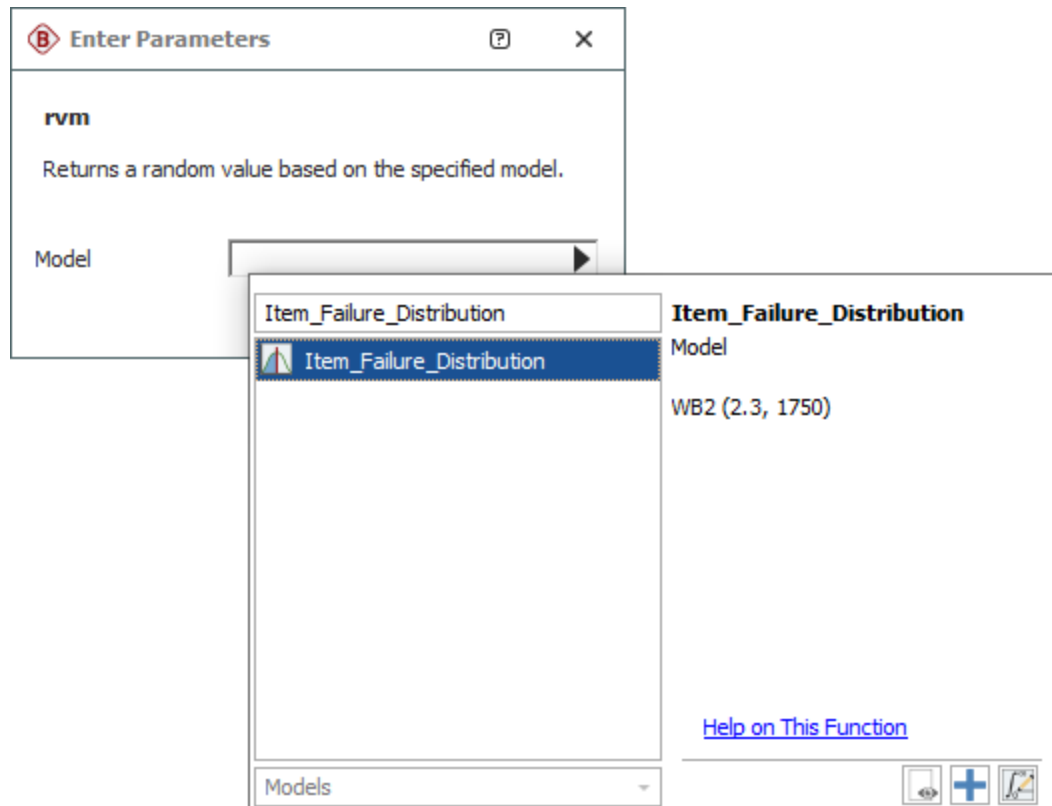
- c. Add a standard block (to generate the failure times)

This block will generate a failure time by returning a random value based on the Item_Failure_Distribution model.

In the block's properties window, right-click inside the **Equation** field, choose **Show Function Selector** then choose **Event Analysis Internal Functions** from the drop-down list. Double-click the **rvm** function.



In the Enter Parameters window that appears, right-click in the **Model** field and open the Function Selector. Double-click the **Item_Failure_Distribution** model.

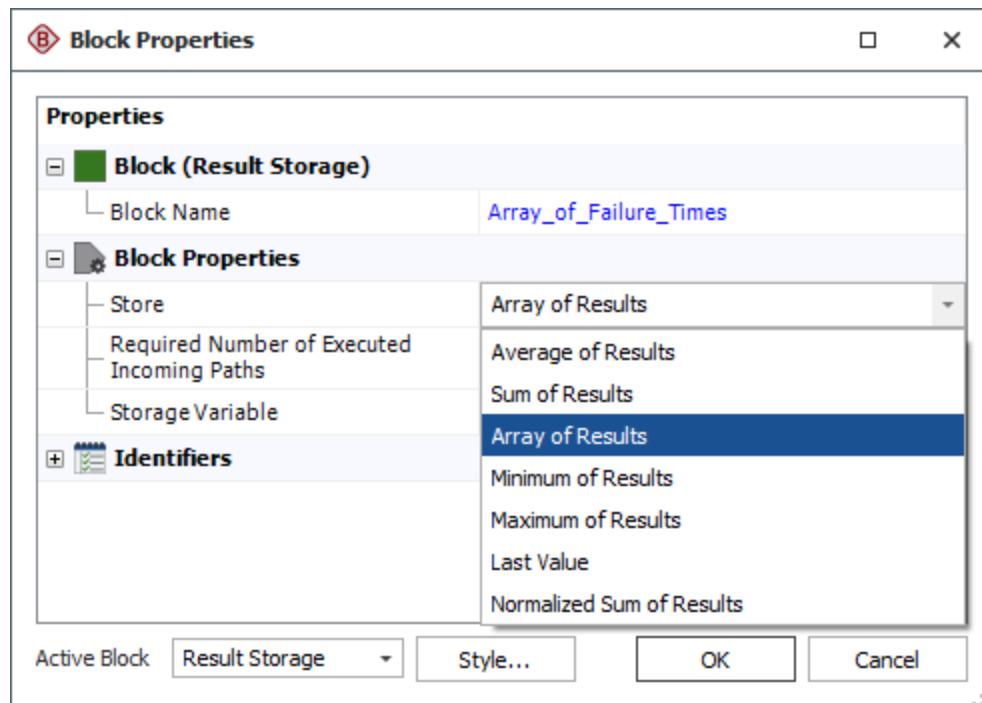


- d. Add a result storage block

This block will store an array of the failure times generated by the standard block.

Right-click inside the diagram and choose to add a result storage block.

In the block's properties window, specify that it will store an array of results.

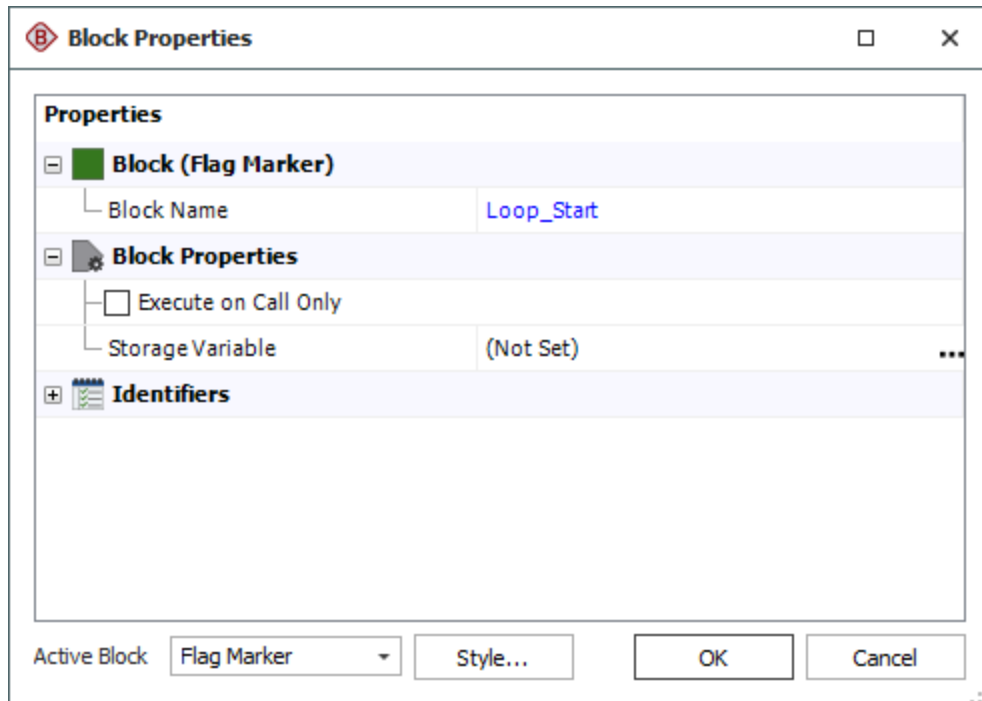


- e. Create a FOR loop

These blocks will form a loop that will cycle through the flowchart until the variable value reaches 10.

Add a flag marker block, a go-to-flag block and a stop flag.

Define the properties.



Block Properties

Properties

- Block (GoTo Flag)**
 - Block Name: Loop_End
- Block Properties**
 - Flag Marker: Loop_Start
- Identifiers**
 - Loop_Start
- Comments

Active Block: GoTo Flag Style... OK Cancel

Block Properties

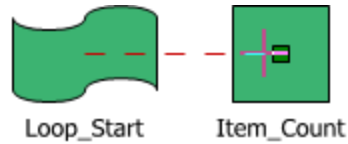
Properties

- Block (Stop Flag)**
 - Block Name: Loop_Exit
- Block Properties**
 - What to Abort: AbortAnalysis
- Identifiers**

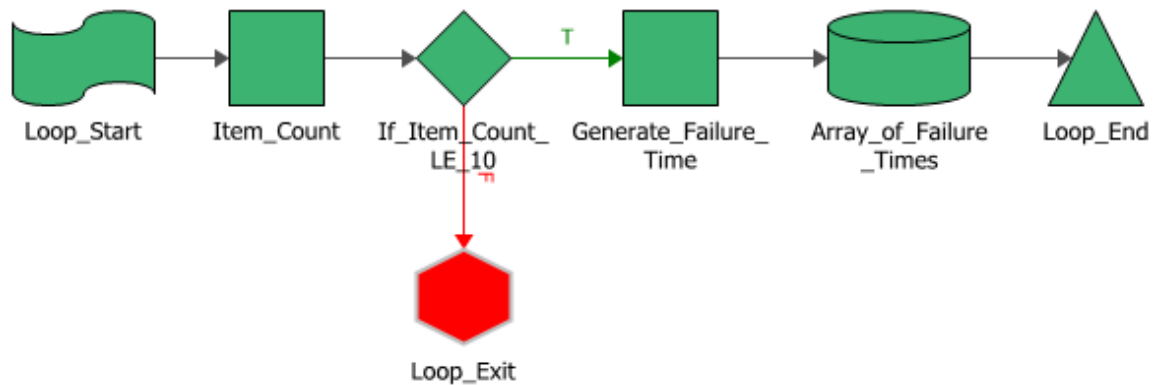
Active Block: Stop Flag Style... OK Cancel

4. Connect blocks

Connect the blocks as shown below. To create each connection, hold down the **ALT** key, click the source block and drag a line to the destination block.



The first connector you create from the conditional block will be marked as the "true" path and the second as the "false" path. If necessary, you can switch these designations by right-clicking the connector and choosing **Set to Failure** or **Set to Success** on the shortcut menu.

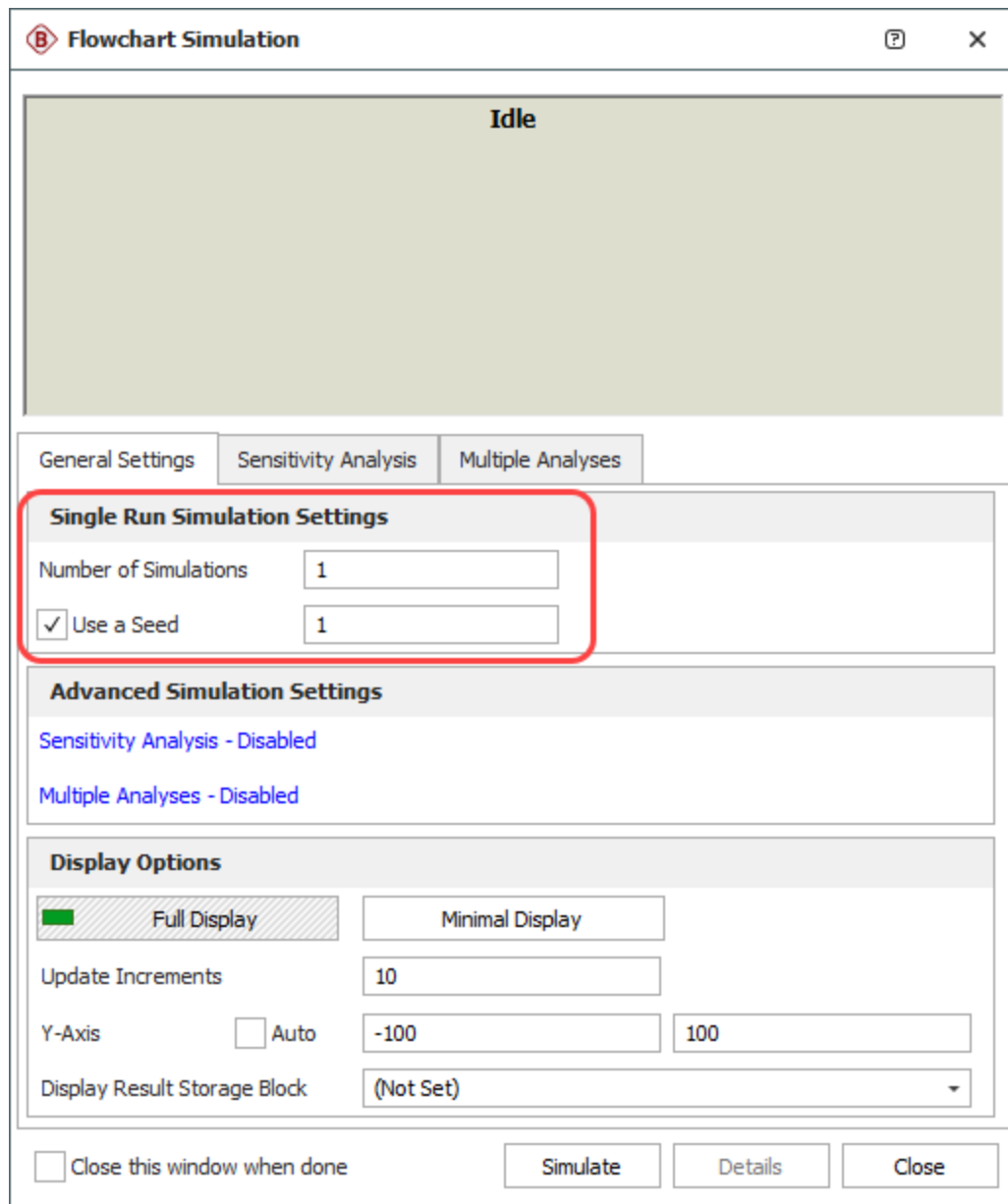


5. Simulate the flowchart

Click the **Simulate** icon on the control panel.



Specify to run a single simulation with a seed of 1 and click **Simulate**.

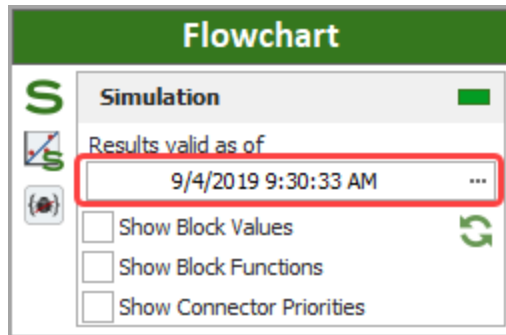


The image shows the 'Flowchart Simulation' dialog box. The main area is labeled 'Idle'. Below it are three tabs: 'General Settings', 'Sensitivity Analysis', and 'Multiple Analyses'. The 'General Settings' tab is active and contains three sections: 'Single Run Simulation Settings', 'Advanced Simulation Settings', and 'Display Options'. The 'Single Run Simulation Settings' section is highlighted with a red box and contains 'Number of Simulations' set to 1 and 'Use a Seed' checked with a value of 1. The 'Advanced Simulation Settings' section shows 'Sensitivity Analysis - Disabled' and 'Multiple Analyses - Disabled'. The 'Display Options' section has 'Full Display' selected, 'Update Increments' set to 10, 'Y-Axis' set to Auto with values -100 and 100, and 'Display Result Storage Block' set to (Not Set). At the bottom, there is a checkbox 'Close this window when done' and three buttons: 'Simulate', 'Details', and 'Close'.

Flowchart Simulation		
Idle		
General Settings Sensitivity Analysis Multiple Analyses		
Single Run Simulation Settings		
Number of Simulations	1	
<input checked="" type="checkbox"/> Use a Seed	1	
Advanced Simulation Settings		
Sensitivity Analysis - Disabled		
Multiple Analyses - Disabled		
Display Options		
<input checked="" type="checkbox"/> Full Display	<input type="checkbox"/> Minimal Display	
Update Increments	10	
Y-Axis	<input type="checkbox"/> Auto	-100 100
Display Result Storage Block	(Not Set)	
<input type="checkbox"/> Close this window when done	Simulate	Details Close

6. View the simulation results

From within the Flowchart Simulation Window, click **Details**. If you have closed the window, click the **Results valid as of** field on the diagram control panel.



To view the failure times generated during the simulation, click the result storage block in the navigation panel.

Simulation Results Explorer

Home

Clipboard: Paste, Cut, Copy, Paste Special

Print: Quick Print, Print, Print Preview

View: Show Expanded Block Name, Freeze Block Name Column, Freeze Heading Rows

Sheet: Transfer Report, Full Report, Send Selection to Weibull ++

Navigation Panel:

- General Summary
- Result Storage Blocks
 - Array_of_Failure_Times

	A	B
1	Block Name: Array_of_Failure_Times	
2	Flowchart(s) Location:	->Event Analysis Flowchart1
3	Storage Type:	Array
4	Runs Stored:	1
5		
6	Result #	Array_of_Failure_Times
7	1	1930.926056
8	2	2008.575072
9	3	2546.727667
10	4	1291.008805
11	5	647.42902
12	6	2164.346878
13	7	1562.131953
14	8	525.730922
15	9	2397.02994
16	10	1653.12614

Result Storage Block Summary

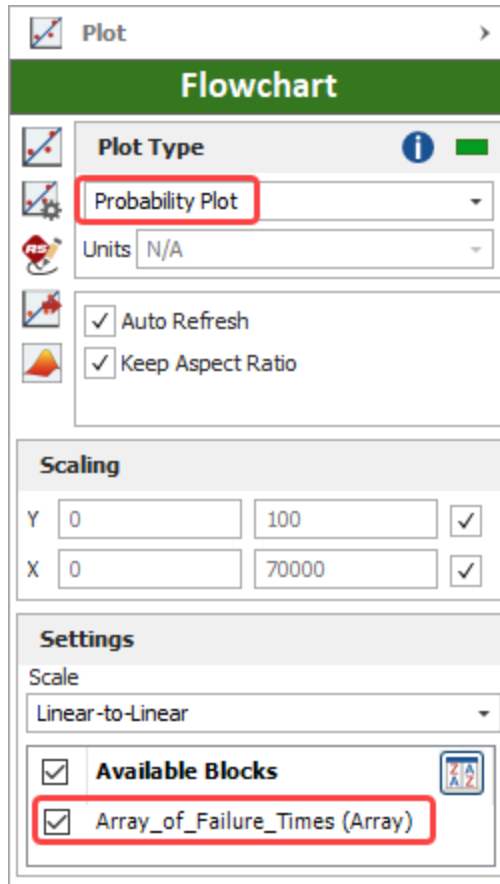
Event Analysis Flowchart1

7. View plots

Click the **Plot** icon on the diagram control panel to open the plot sheet.

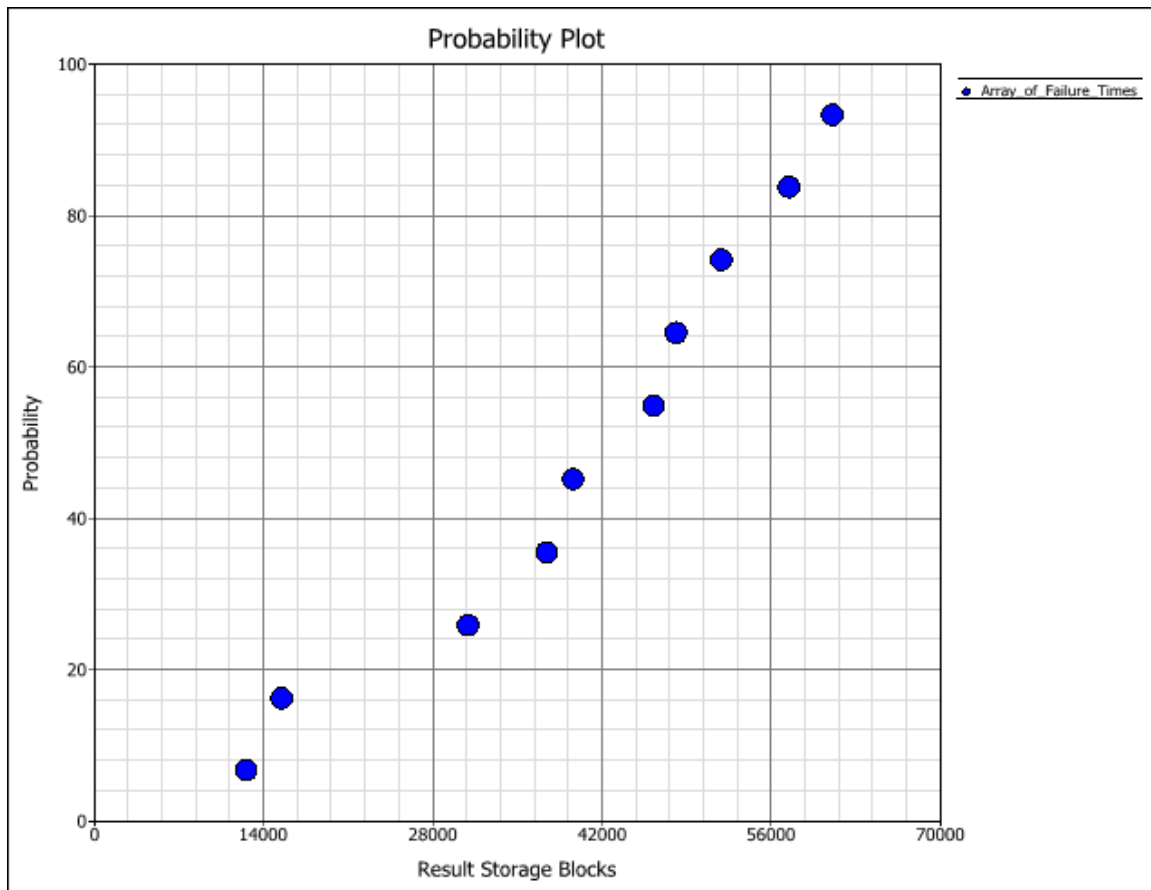


On the plot sheet control panel, choose the plot type, then select the result storage block(s) to show in the plot.



The screenshot shows the 'Plot' control panel with a green header bar labeled 'Flowchart'. The panel is divided into several sections:

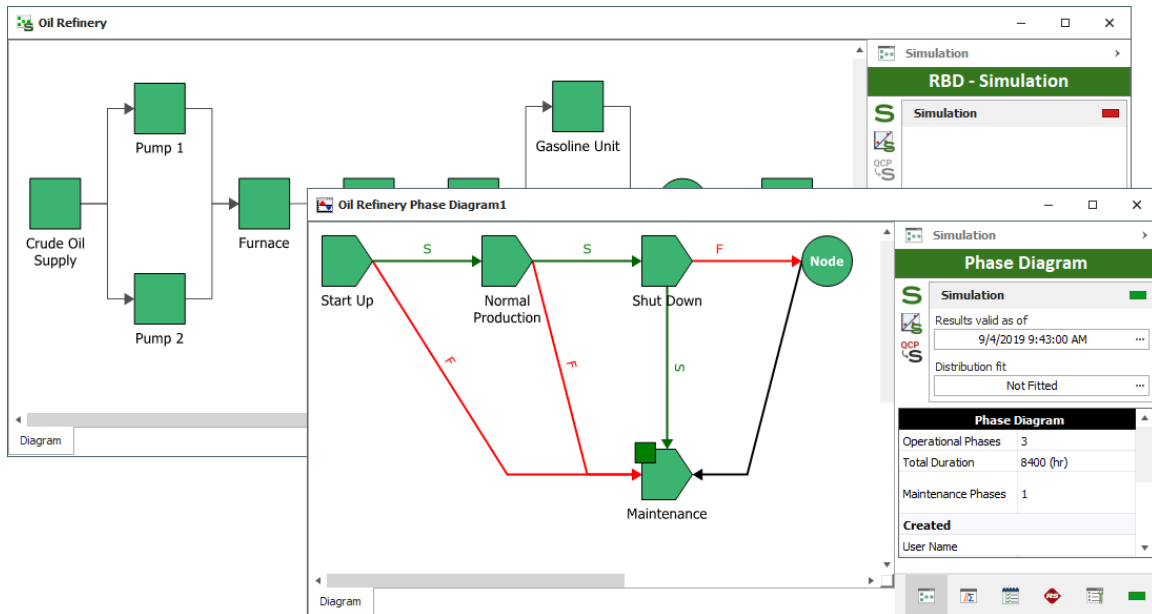
- Plot Type**: A dropdown menu set to 'Probability Plot', which is highlighted with a red rectangle.
- Units**: A dropdown menu set to 'N/A'.
- Auto Refresh**: A checked checkbox.
- Keep Aspect Ratio**: A checked checkbox.
- Scaling**: A section with two rows of input fields for Y and X axes. The Y axis has a minimum of 0 and a maximum of 100. The X axis has a minimum of 0 and a maximum of 70000. Both rows have a checked checkbox on the right.
- Settings**: A section with a 'Scale' dropdown set to 'Linear-to-Linear'.
- Available Blocks**: A section with a checked checkbox and a list of available blocks. The block 'Array_of_Failure_Times (Array)' is highlighted with a red rectangle.



More Analyses and Tools

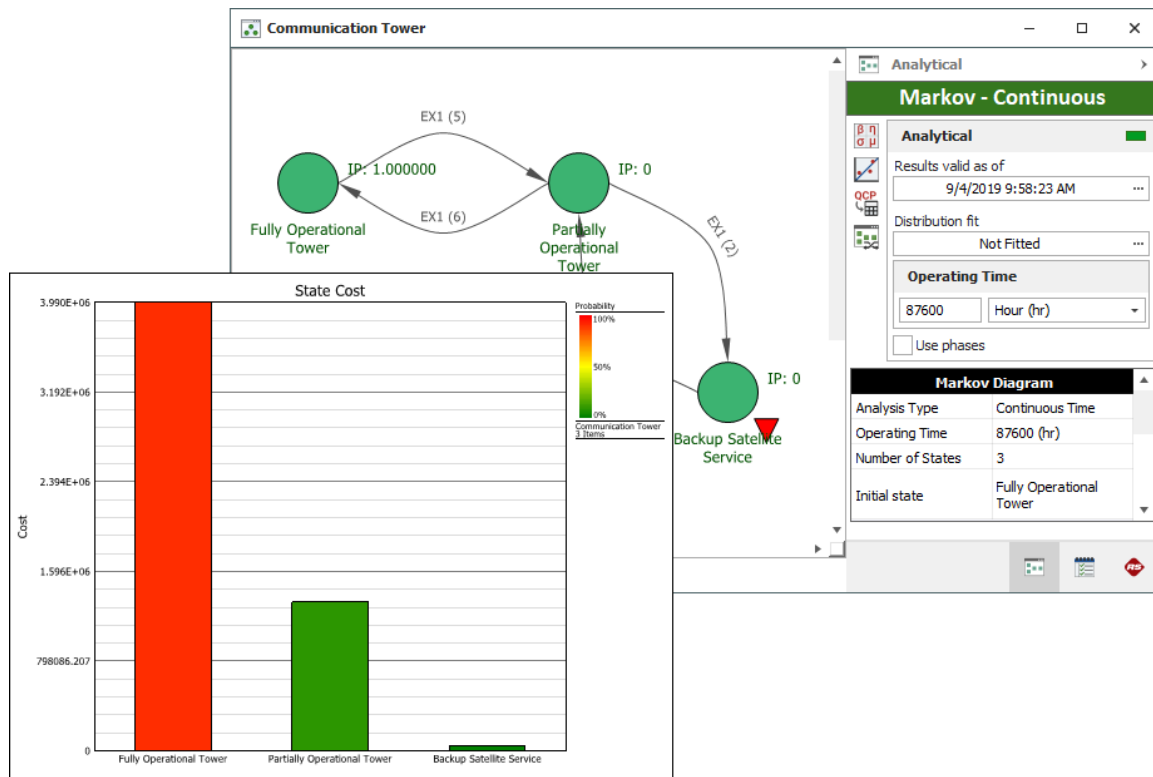
Phase Diagrams

Reliability phase diagrams represent scenarios in which a system may undergo changes over time.



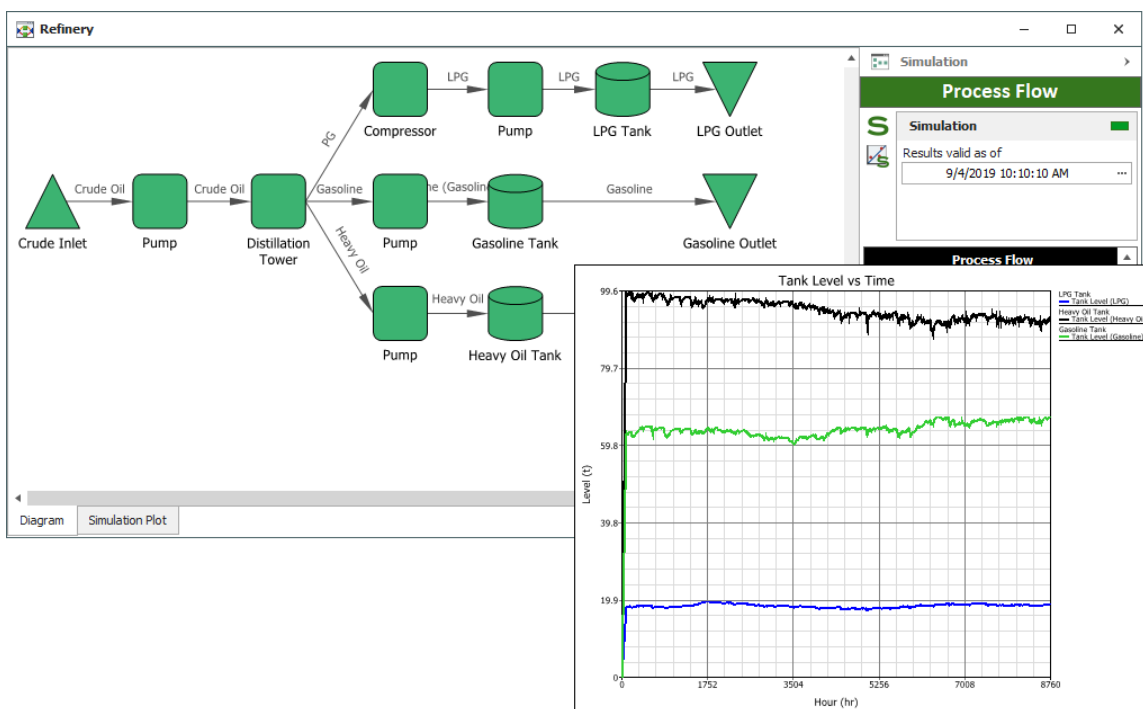
Markov Diagrams

Markov diagrams model the behavior of systems based on memoryless transitions between states, allowing you to look at partial or degraded working states, and to start analysis in varying states.



Process Flow Simulation Diagrams

A process flow simulation diagram is used to model a continuous process flow, typically a fluid flow, using a diagram in which the components are connected in flow-wise configuration. The simulation can be used to estimate the amount of raw material consumed by the process, as well as the amount of finished product and waste generated by the process in a given time frame.



Reliability Allocation

The allocation analysis tool helps determine the reliability requirements for individual components/assemblies that would be needed to achieve an overall reliability goal.

The screenshot displays the 'Allocation Analysis1' window. It features a table with columns: Block Name, Reliability Importance, Current Reliability, Maximum Achievable Reliability, Feasibility, Target Reliability, Equivalent Parallel Units, and Comments. The table lists 'Subsystem A' and 'Subsystem B' with their respective reliability values. A red arrow points from 'Subsystem A' in the table to the 'Allocation Analysis' sidebar on the right. The sidebar includes an 'Allocation Type' dropdown set to 'Cost Optimized', a 'Refresh' button, and input/output fields for Target Reliability (0.968431), Time (500), Units (Hour (hr)), Iterations (50), Current Reliability (0.952914), and System Reliability (0.968431). The 'Color Limits' section shows a range of 0.00% - 100.00%.

Block Name	Reliability Importance	Current Reliability	Maximum Achievable Reliability	Feasibility	Target Reliability	Equivalent Parallel Units	Comments
Subsystem A	0.980968	0.952914	1	Easy (1)	0.968431	1.130834	
Subsystem B	0.952914	0.980968	1	Hard (9.9)	0.980968	1.000000	

Allocation Analysis

Allocation Type: Cost Optimized

Refresh

Inputs

Target Reliability: 0.968431

Time: 500

Units: Hour (hr)

Iterations: 50

Outputs

Current Reliability: 0.952914

System Reliability: 0.968431

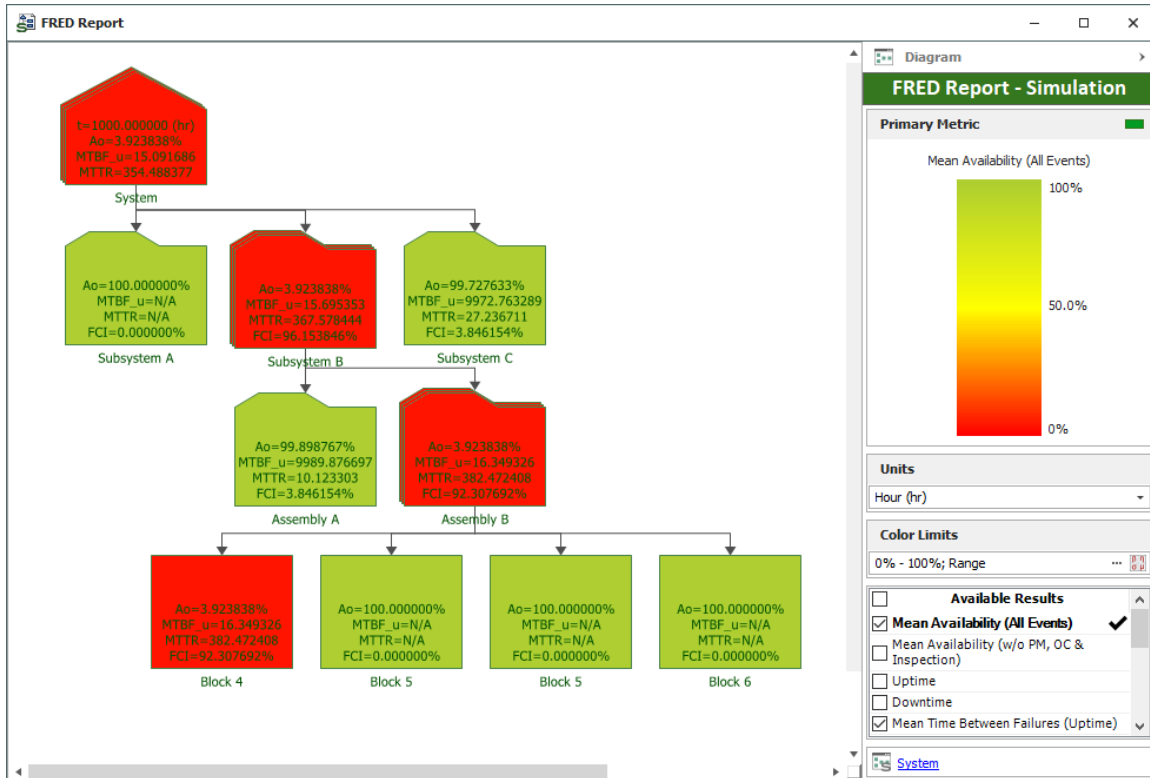
Color Limits

0.00% - 100.00%; Range

Subsystem A

FRED Reports

FRED reports provide a graphical demonstration of the reliability and maintainability/availability characteristics of the components in a system and help to identify the components that may require improvement.



Optimum Replacement

The Optimum Replacement tool helps to determine the best time to inspect and/or replace components, based on the costs for planned and unplanned maintenance.

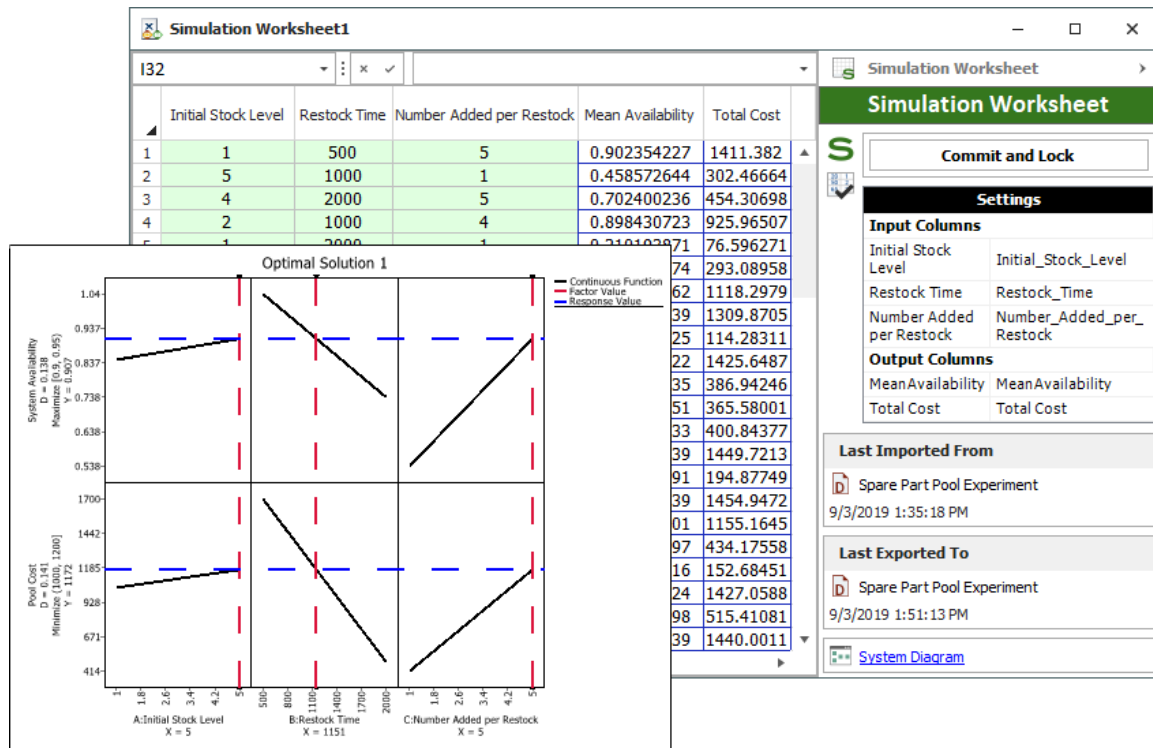
The Optimum Replacement tool interface displays a table of component maintenance data. The table columns are: Block Name, Planned Replacement Cost, Unplanned Replacement Cost, Optimum Replacement Time (hr), and Replacement Cost per Unit Time (hr). The components listed are Oil & Filter, Water Pump, Timing Belt, Air Filter, Spark Plugs, and Fuel Filter. The Optimum Replacement Time (hr) for each component is highlighted in a different color: blue for Oil & Filter, red for Water Pump, Timing Belt, and Spark Plugs, and green for Fuel Filter. The Replacement Cost per Unit Time (hr) is shown as 0.117246.

Block Name	Planned Replacement Cost	Unplanned Replacement Cost	Optimum Replacement Time (hr)	Replacement Cost per Unit Time (hr)
Oil & Filter	30	5000	3196.434610	0.011045
Water Pump	700	4000	37209.829755	0.038682
Timing Belt	800	4500	37209.829755	0.036619
Air Filter	25	1500	3196.434610	0.012295
Spark Plugs	80	250	37209.829755	0.008932
Fuel Filter	70	800	10920.363780	0.009673

Replacement Cost Per Unit Time (hr) 0.117246

Simulation Worksheets

Simulation worksheets can vary values that are used when simulating an RBD or a flowchart, allowing you to investigate the effect of various factors on the simulation results (e.g., how the restocking interval and initial quantity in a spare part pool affect the cost of maintaining a system). The values can be entered manually, or can be transferred from an experiment design folio in Weibull++. After simulation, you can transfer the results into the design folio in Weibull++ for analysis and/or optimization.



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13.2 You agree that the Licensor may use Your company name in Licensor's customer lists and other promotional materials describing Your company as a customer or user of Licensor's software or services, as applicable, unless it receives written notice from You objecting to such use.

13.3 This License Agreement, its subject matter or its formation (including non-contractual disputes or claims) shall be governed by and construed in accordance with English law and submitted to the non-exclusive jurisdiction of the English courts.

13.4 This License Agreement constitutes the complete and exclusive statement of the agreement between the Licensor and You with respect to the subject matter of this License and supersedes all proposals, representations, understandings and prior agreements, whether oral or written, and all other communications between the parties relating to that subject matter except for those expressly referred to in this License Agreement.

13.5 Any clause in this License Agreement that is found to be invalid or unenforceable shall be deemed deleted and the remainder of this License Agreement shall not be affected by that deletion.

13.6 Failure or neglect by either party to exercise any of its rights or remedies under this License Agreement will not be construed as a waiver of that party's rights nor in any way affect the validity of the whole or part of this License Agreement nor prejudice that party's right to take subsequent action.

13.7 This License Agreement is personal to You and You may not assign, transfer, sub-contract or otherwise part with this License or any right or obligation under it without the Licensor's prior written consent.

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