

Quick Tour



BlockSim

VERSION 2021

ReliaSoft

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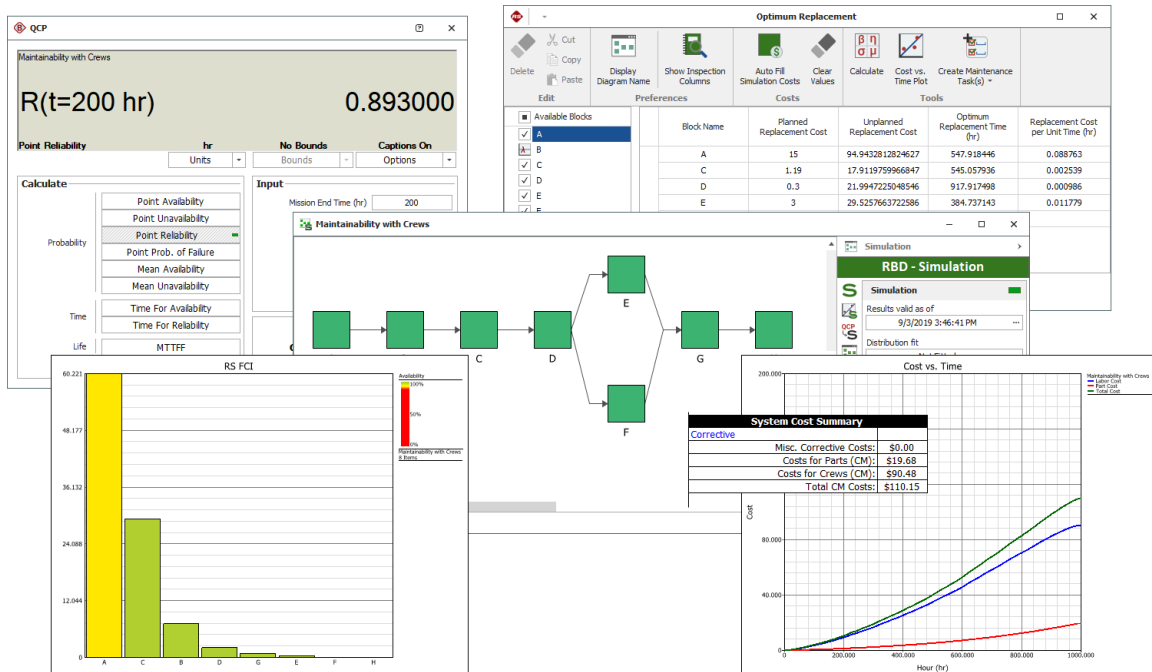
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Quick Tour of BlockSim

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?



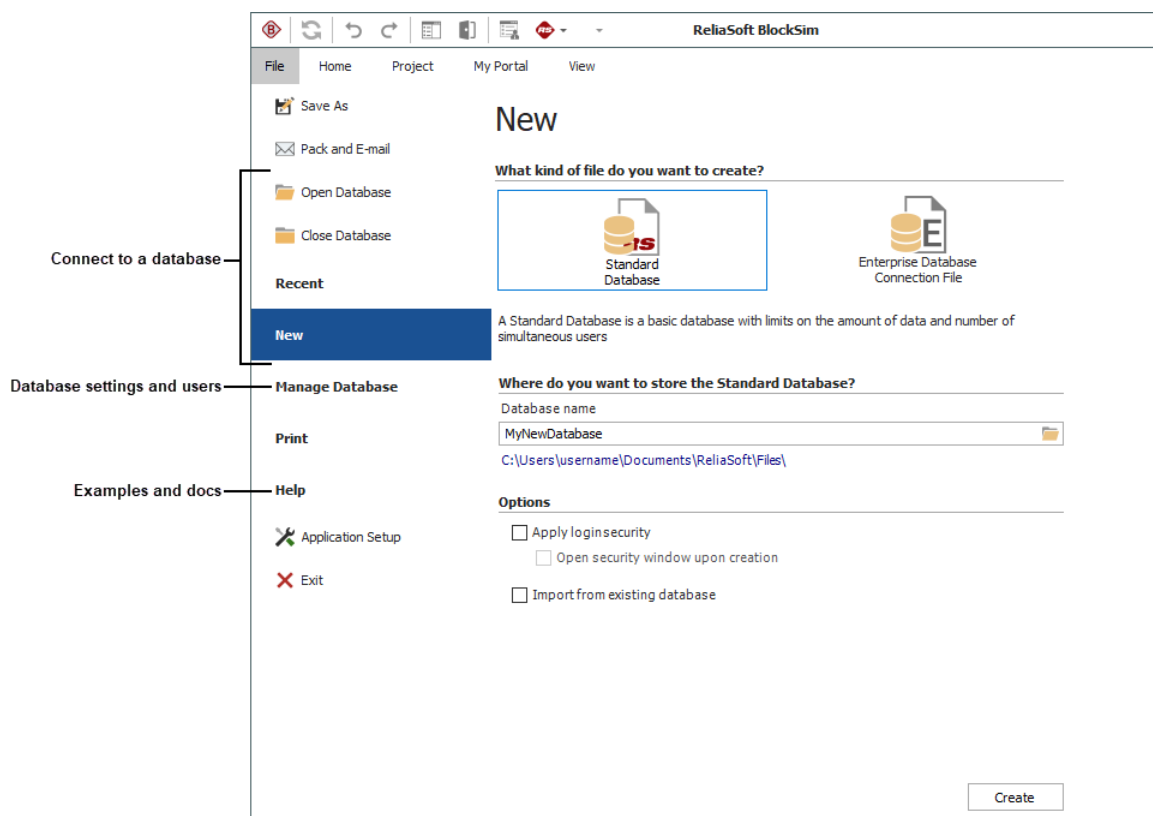
Using Databases and Projects

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.

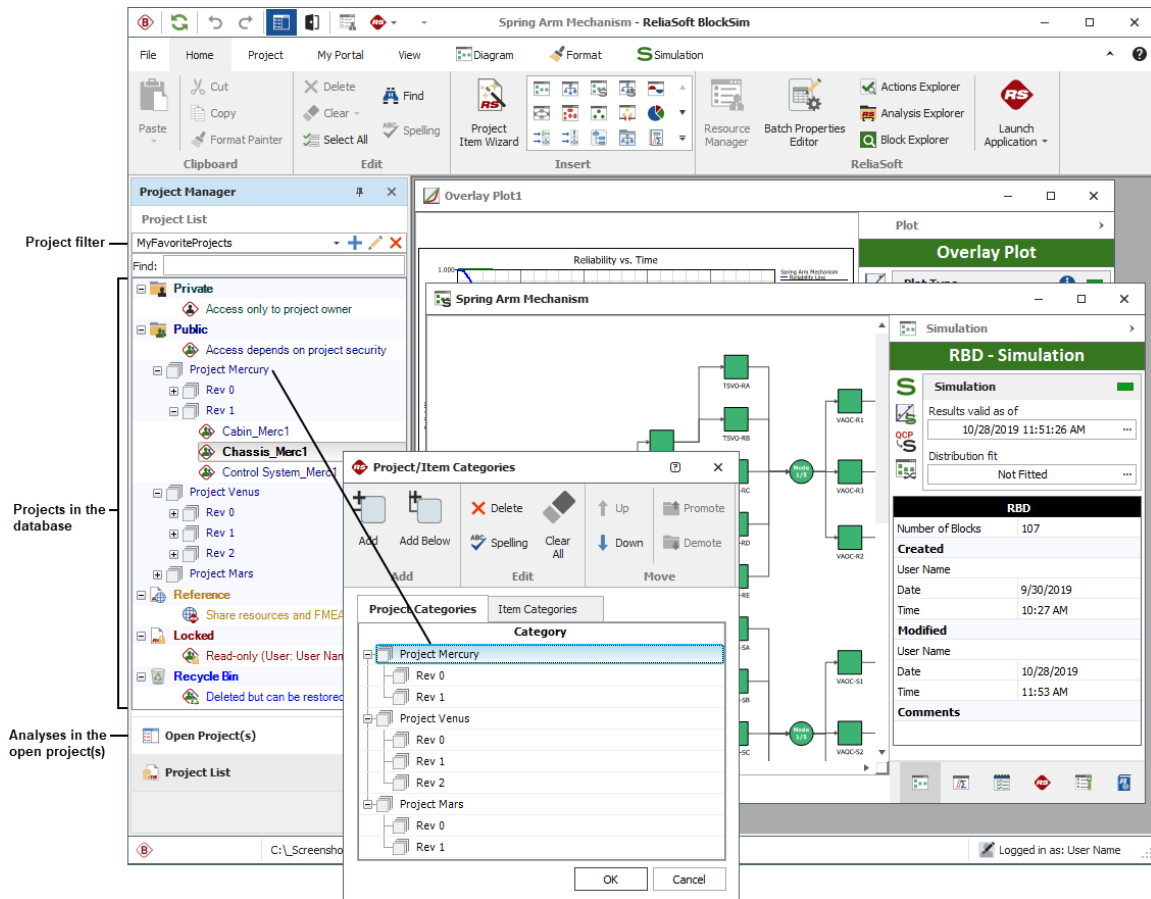


Project List

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 **project plans**, **resources** and **project attachments** are visible in all ReliaSoft desktop applications.

Using Fault Trees

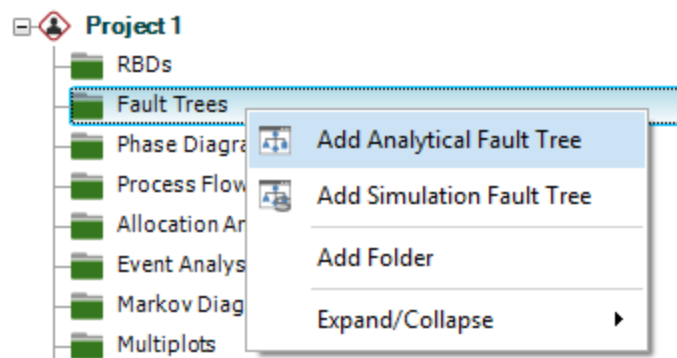
BlockSim's fault trees can be configured as analytical diagrams (which use the exact algebraic equation for the system model but impose limitations on what can be modeled and what results can be obtained) or simulation diagrams (which provide more modeling options and results but must be analyzed with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

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:

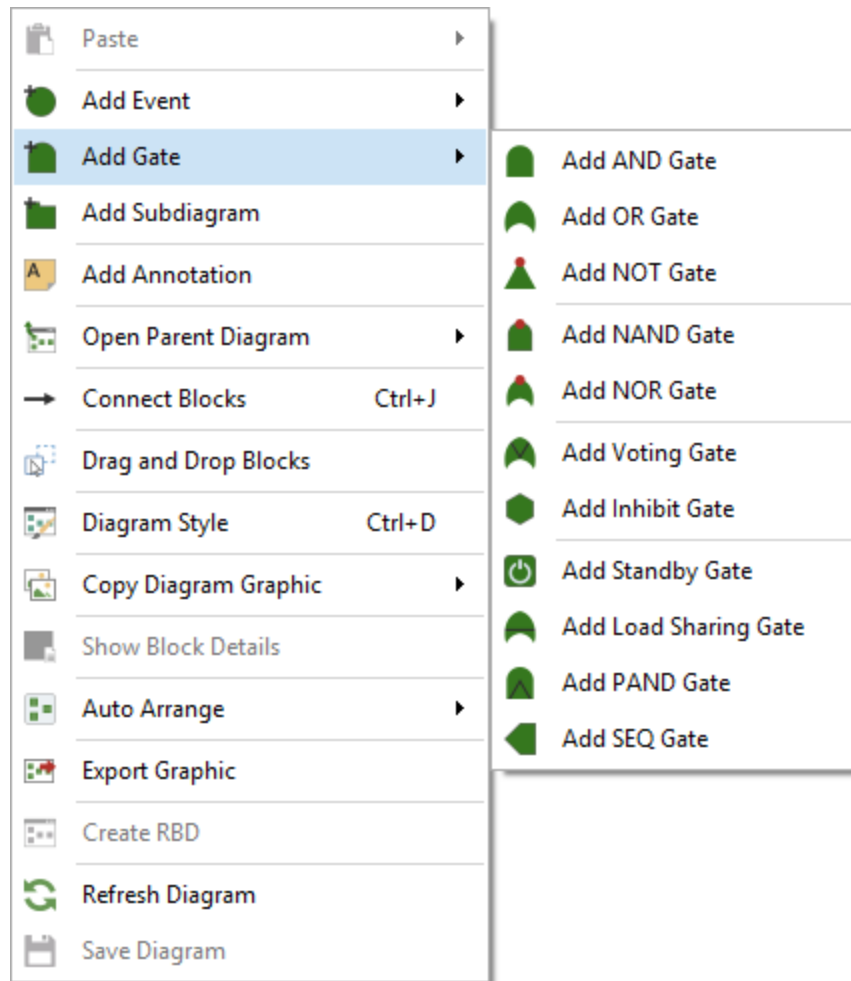
1. Add fault tree diagram

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



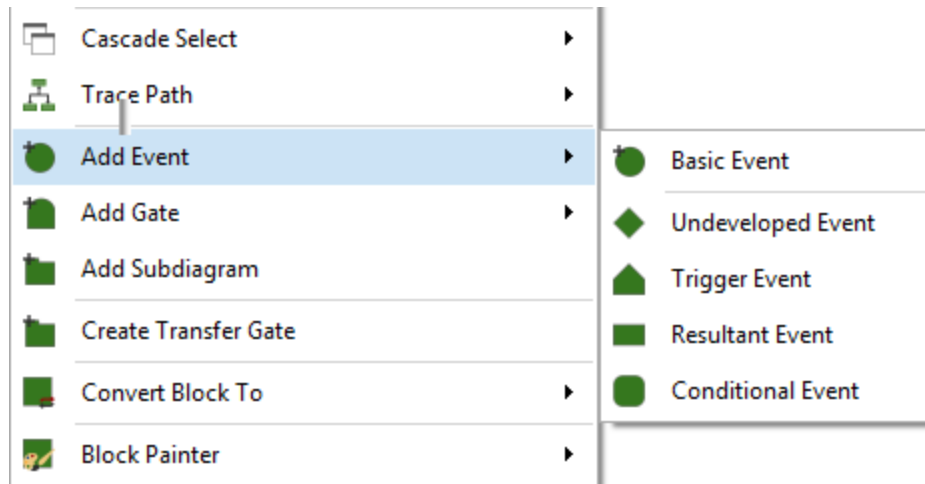
2. Add gates

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



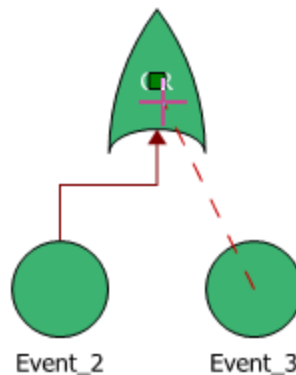
3. Add events

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)

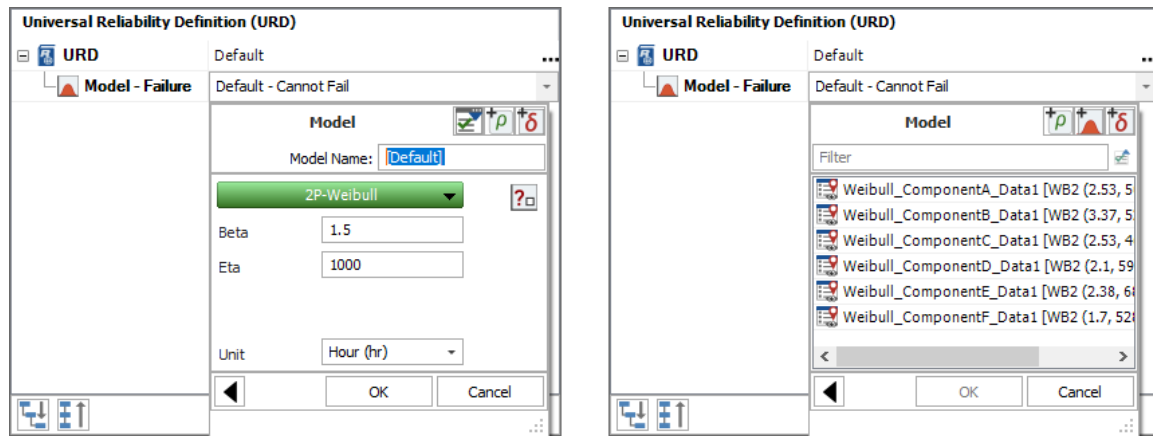
If you need to create a new connection, hold down the **ALT** key, click the source block and drag a line to the destination block.



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.

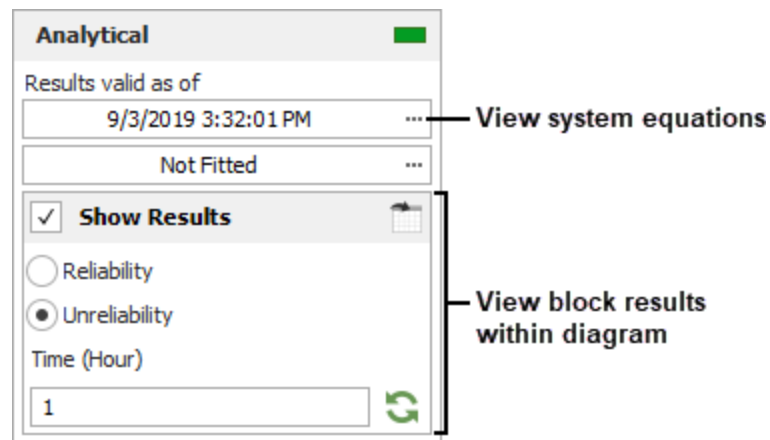


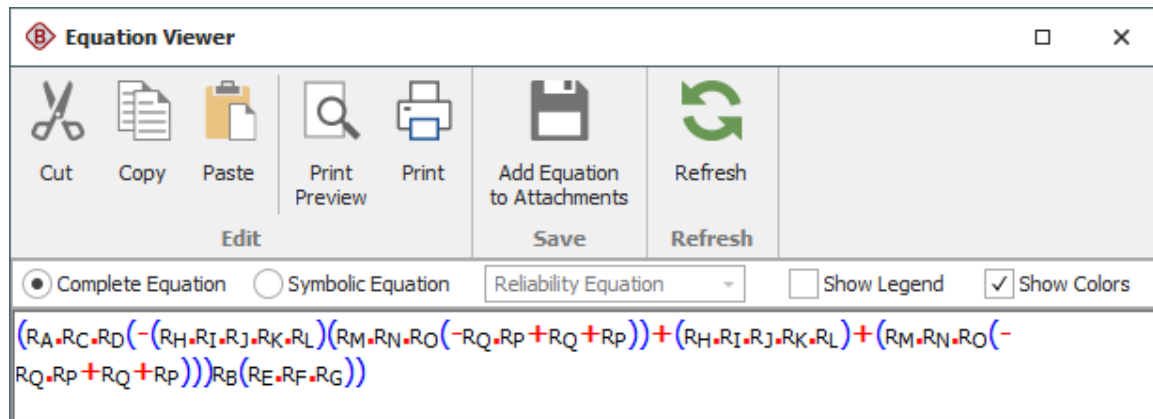
6. Analyze the diagram

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



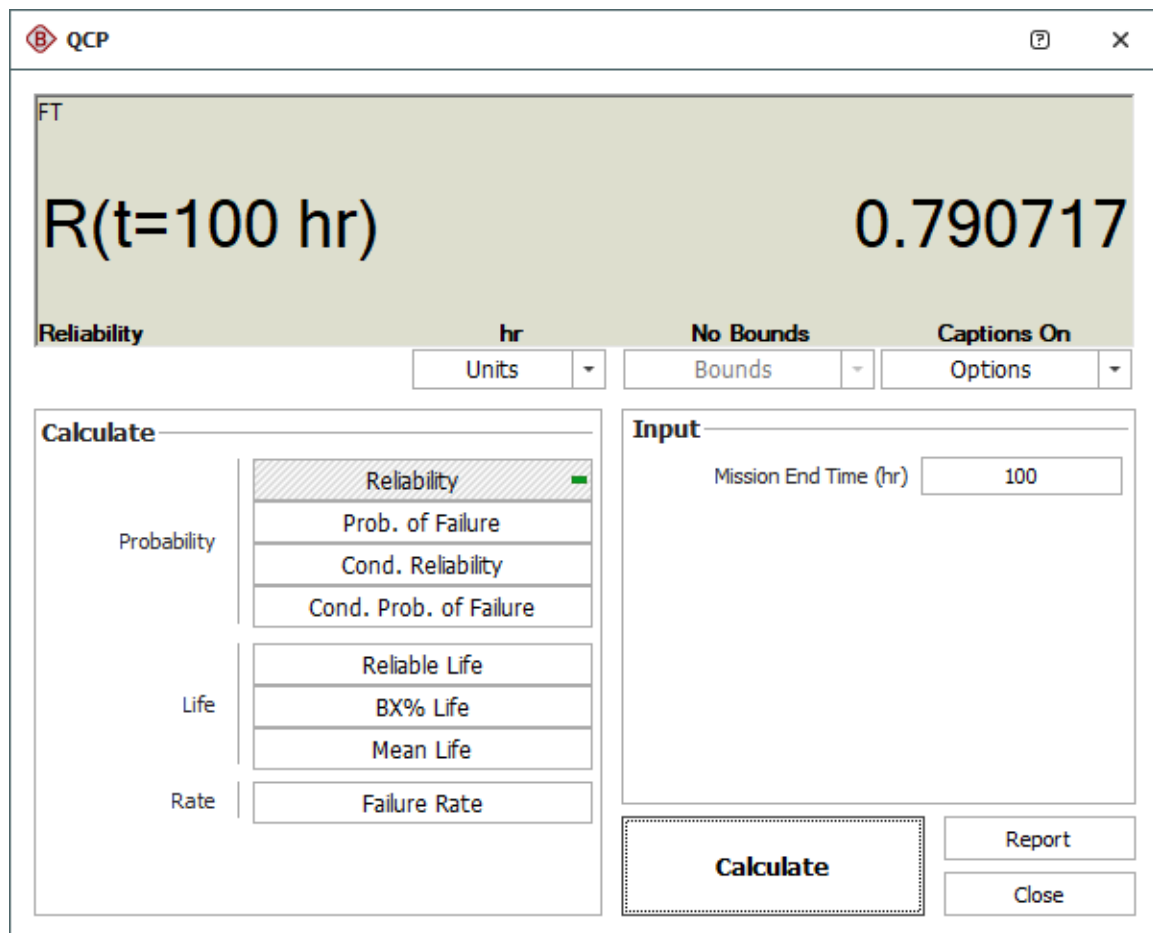
To view the calculated reliability or unreliability at a specific time for each block, select **Show Results** on the control panel and specify the time. To view the algebraic equations for the system reliability, pdf and failure rate, click the **Results valid as of** field on the control panel.





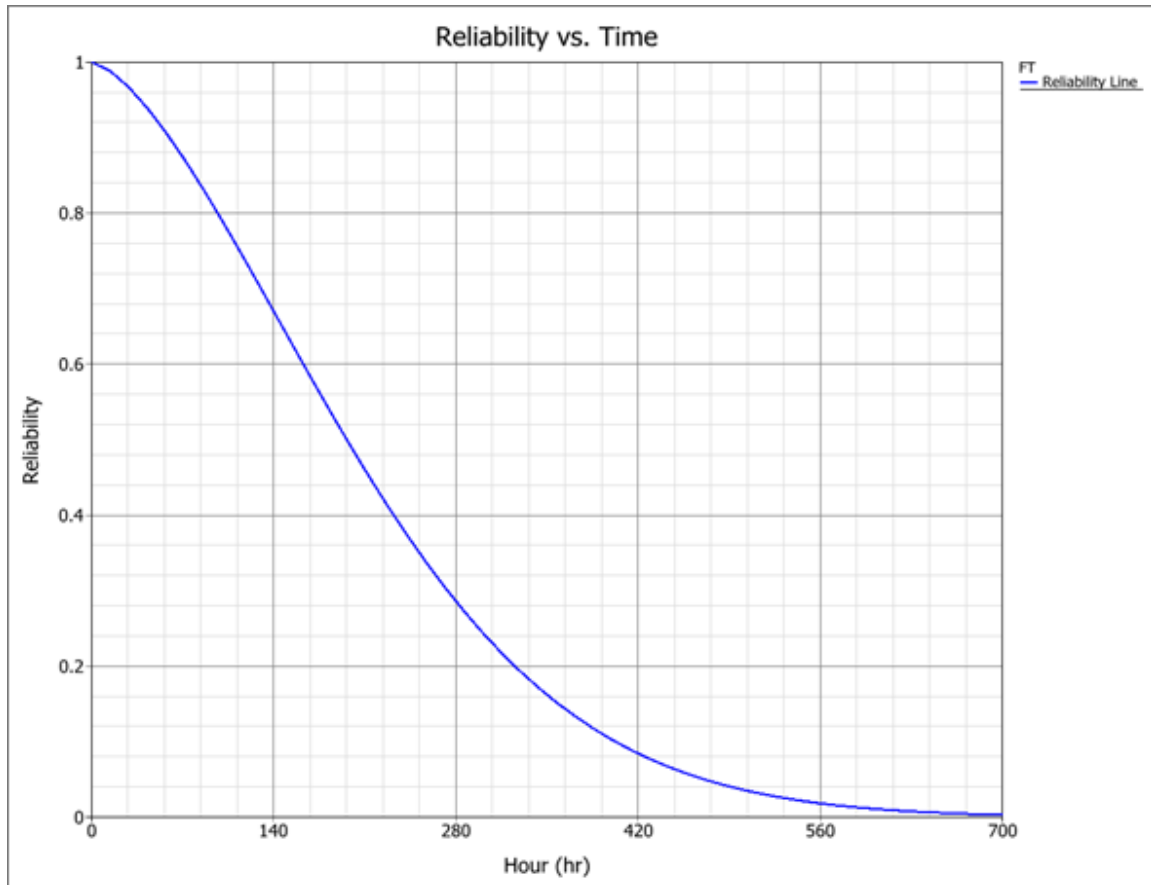
7. Calculate metrics

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.



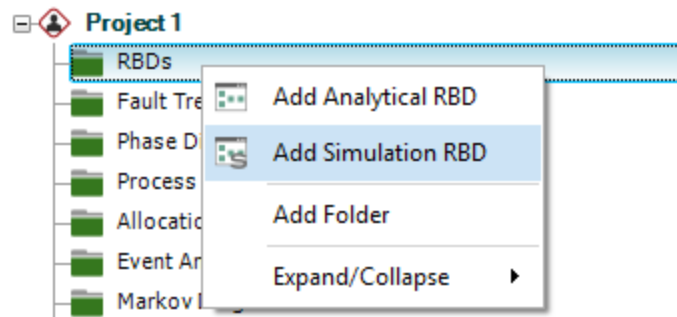
Using Simulation RBDs

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:

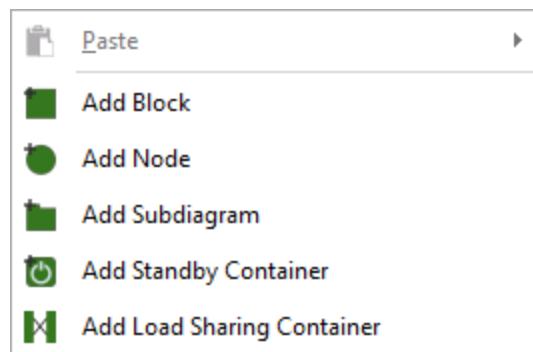
1. Add diagram

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

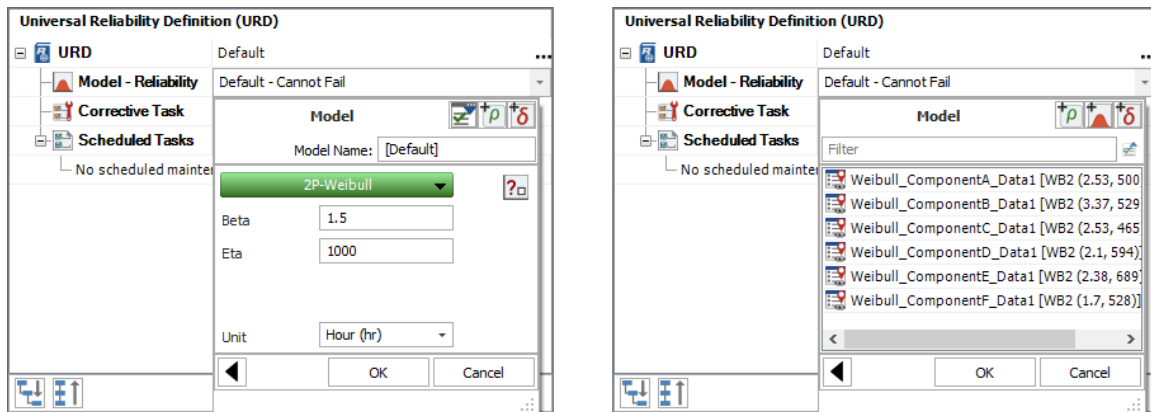
Hold down the **ALT** key, click the source block and drag a line to the destination block.



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.

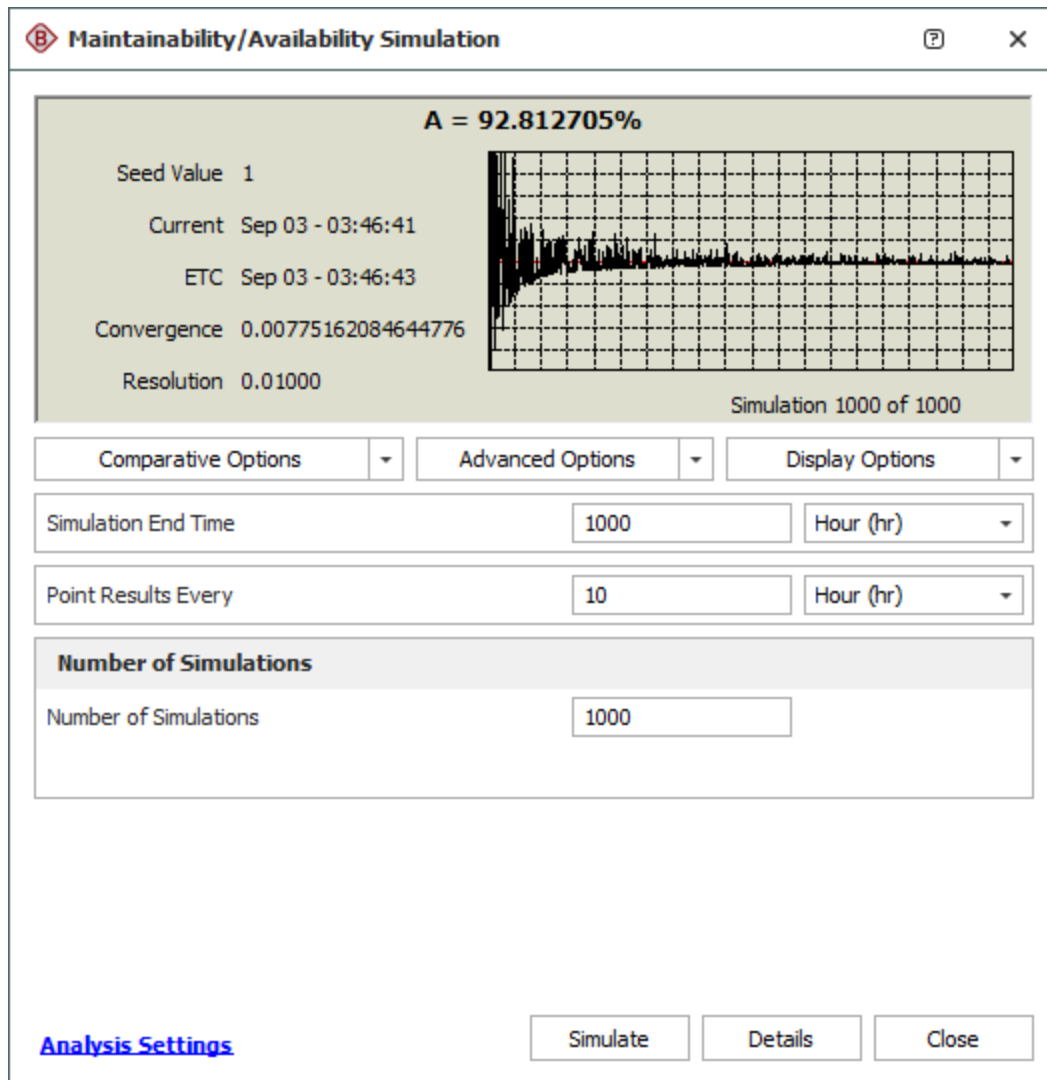


5. Simulate the diagram

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)

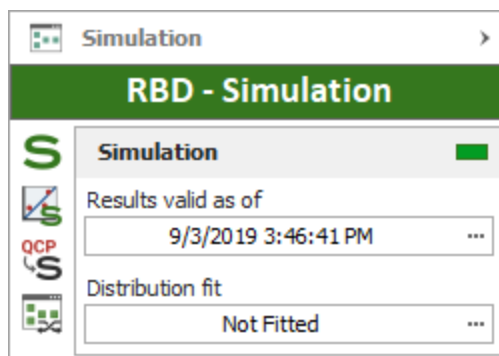
Number of Simulations

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.



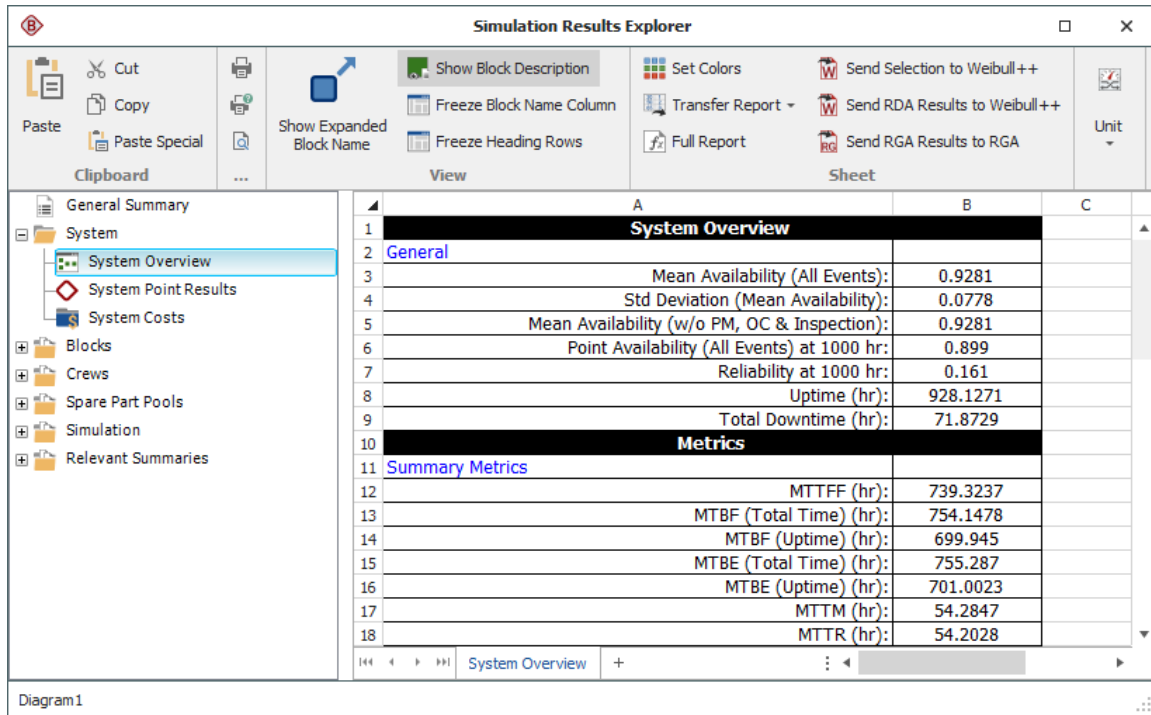
Simulation

RBD - Simulation

Simulation

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

Distribution fit
Not Fitted



Simulation Results Explorer

Clipboard: Paste, Cut, Copy, Paste Special

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

Sheet: Set Colors, Transfer Report, Full Report, Send Selection to Weibull++, Send RDA Results to Weibull++, Send RGA Results to RGA, Unit

General Summary

- System
 - System Overview**
 - System Point Results
 - System Costs
- Blocks
- Crews
- Spare Part Pools
- Simulation
- Relevant Summaries

	A	B	C
1	System Overview		
2	General		
3	Mean Availability (All Events):	0.9281	
4	Std Deviation (Mean Availability):	0.0778	
5	Mean Availability (w/o PM, OC & Inspection):	0.9281	
6	Point Availability (All Events) at 1000 hr:	0.899	
7	Reliability at 1000 hr:	0.161	
8	Uptime (hr):	928.1271	
9	Total Downtime (hr):	71.8729	
10	Metrics		
11	Summary Metrics		
12	MTTFF (hr):	739.3237	
13	MTBF (Total Time) (hr):	754.1478	
14	MTBF (Uptime) (hr):	699.945	
15	MTBE (Total Time) (hr):	755.287	
16	MTBE (Uptime) (hr):	701.0023	
17	MTTM (hr):	54.2847	
18	MTTR (hr):	54.2028	

Diagram1

7. Calculate metrics

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



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

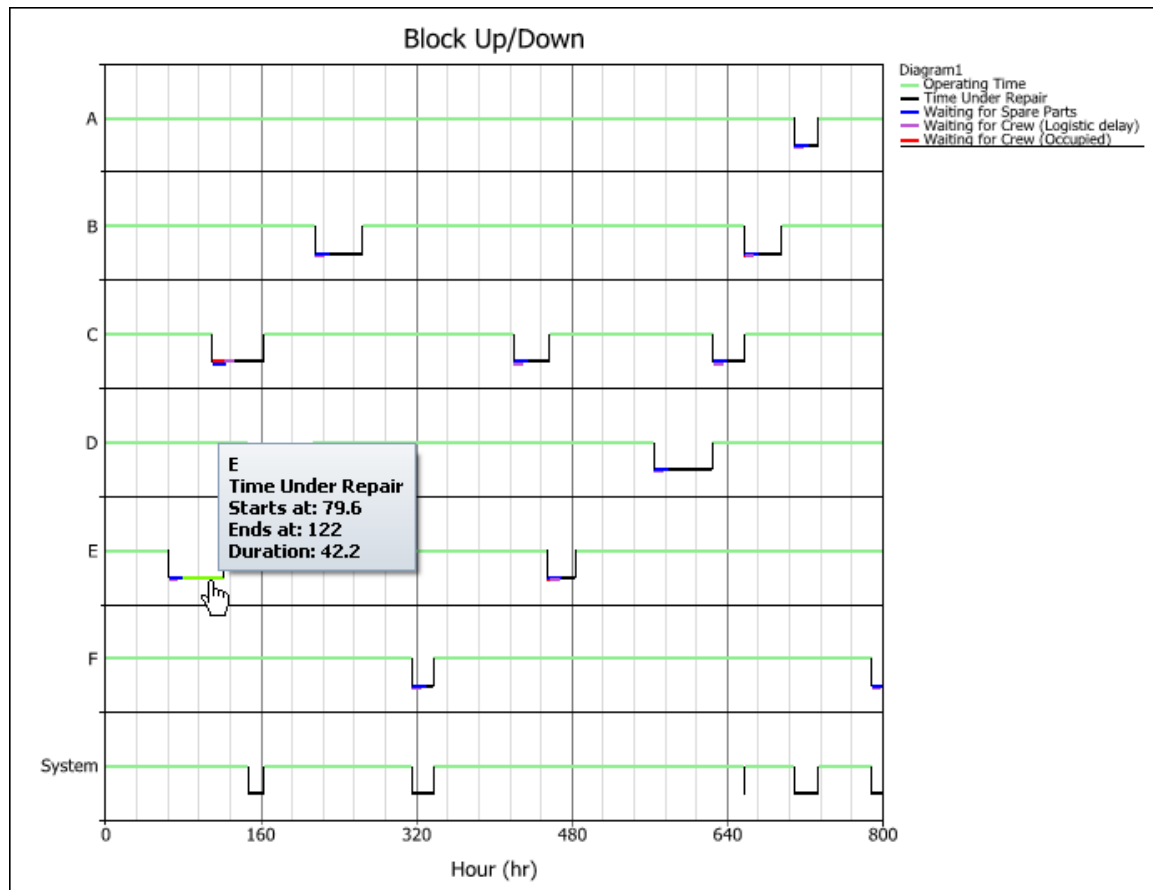
Details

Close

8. View plots

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





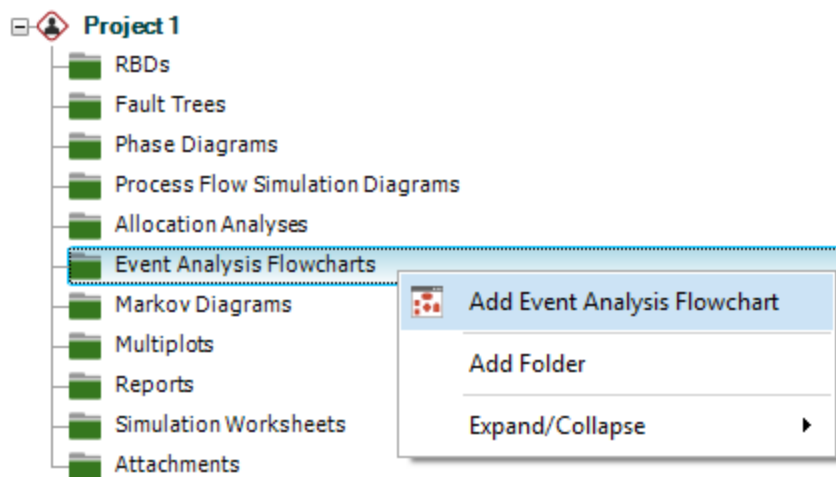
Using Event Analysis Flowcharts

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**.

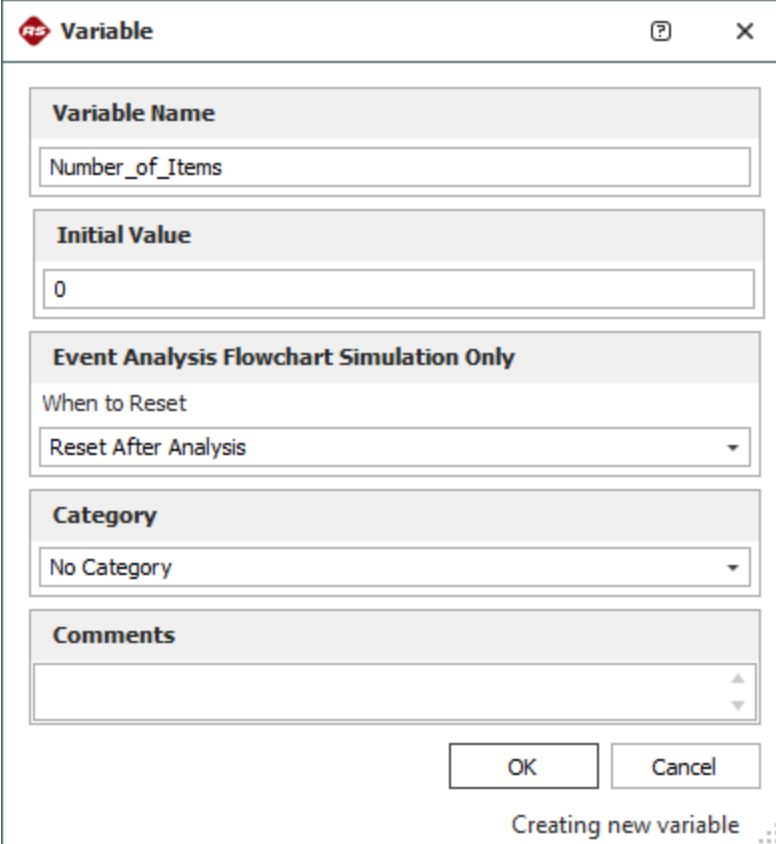


In the Resource Manager, choose **Variables** and then choose **Home > Edit > Add**.

The screenshot shows the Resource Manager interface for 'Project: Project 1'. The left sidebar contains a list of resource types: URDs, Variables (highlighted with a red box), Models, Corrective Tasks, and Scheduled Tasks. The top toolbar has a 'Display' section with 'Show All', 'Show Only Unused', and 'Show Only Duplicates'. The 'Edit' section contains 'Show Local', 'Show Global', 'Show Reference', 'Add' (highlighted with a red box), 'Batch Add', 'Duplicate', 'View', and 'Delete'. The main table displays a single variable named 'ABC'.

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:** A text box containing 'Number_of_Items'.
- Initial Value:** A text box containing '0'.
- Event Analysis Flowchart Simulation Only:** A section containing a 'When to Reset' dropdown menu with 'Reset After Analysis' selected.
- Category:** A dropdown menu with 'No Category' selected.
- Comments:** A text area with a scroll bar.
- Buttons:** 'OK' and 'Cancel' buttons.
- Status:** A message at the bottom right says '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: Reliability
- Model Type: Distribution
- Distribution: 2P-Weibull
- Parameters and Inputs
 - Beta: 2.3
 - Eta: 1750
 - Units: Day (day)

OK Cancel

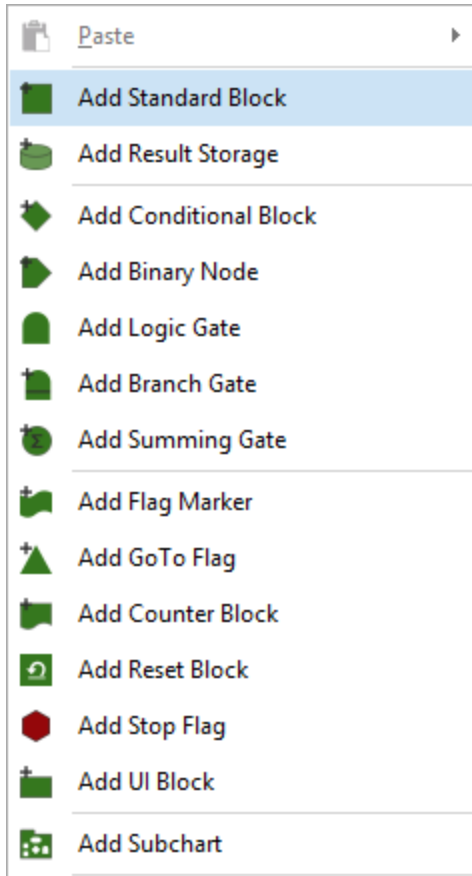
Creating new model

3. Add blocks

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

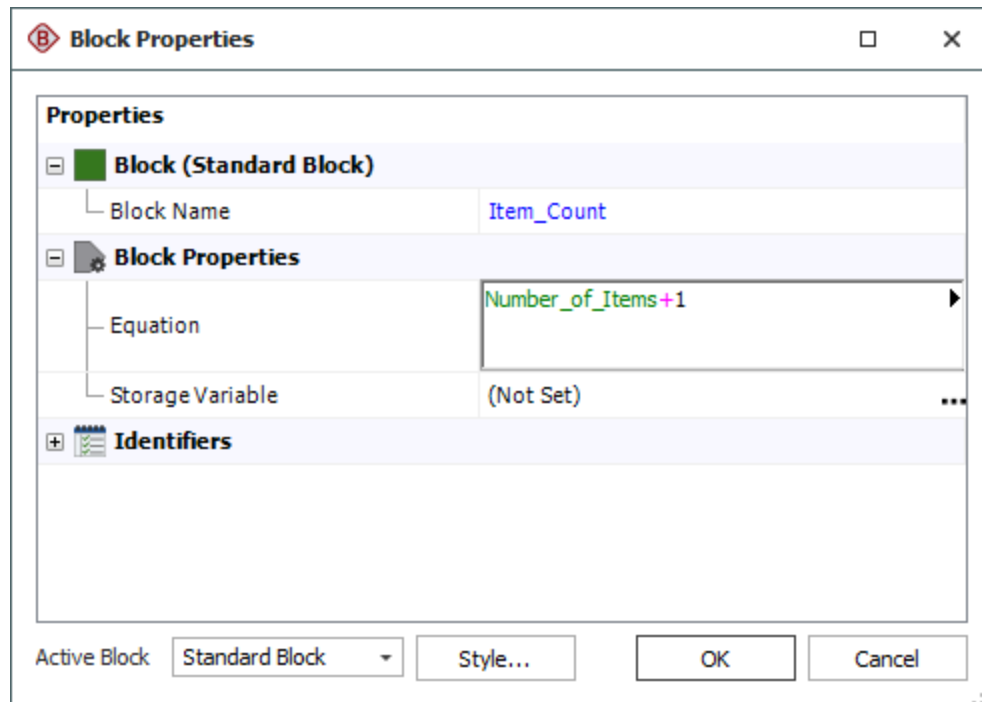
This block will increment the value of the Number_of_Items variable.

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

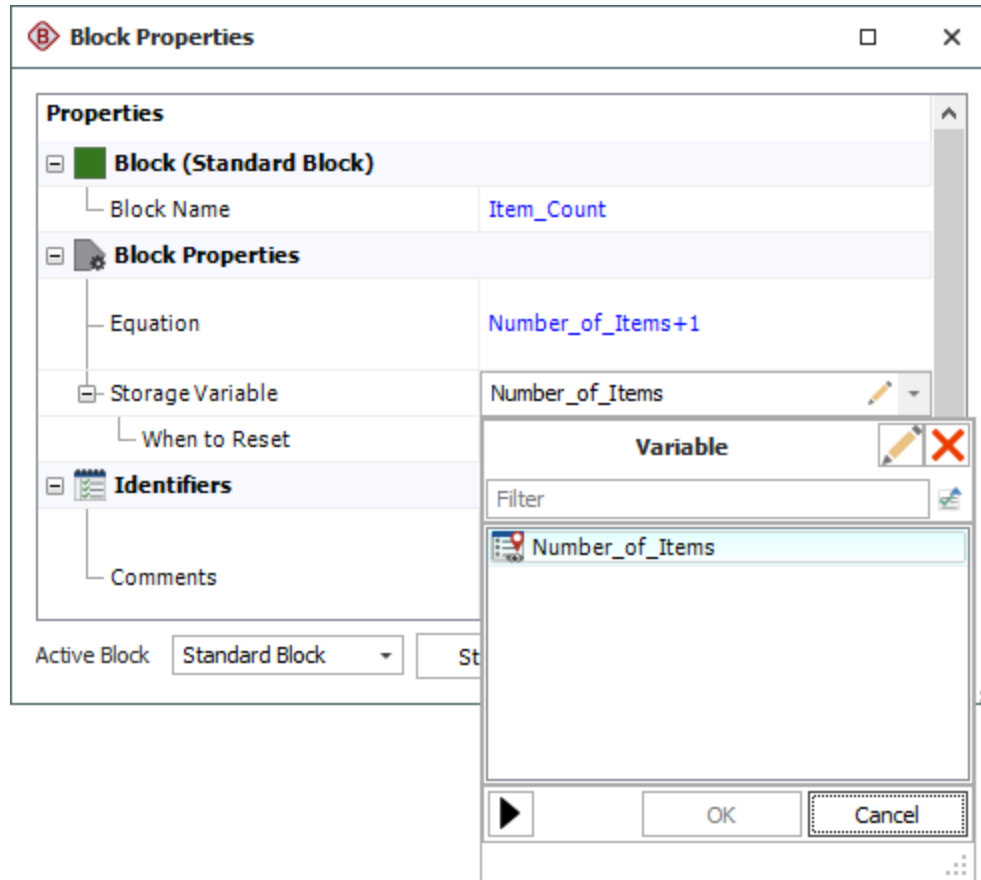


To edit the block's properties, right-click it and choose **Block Properties**.

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



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

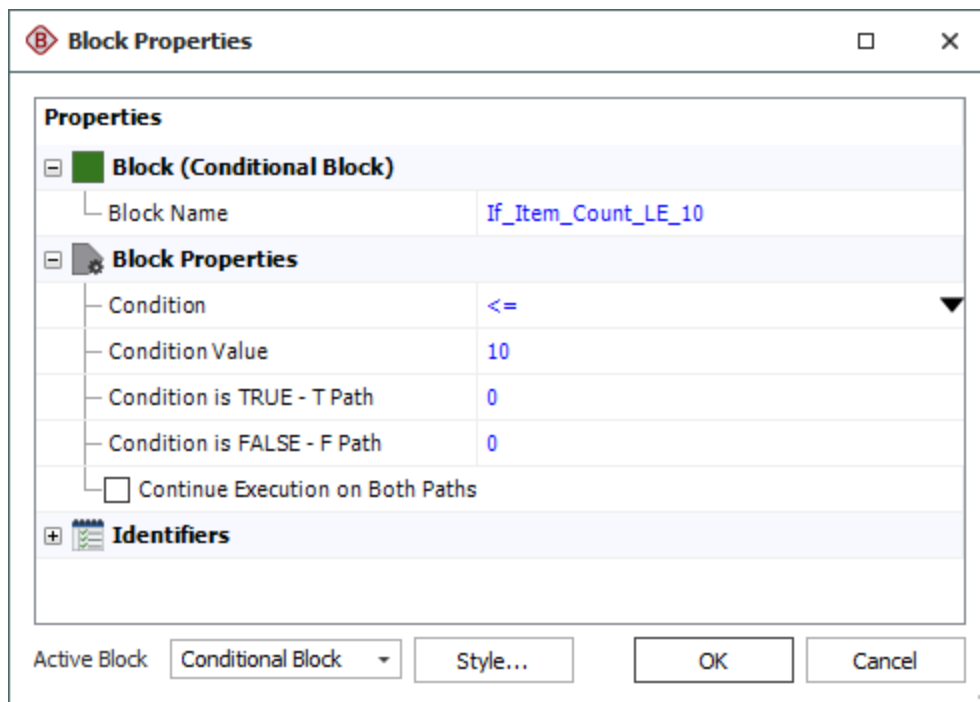


- b. Add a conditional block (i.e., create an IF statement)

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.

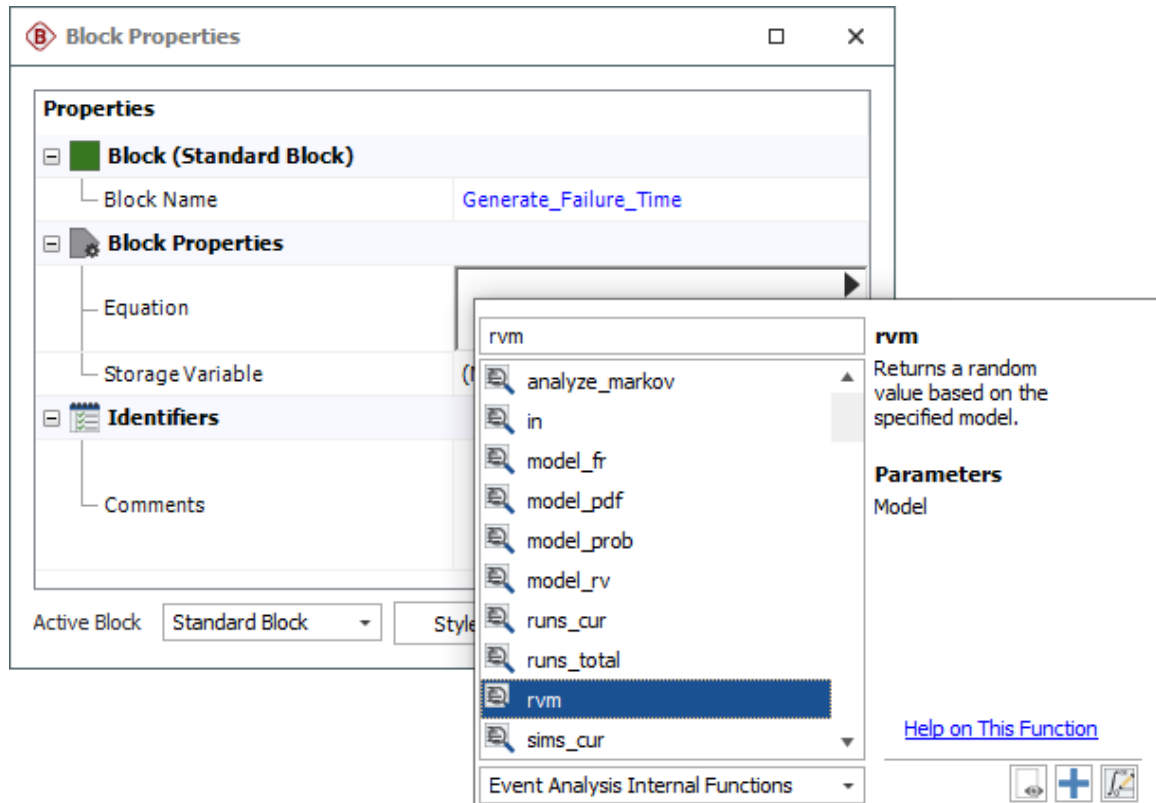
In the block's properties window, specify that if the incoming value is less than or equal to 10, a value of 0 will be passed on the "true" path. Otherwise, a value of 0 will be passed on the "false" path.



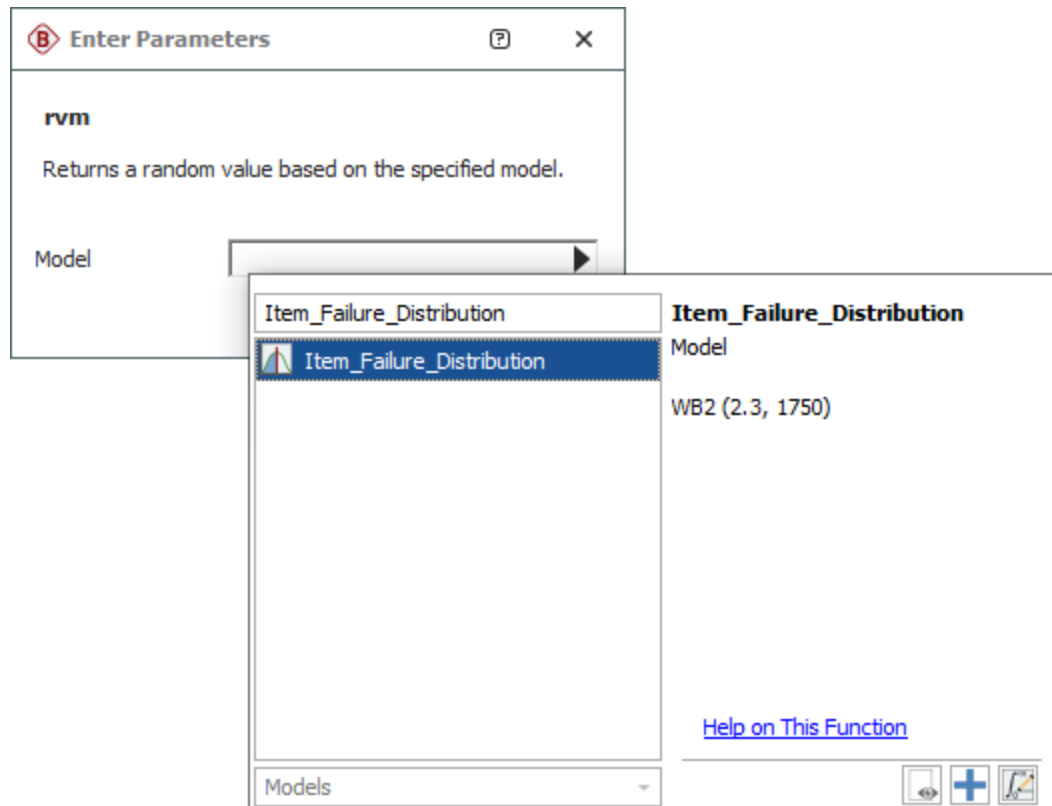
- c. Add a standard block (to generate the failure times)

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.

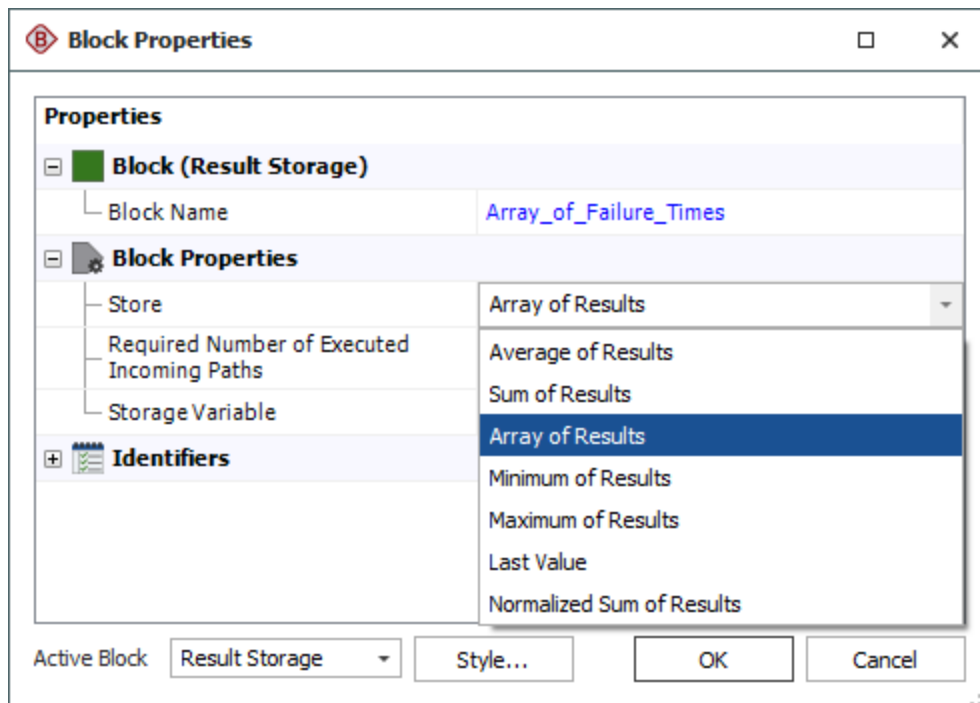


- d. Add a result storage block

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.

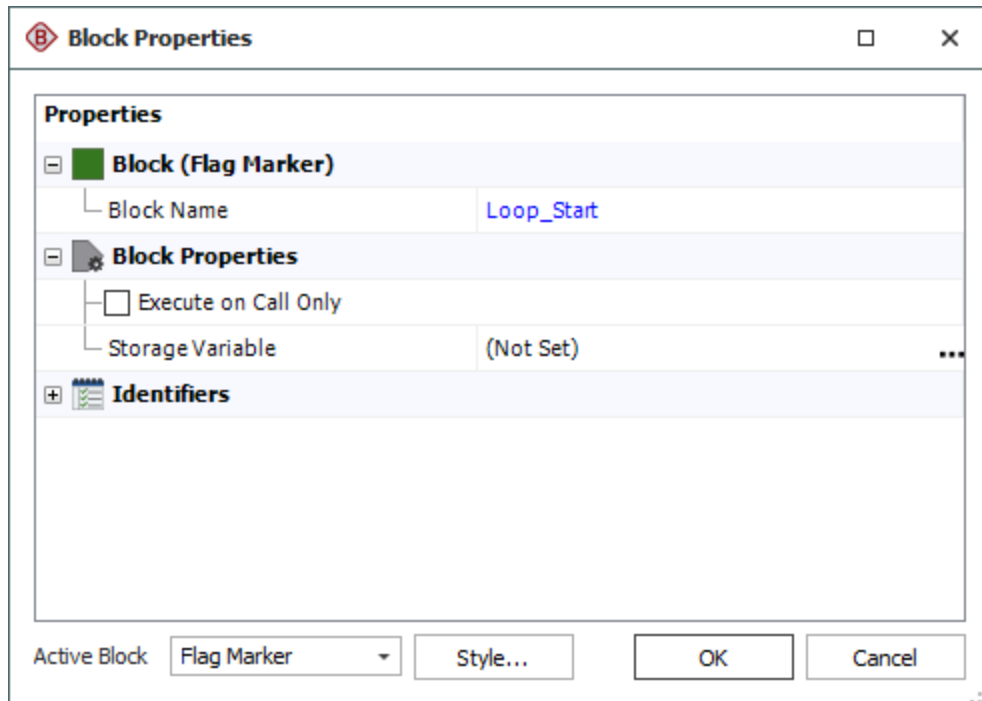


- e. Create a FOR loop

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**
 - Comments: Loop_Start

Active Block: GoTo Flag Style... OK Cancel

Block Properties

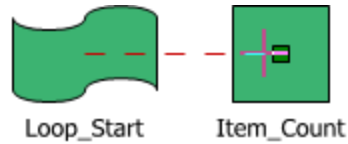
Properties

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

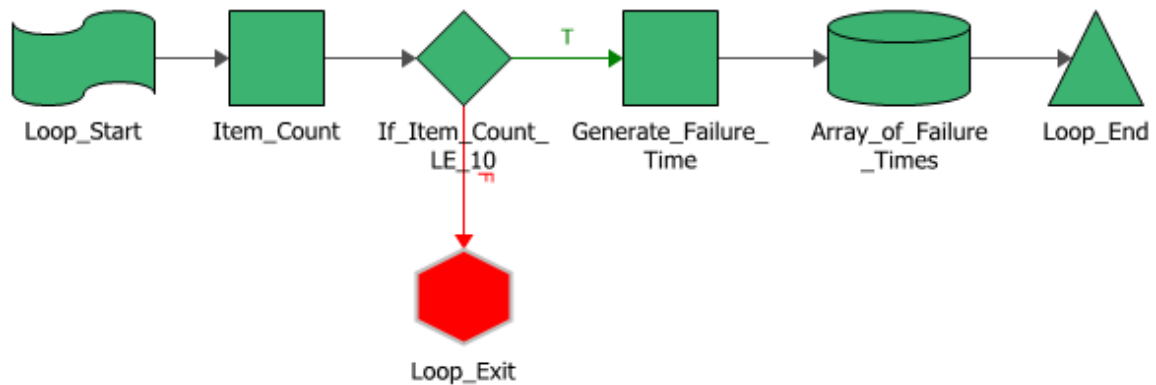
Active Block: Stop Flag Style... OK Cancel

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.

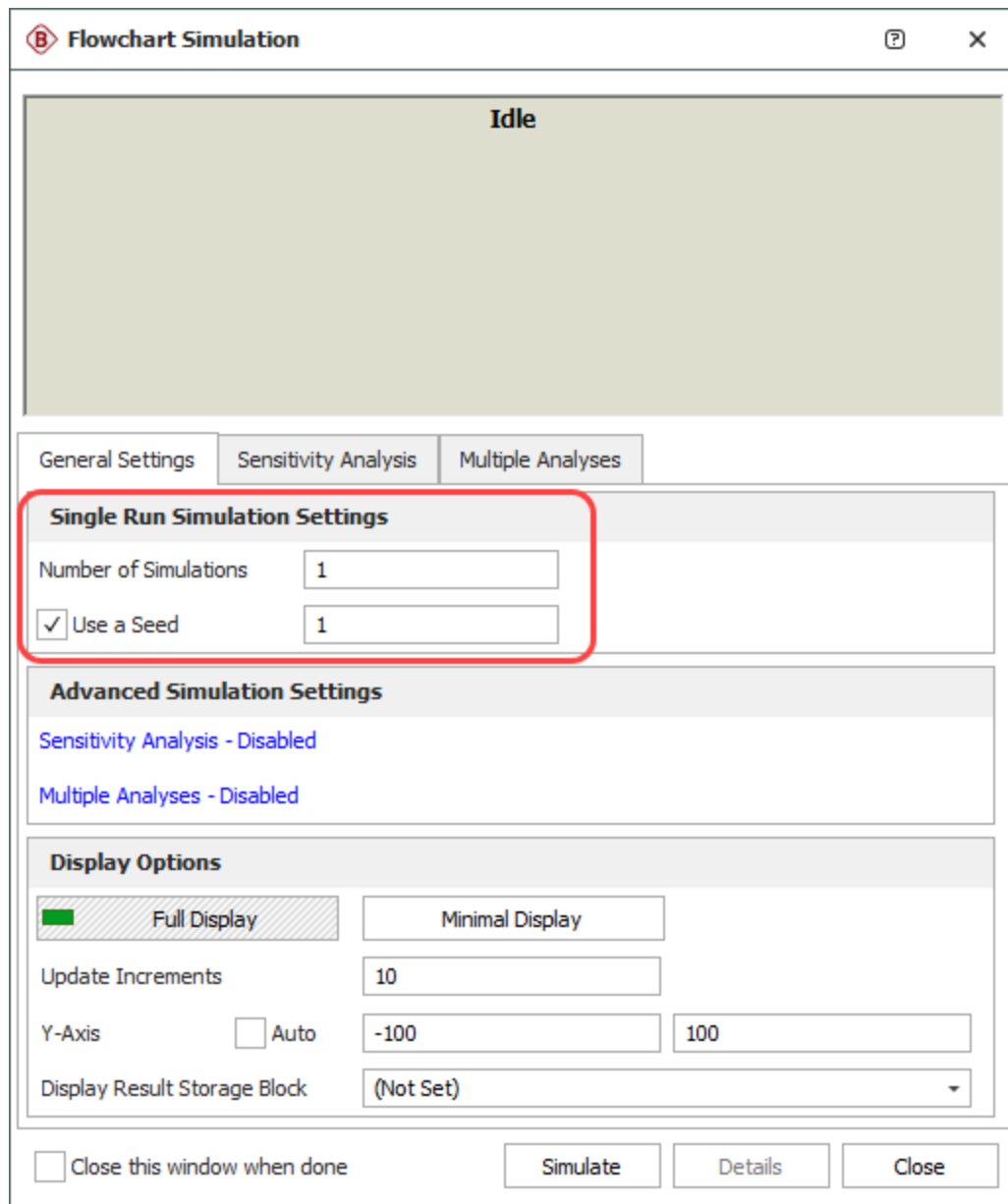


5. Simulate the flowchart

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 the main area are three tabs: 'General Settings', 'Sensitivity Analysis', and 'Multiple Analyses'. The 'General Settings' tab is selected. Within this tab, the 'Single Run Simulation Settings' section is highlighted with a red box. It contains two fields: 'Number of Simulations' set to 1, and 'Use a Seed' checked with a value of 1. Below this is the 'Advanced Simulation Settings' section, which shows 'Sensitivity Analysis - Disabled' and 'Multiple Analyses - Disabled'. The 'Display Options' section has 'Full Display' selected (indicated by a green bar), '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

☒ Use a Seed: 1

Advanced Simulation Settings

Sensitivity Analysis - Disabled

Multiple Analyses - Disabled

Display Options

☒ Full Display | Minimal Display

Update Increments: 10

Y-Axis: ☐ Auto | -100 | 100

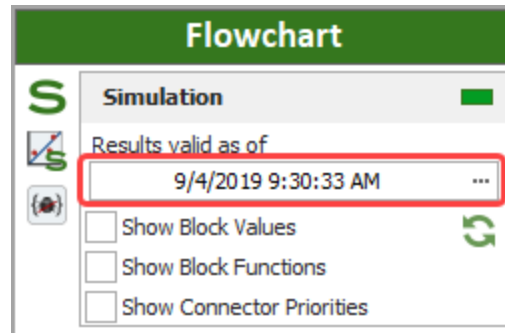
Display Result Storage Block: (Not Set)

☐ 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.

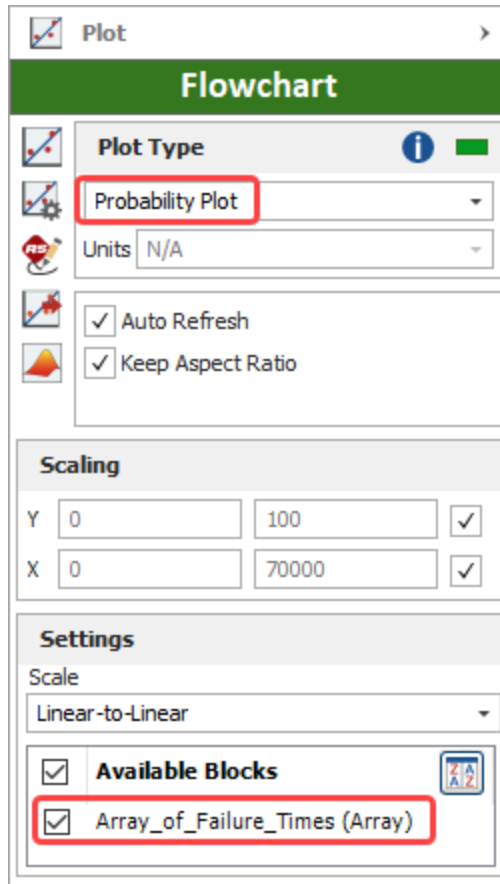
Result #	Array_of_Failure_Times
1	1930.926056
2	2008.575072
3	2546.727667
4	1291.008805
5	647.42902
6	2164.346878
7	1562.131953
8	525.730922
9	2397.02994
10	1653.12614

7. View plots

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

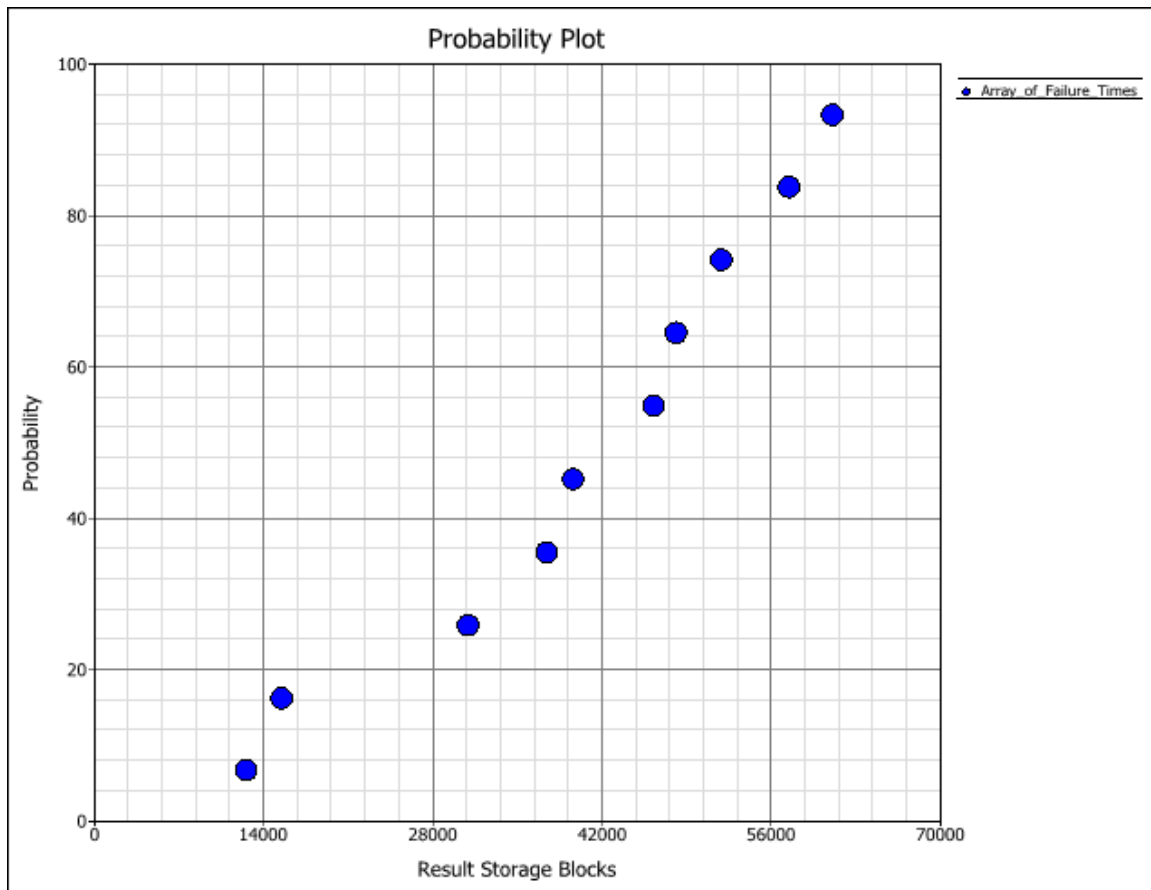


On the plot sheet control panel, choose the plot type, then select the result storage block(s) to show in the plot.



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

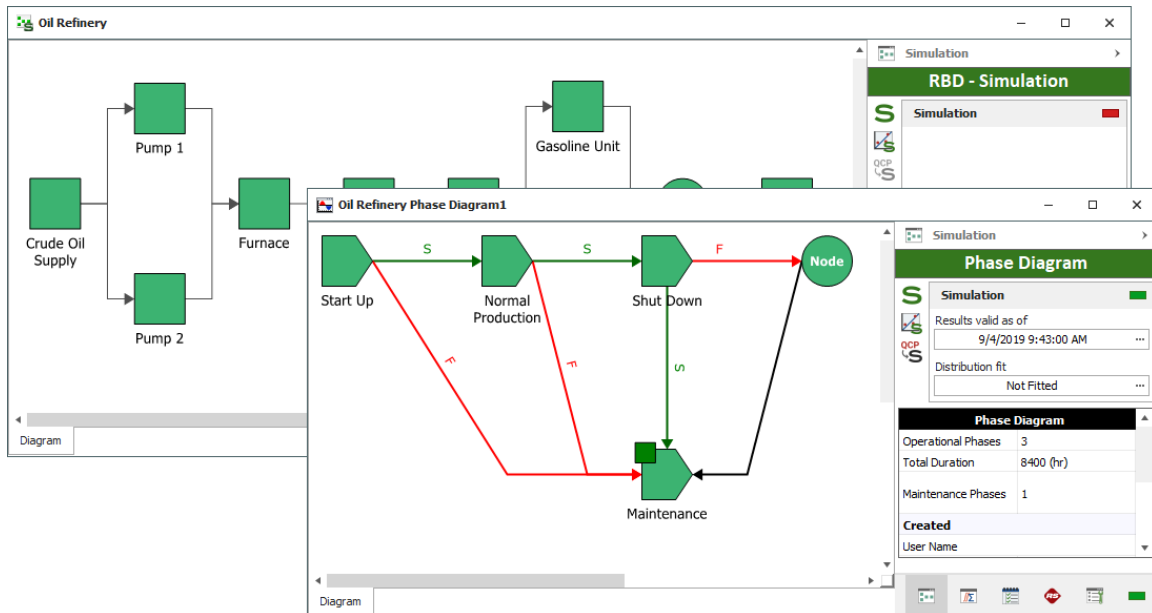
- Plot Type**: A dropdown menu set to 'Probability Plot', which is highlighted with a red rectangle.
- Units**: A dropdown menu set to 'N/A'.
- Checkboxes**: Two checked options: 'Auto Refresh' and 'Keep Aspect Ratio'.
- Scaling**: A section with input fields for Y (0 to 100) and X (0 to 70000), each with a checkmark.
- 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

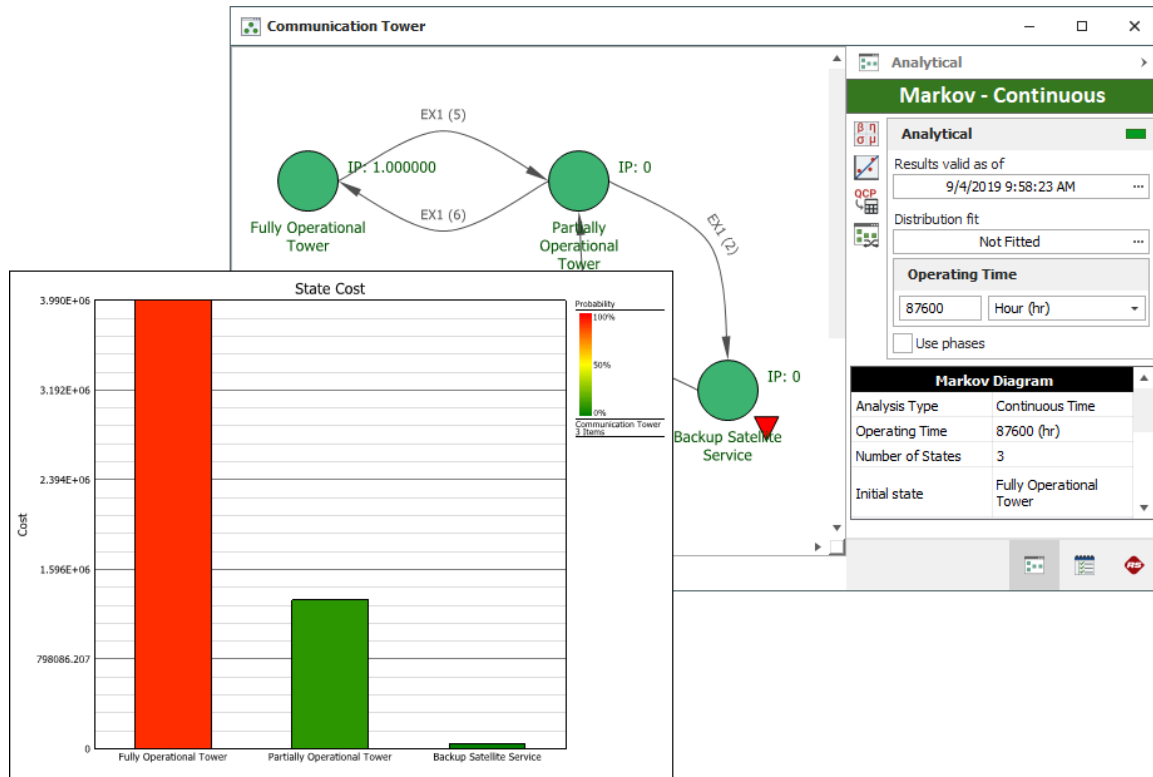
Phase Diagrams

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



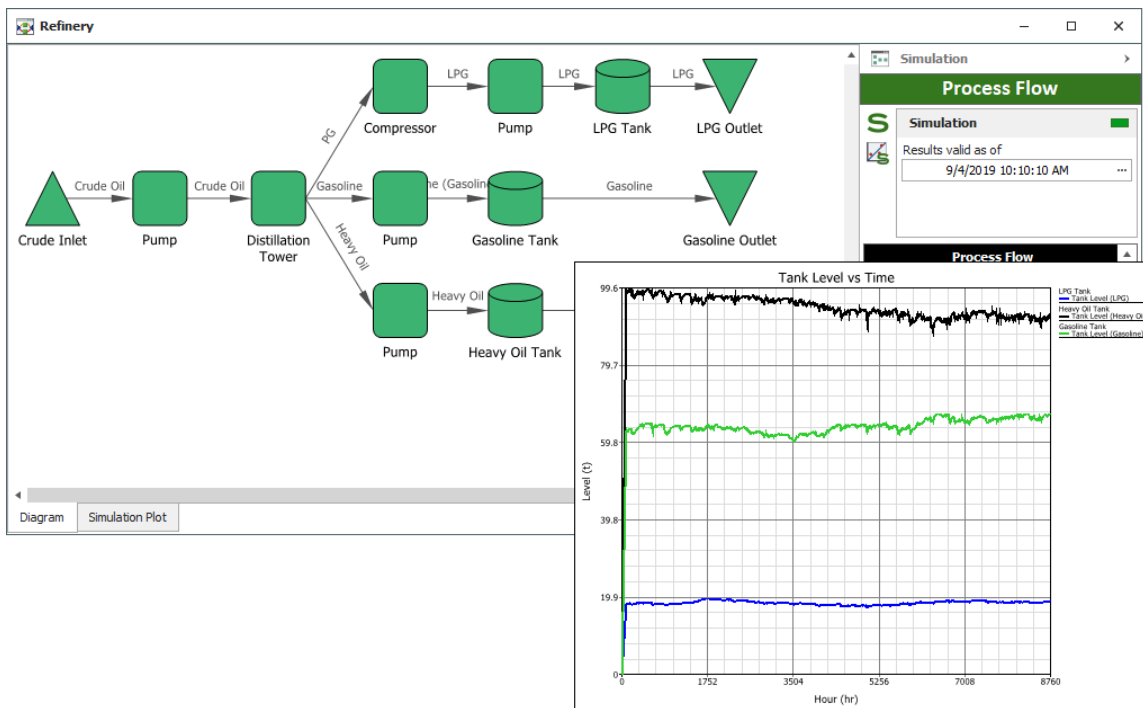
Markov Diagrams

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' tool interface. It features a main table with columns for Block Name, Reliability Importance, Current Reliability, Maximum Achievable Reliability, Feasibility, Target Reliability, Equivalent Parallel Units, and Comments. A red arrow points from the 'Subsystem A' row in the top table to the 'Assembly A' row in the bottom table. The bottom table also includes a 'System' tab at the bottom left. The right sidebar contains 'Calculations' and 'Allocation Analysis' sections, with 'Allocation Type' set to 'Cost Optimized'. The 'Inputs' section shows 'Target Reliability' as 0.968431, 'Time' as 500, 'Units' as 'Hour (hr)', and 'Iterations' as 50. The 'Outputs' section shows 'Current Reliability' as 0.952914 and 'System Reliability' as 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	

Block Name	Reliability Importance	Current Reliability	Maximum Achievable Reliability	Feasibility	Target Reliability	Equivalent Parallel Units	Comments
Assembly A	0.998807	0.954052	1	Moderate (5)	0.969342	1.131355	
Assembly B	0.037541	0.979923	1	Moderate (5)	0.986369	1.099088	
Assembly B	0.037541	0.979923	1	Moderate (5)	0.979923	1.000000	
Assembly B	0.037541	0.979923	1	Moderate (5)	0.979923	1.000000	

System Subsystem A Assembly A

Calculations

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

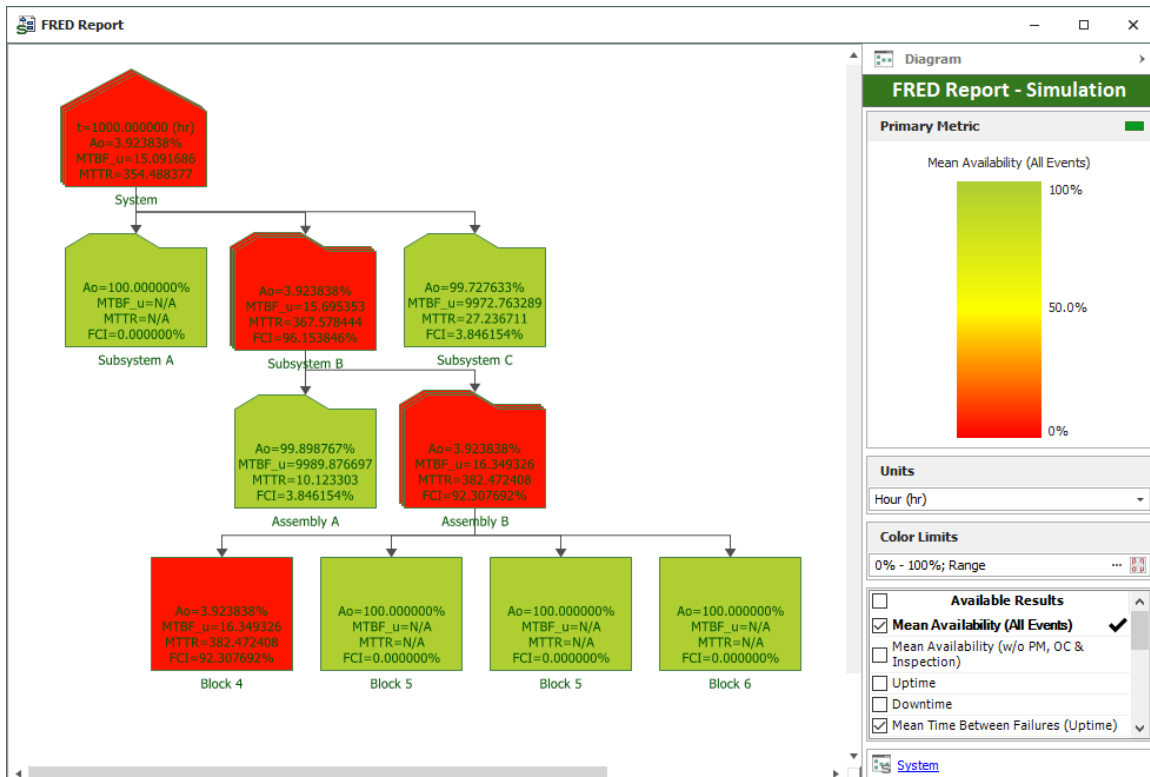
Color Limits

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

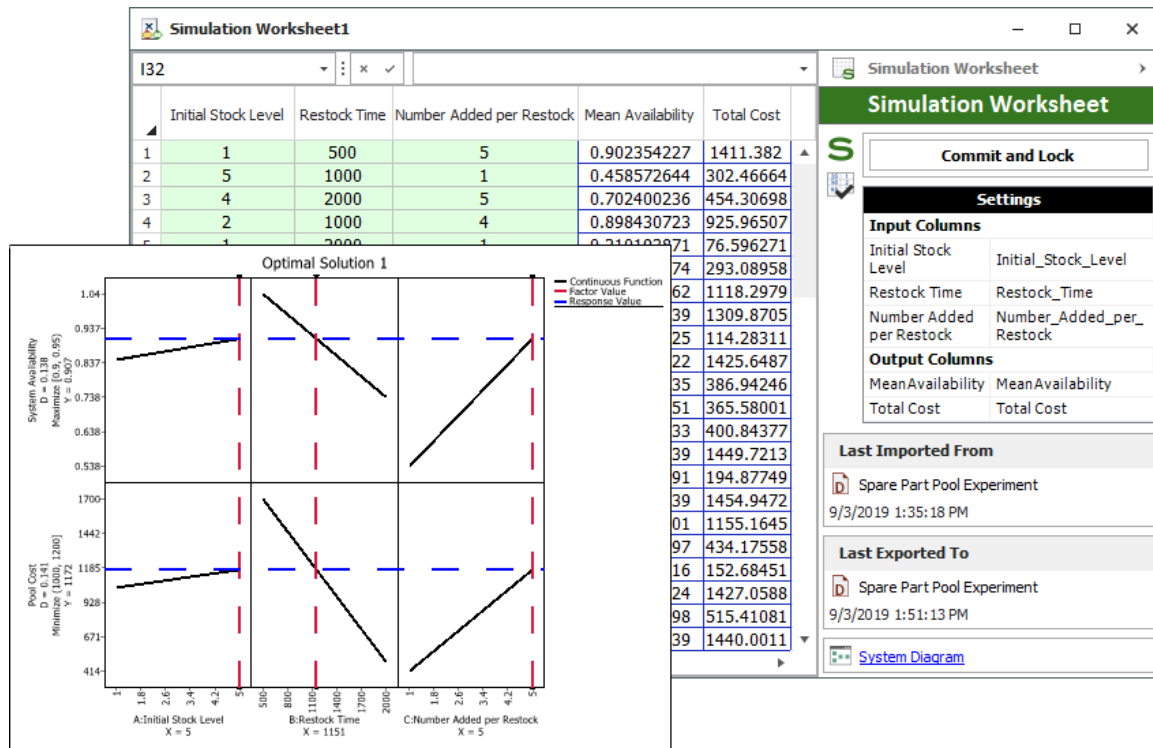
The Optimum Replacement tool helps to determine the best time to inspect and/or replace components, based on the costs for planned and unplanned maintenance.

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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(b) You fail to comply with any provisions of this License Agreement;

(c) You commit a material or persistent breach of this License Agreement which You fail to remedy (if remediable) within 14 days after the service on You of written notice requiring You to do so;

(d) a petition for a bankruptcy order to be made against You has been presented to the court; or

(e) where You, as the Corporate Licensee, become insolvent or unable to pay its (the company's) debts, enters into liquidation, whether voluntary or compulsory (other than for reasons of bona fide amalgamation or reconstruction), passes a resolution for its winding-up, has a receiver or Administrator manager, trustee, liquidator or similar officer appointed over the whole or any part of its assets, makes any composition or arrangement with its creditors or takes or suffers any similar action in consequence of its debt, or becomes unable to pay its debts or ceases to trade.

11.2 In the event of termination in accordance with clause 10.1, You must immediately pay to the Licensor any sums due to the Licensor under the License Agreement and (at the Licensor's sole option) You must return, destroy or delete all copies of the Software Product from all storage media in Your control and, in the case of destruction, certify to the Licensor that You have done so.

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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.