

Quick Tour



XFMEA



RCM++

VERSION 2024

ReliaSoft

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Quick Tour of XFMEA and RCM++

XFMEA facilitates data management and reporting for all types of **FMEA** (including Design FMEA, Process FMEA, FMECA, etc.). It also supports related analyses such as **P-Diagrams**, **DVP&Rs (Test Plans)**, **Design Reviews Based on Failure Mode (DRBFMs)**, **Process Flow Diagrams** and **Process Control Plans**.

RCM++ facilitates the **Reliability Centered Maintenance (RCM)** approach for creating effective scheduled maintenance plans. It supports traditional RCM decision logic diagrams, and also offers simulation/calculation engines to compare maintenance strategies based on cost and availability.

Answer a wide variety of questions such as:

- What is the risk in a product or process?
- Which components or assemblies pose the greatest risk?
- What failure modes might occur? What is the effect of failure?
- What controls are in place to mitigate the risk?
- What tests need to be performed?
- How can we improve the design?
- How should we plan for scheduled inspections and maintenance?

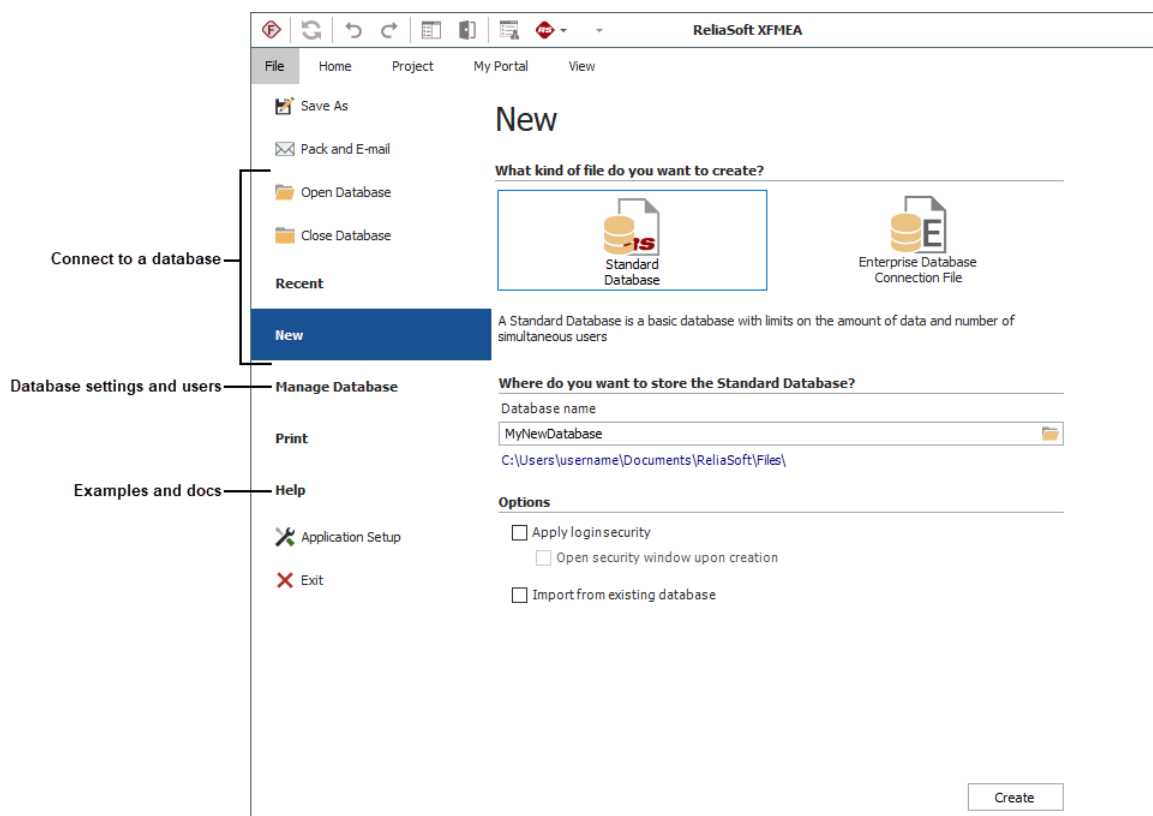
Using Databases and Projects

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.

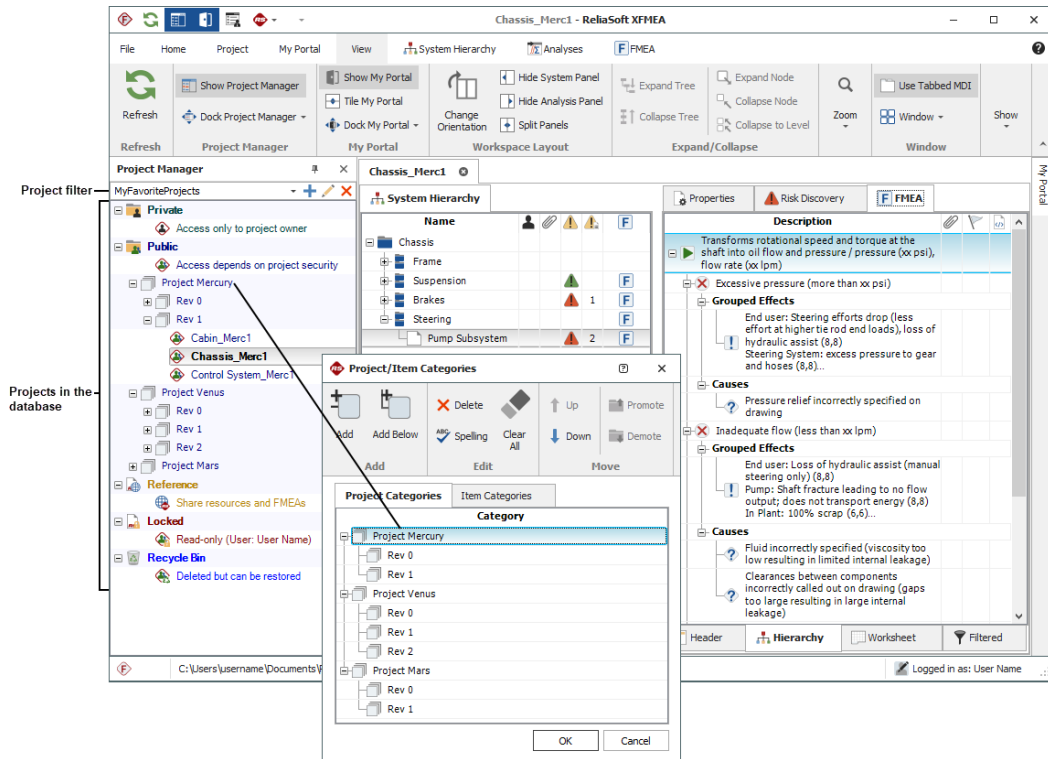


Project List

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.



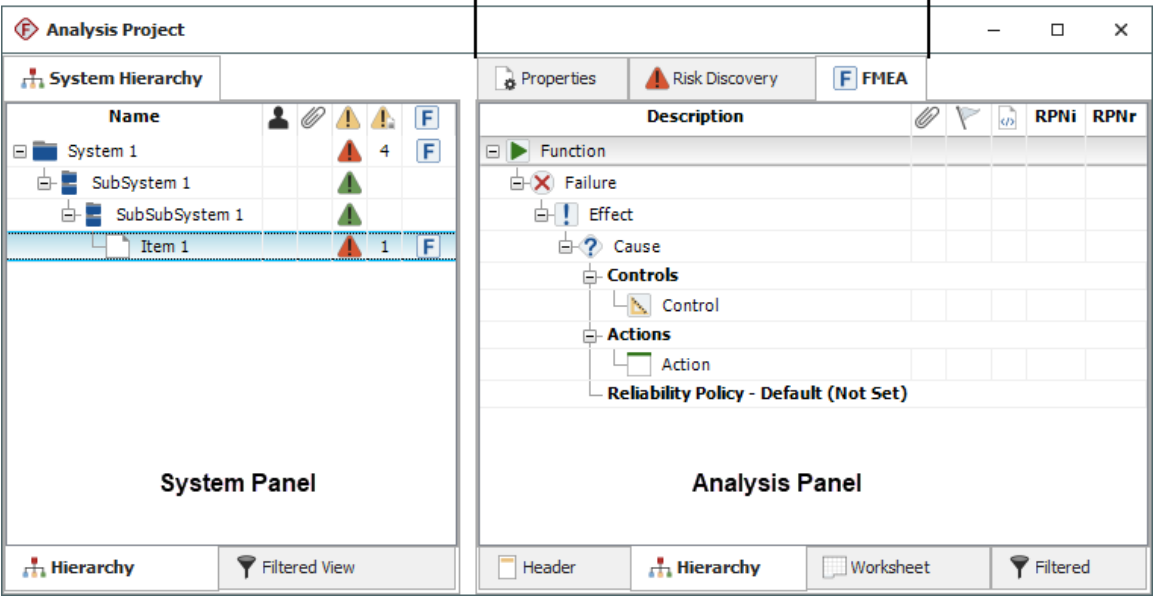
System Panel and Analysis Panel

The **System panel** shows the items that may be analyzed in the project.

- It can be a single item or a complex multi-level system configuration.
- It can be physical components/equipment or steps in a process.

The **Analysis panel** shows properties and analyses for the item that is currently selected.

These tabs allow you to view different analyses for the item that is currently selected.



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

Project Properties

FMEA Structure

Each project has an **FMEA structure** that will be the same for all FMEAs and RCMs in the project.

- **Grouped Effects and Causes** (commonly used for FMEA)

The effects will be entered as separate records but displayed together in the FMEA; the software calculates RPNs based on the highest severity rating.

Description	SEVi	OCCi	DETi	RPNi
Function				
Failure Mode A				
Grouped Effects				
Effect 1 (2,-) Effect 2 (8,-)	8			
Causes				
Cause 1		5	5	200
Cause 2		5	5	200
Cause 3		5	5	200

- **Effects Before Causes** (can be used for FMEA or RCM)

Description	SEVi	OCCi	DETi	RPNi
Function				
Failure Mode A				
Effect 1	8			
Cause 1		5	5	200
Cause 2		5	5	200
Cause 3		5	5	200

- **Causes Before Effects** (sometimes used for RCM)

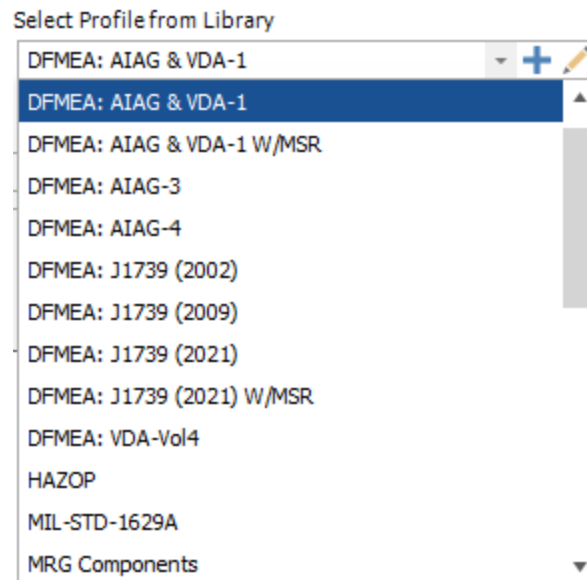
Description
Function
Functional Failure
Failure Mode
Effect

Configurable Settings

Each project also has its own **configurable settings** that enable you to customize:

- Data fields and names
- Classifications, categories and other drop-down lists
- Rating scales and preferences for FMEA risk priority metrics
- Logic for risk discovery and RCM decision charts

Use the **Select Profile from Library** option in the project properties to quickly apply a pre-defined group of settings.



Using FMEAs

Failure Modes and Effects Analysis (FMEA) and Failure Modes, Effects and Criticality Analysis (FMECA) are methodologies designed to identify potential failure modes for a product or process, to assess the risk associated with those failure modes, to rank the issues in terms of importance and to identify and carry out corrective actions to address the most serious concerns.

The basic steps for using an FMEA are:

1. Create the project and set project properties

Choose **Project > Management > Create Project**.

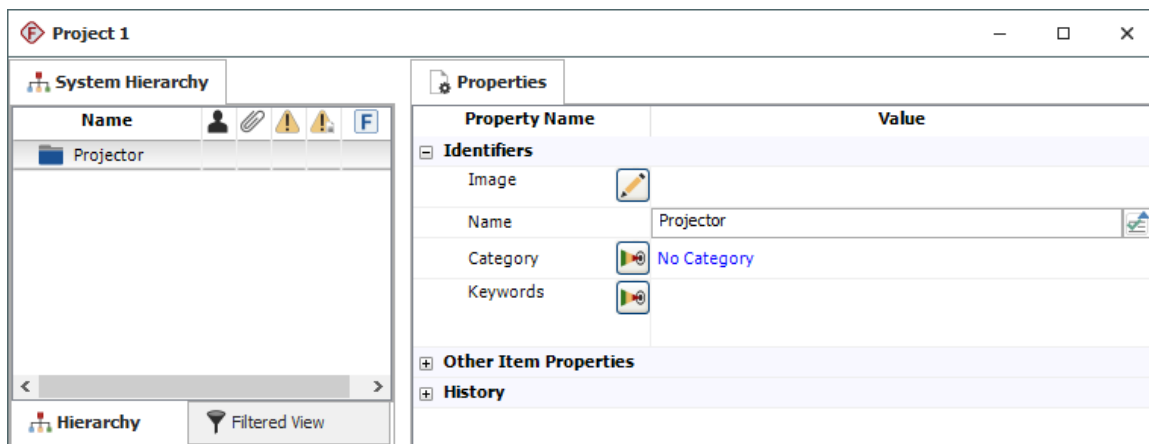


In the Project Properties window, specify the **FMEA Structure** and the **Profile** that will be used to set the configurable settings.

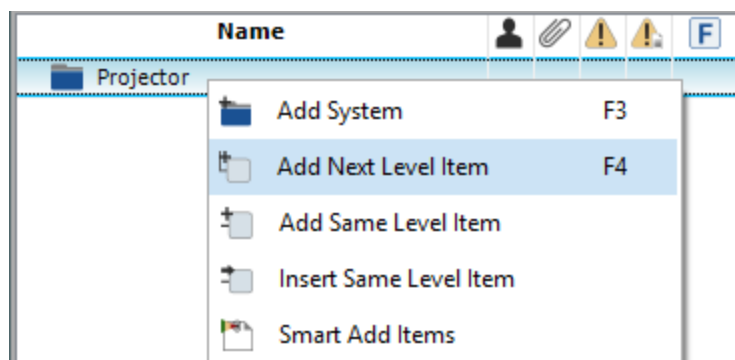
FMEA Structure	Select Profile from Library
Grouped Effects and Causes	DFMEA: AIAG-4

2. Add items in the system hierarchy

The first item is added to the system hierarchy when you create the project. Use the Properties tab in the Analysis panel to rename it and set other properties.

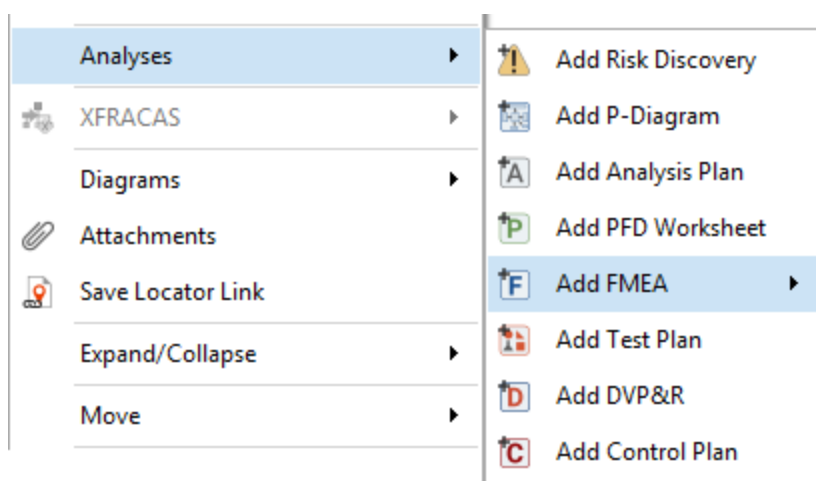


To add items, right-click inside the system hierarchy and choose **Add System**, **Add Next Level Item**, etc.



3. Add a new FMEA

To add an FMEA for an item, right-click the item in the system hierarchy and choose **Analyses > Add FMEA**.



4. Add records in the FMEA hierarchy

The Hierarchy tab for an FMEA displays the analysis records in a hierarchical tree, which tends to be good for viewing a lot of information in a small amount of space. In this view, you will use properties windows to add or edit FMEA records. When you add a new FMEA, the Function window will automatically open. Enter the details and click either **Add Function** (to add the next function description), **Add Failure** (to add the first failure mode for this function) or **OK** (to close the window).

Add Function


Home

Add Function **Add Failure** **Add Effect** **Add Cause** **Add Control** **Add Action** **Configurable Settings** **Tools**

Function

Function: Projector provides 2X zoom capability throughout the life of the projector under all operating conditions as defined in the technical specification

Name: *

Keywords: 

Associated Records

Item: Projector

History

Function

OK **Cancel**

Creating new function

5. Use Select Existing Text utilities

The Select Existing Text window provides a list of existing descriptions that might apply to the current text field or analysis. If you want to use this utility to replace or append text in an input field, click the icon next to the field.



Select Existing Text

Project Filter Show All + ✎ ✕

Item Filter Show All + ✎ ✕

Record Filter FMEA Failure

Phrase Sets All

Field Text Contains

Field Text

- ☐ Lamp Shatters
- ☐ No image is projected
- ☐ The image is distorted at the maximum zoom of 2X
- ☐ The image is not clear at the maximum throw distance of 18.1m
- ☐ The zoom capability degrades over the life of the project
- ☐ User must exert more than 3 lb force to remove bulb
- ☒ Zoom capability is less than 2X

Phrase Set (Failure)

- ☐ <None>
- ☐ Abrasion
- ☐ Bent
- ☐ Breakage

New Text Preview (31/2000) Clear Text

Zoom capability is less than 2X

☒ Replace ☐ Append Separator ,

OK Cancel

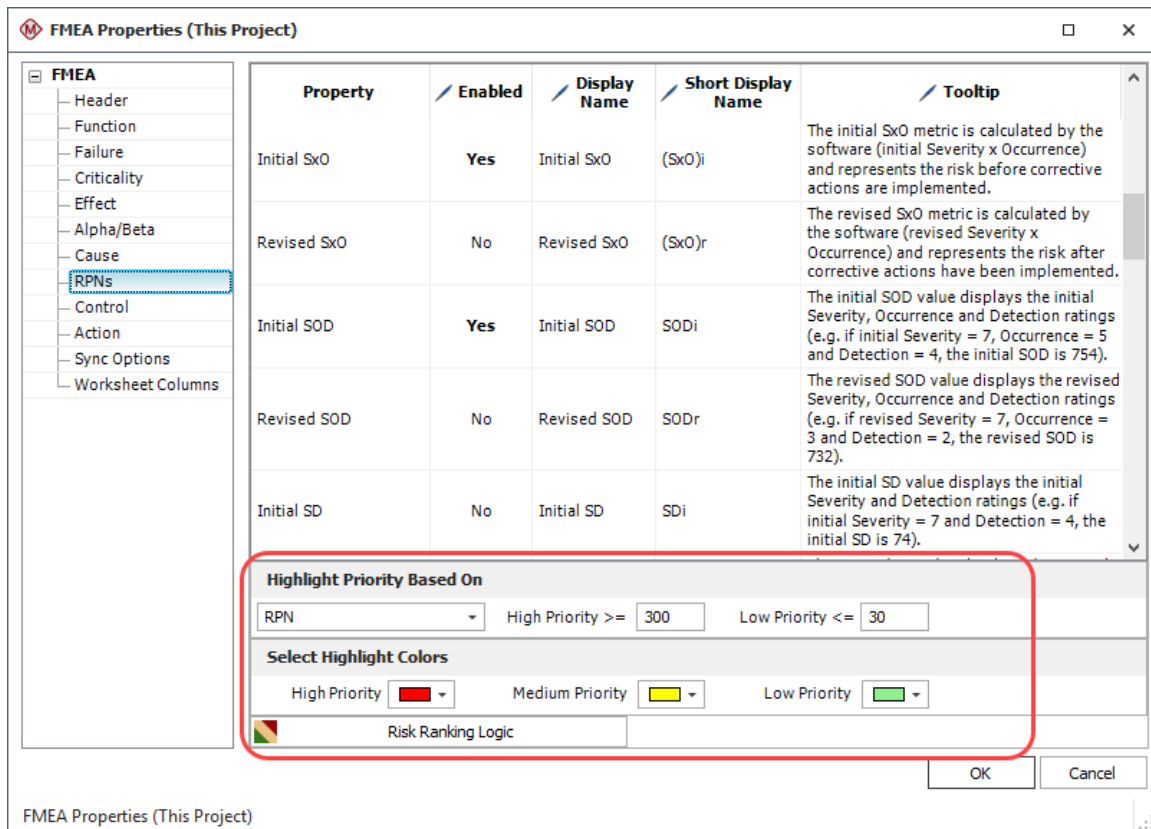
The Select Existing Text window can also be used to add multiple records at once. For example, right-click a function record and choose **Add Multiple Failures > Select Existing Text**.

6. View RPNs and related metrics

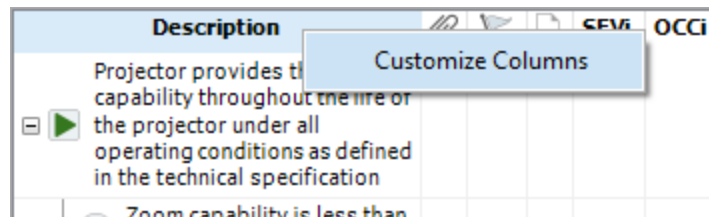
You can choose to calculate and display a variety of metrics based on the Severity, Occurrence and Detection ratings that have been assigned for effects and causes in the FMEA: RPN, SxO, SOD, SD or QCPN. To configure the metrics that are enabled for the current project, choose **FMEA > Tools > Configurable Settings**.



On the RPNs page, use the Enabled column to specify which metrics will be available in the current project. Use the **Highlight Priority Based On** area to configure the logic that will be employed when a user turns on the priority highlights feature.



To choose which metrics will be displayed in the FMEA hierarchy for your computer, right-click a column heading in the FMEA and choose **Customize Columns**.



To turn on priority highlighting, choose **FMEA > Tools > Highlight Priority**.

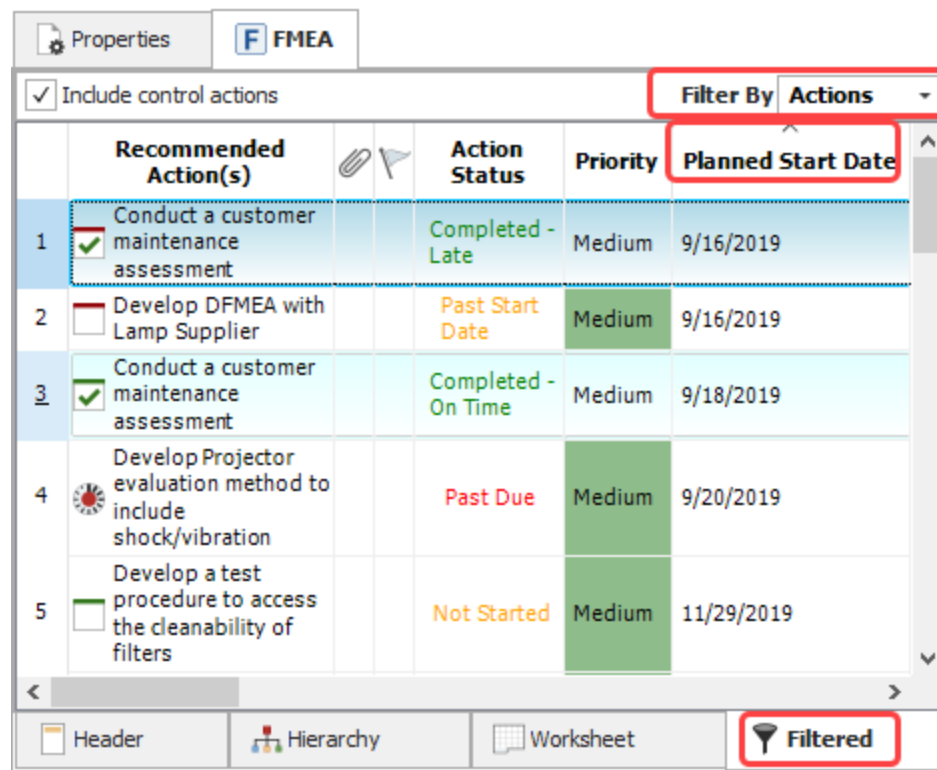


7. Use the filtered and worksheet views

a. Filtered view

Click the Filtered tab at the bottom of the FMEA to open the filtered view. This view presents a sortable list of all records of a particular type, such as causes sorted by RPN or

actions sorted by due date. Use the **Filter By** drop-down list to select which records are displayed. Then click inside the column heading you wish to sort by.



	Recommended Action(s)	Action Status	Priority	Planned Start Date
1	Conduct a customer maintenance assessment	Completed - Late	Medium	9/16/2019
2	Develop DFMEA with Lamp Supplier	Past Start Date	Medium	9/16/2019
3	Conduct a customer maintenance assessment	Completed - On Time	Medium	9/18/2019
4	Develop Projector evaluation method to include shock/vibration	Past Due	Medium	9/20/2019
5	Develop a test procedure to access the cleanability of filters	Not Started	Medium	11/29/2019

b. FMEA worksheet

Click the Worksheet tab at the bottom of the FMEA to open the worksheet view. This view allows you to type directly into the worksheet cells and tab through the analysis as you would in a spreadsheet application.

Properties		FMEA			
	Function	Potential Failure Mode	Potential Effect(s) of Failure	SEVi	Classification
1	Projector provides the 2X zoom capability throughout the life of the projector under all operating conditions as defined in the technical specification	Zoom capability is less than 2X	Unable to enlarge image to required specification. Image is too small for close-up projection. (7,-)	7	
2					
3		The image is distorted at the maximum zoom of 2X	Image is unclear, difficult to read printed words (7,-)	7	
4					
5		The zoom capability degrades over the life of the project	Unable to enlarge image to required specification. Image is too small for close-up projection. (7,-)	7	

Function 0 Attachments

Header Hierarchy **Worksheet** Filtered

To use the entire workspace for the worksheet view, choose **View > Workspace Layout > Hide System Panel**.



To return to a split workspace, choose **View > Workspace Layout > Split Panels**.

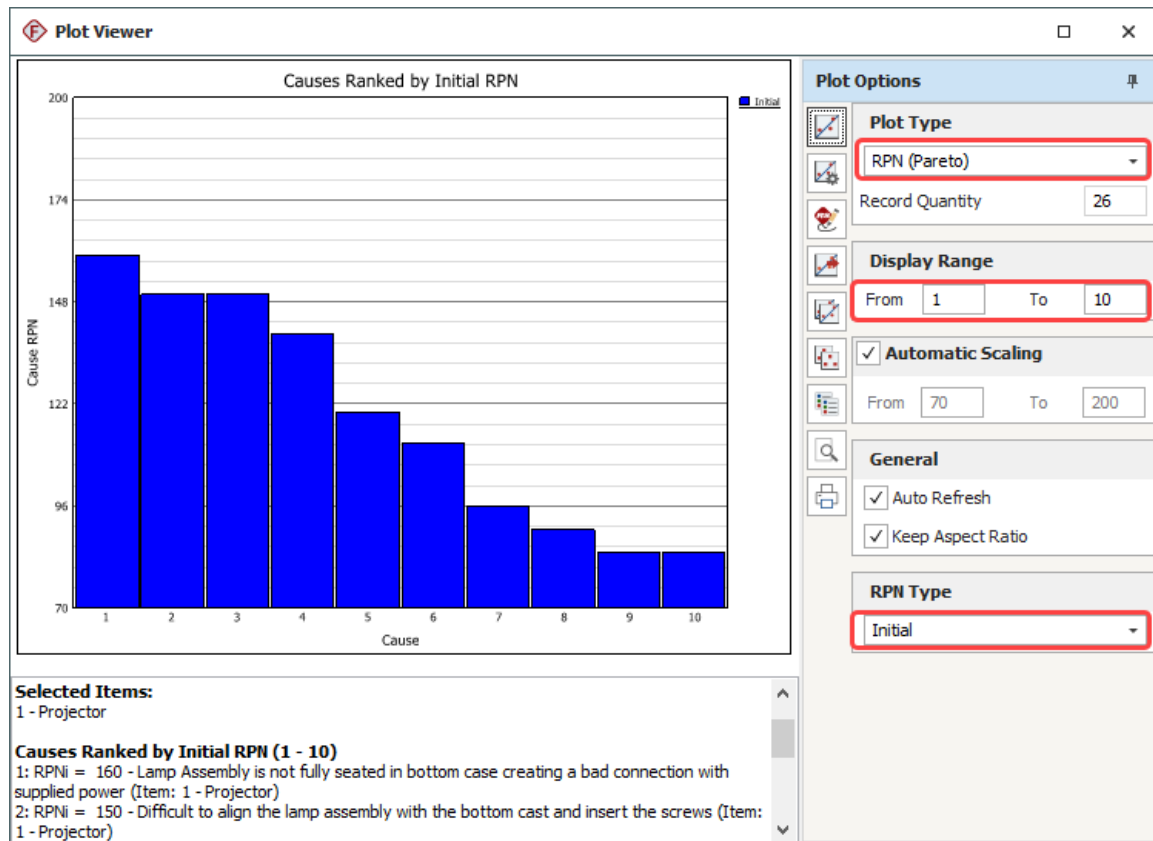


8. Create plots

Choose **Home > Reporting > Plots**.



Select the item(s) that you want to include in the plot. Then use the control panel to select the plot type and other settings.



9. Run a query


Choose **Home > Reporting > Queries**.



First use the left panel to specify the data source (selected projects throughout the database or selected items within the current project). Then use the right panel to specify the query criteria and output preferences.

Select the type of record you wish to query

Query

FMEA Causes  ☐ Show Project ☒ Show Priority Colors

Criteria Headers Customization Results

Match the criteria from: ☒ All rows ☐ Any row

Property Name	Include in Results	Criterion 1	And/Or	Criterion 2
Initial RPN	<input checked="" type="checkbox"/>	is greater than or equal to 100	AND	is less than or equal to
Revised RPN	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
% Reduction in Cause RPN	<input type="checkbox"/>			
Initial SxO	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
Initial SOD	<input type="checkbox"/>			
URD (Cause)	<input type="checkbox"/>	Contains	OR	Contains
Reliability model (Cause)	<input type="checkbox"/>			
Target Reliability (Cause)	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
Current Reliability (Cause)	<input type="checkbox"/>			
Probability of Failure (Cause)	<input type="checkbox"/>			
Has Actions	<input type="checkbox"/>	is	AND	is
Has Controls	<input type="checkbox"/>	is	AND	is
Created By	<input type="checkbox"/>	is	OR	is
Date Created	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
Last Updated By	<input type="checkbox"/>	is	OR	is
Last Updated	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
Effects Properties	<input type="checkbox"/>			
Effect ID	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
Effect #	<input type="checkbox"/>	is greater than or equal to	AND	is less than or equal to
Potential Effect(s) of Failure	<input type="checkbox"/>	Contains	OR	Contains
Name (Effect)	<input type="checkbox"/>	Contains	OR	Contains
Keywords (Effect)	<input type="checkbox"/>	Contains	OR	Contains
Initial Severity	<input checked="" type="checkbox"/>	is greater than or equal to 8 - Loss of Primary Function	AND	is less than or equal to

Select which columns to display in the results

Specify criteria to limit the query results

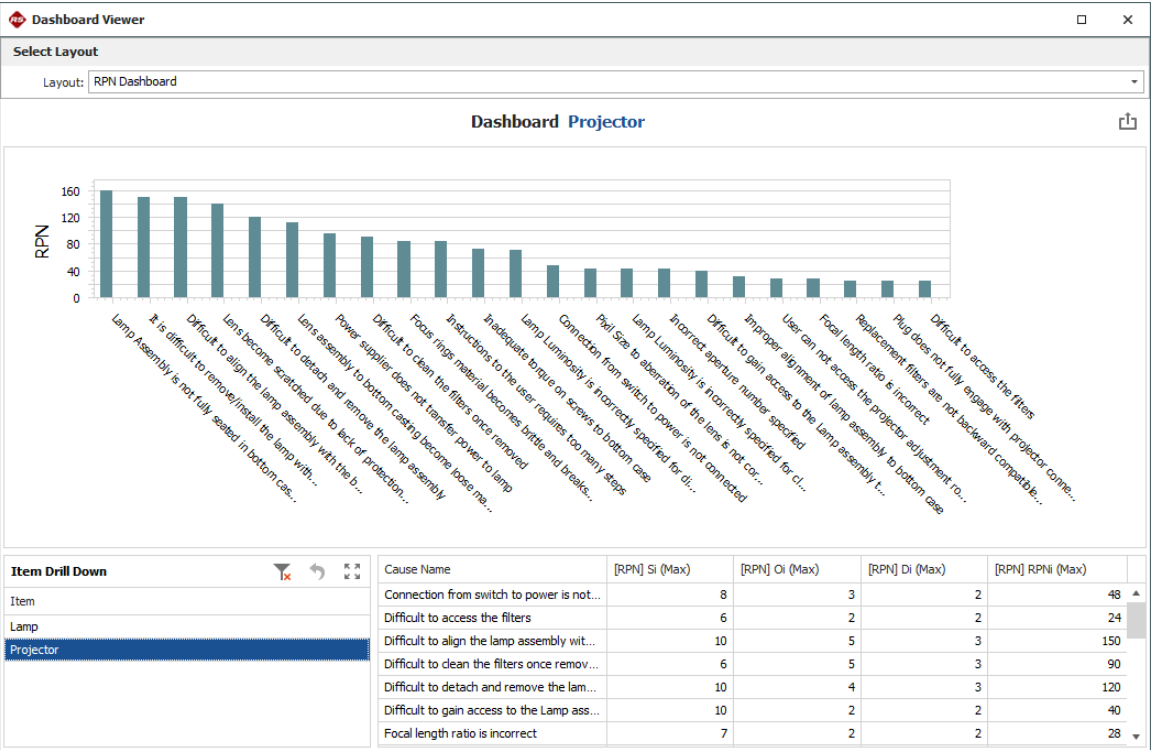
Click **Run Query** to view the records that match the criteria.

10. View a dashboard

Choose **Home > Reporting > Dashboard > Dashboard Viewer**.



In the **Layout** drop-down list, select one of the layouts that have been predefined for FMEA data and then use the dashboard to view the desired information. For example, in the RPN Dashboard you can click an item in the **Item Drill Down** panel to select which item's data will be displayed in the other 2 panels.

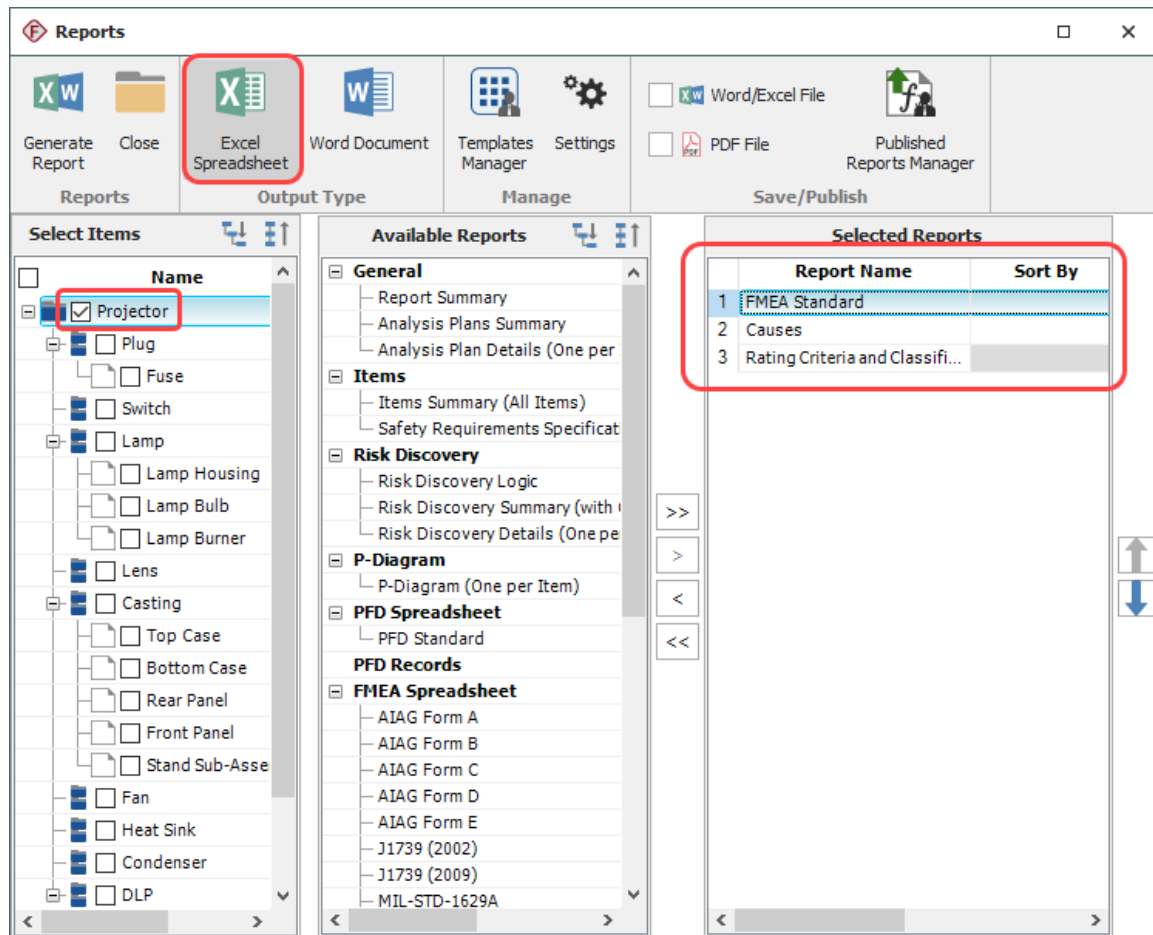


11. Generate a report

Choose **Home > Reporting > Reports.**



Select the items that you want to create a report for, the report forms you want to include in the generated report and the desired output type (Excel or Word).



Click **Generate Report** to create the report.

Using RCMs

Reliability Centered Maintenance (RCM) analysis provides a structured framework for analyzing the functions and potential failures for a physical asset in order to develop a scheduled maintenance plan that will provide an acceptable level of operability, with an acceptable level of risk, in an efficient and cost effective manner.

The basic steps for performing RCM analysis are:

1. Create the project and set project properties

Choose **Project > Management > Create Project**.

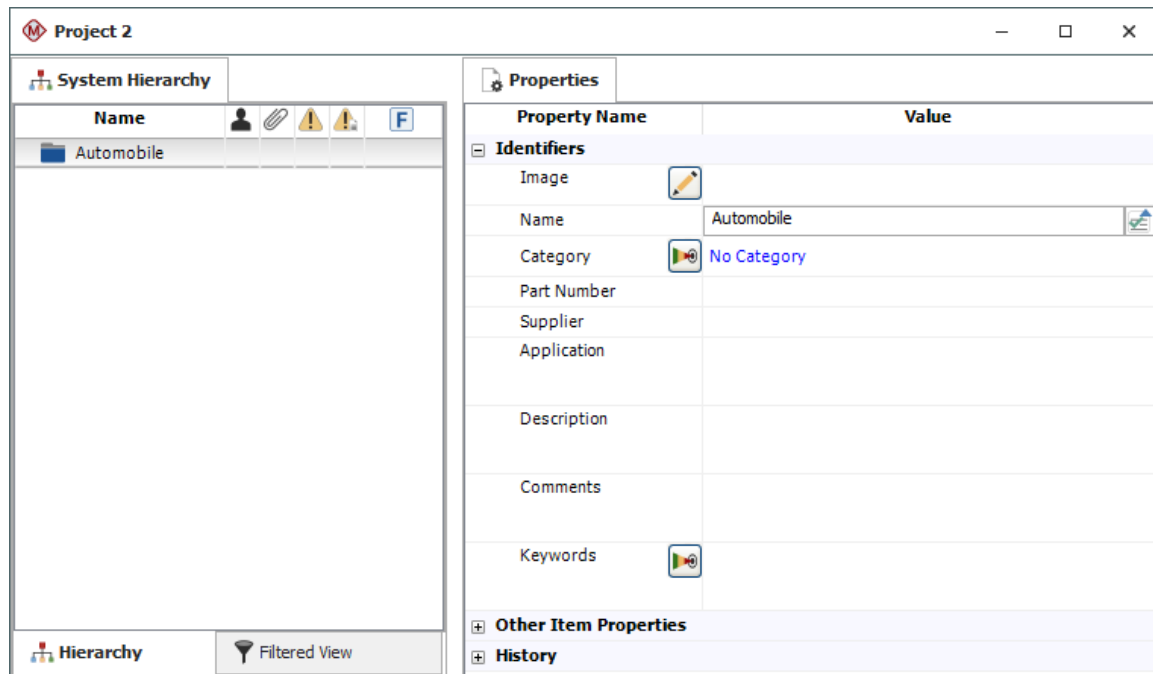


In the Project Properties window, specify the **FMEA Structure** and the **Profile** that will be used to set the configurable settings.

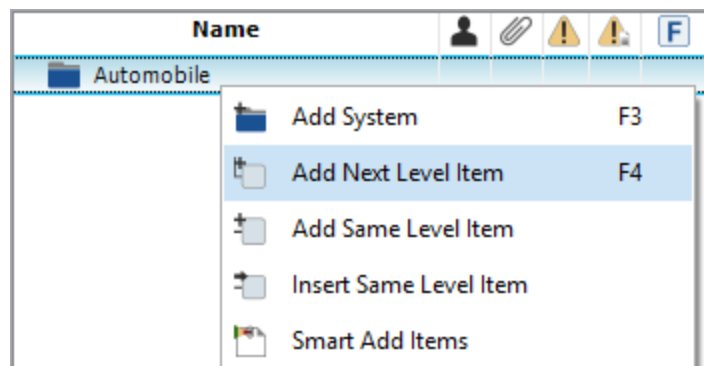
FMEA Structure	Select Profile from Library
Effects Before Causes	Standard RCM

2. Add items in the system hierarchy

The first item is added to the system hierarchy when you create the project. Use the Properties tab in the Analysis panel to rename it and set other properties.

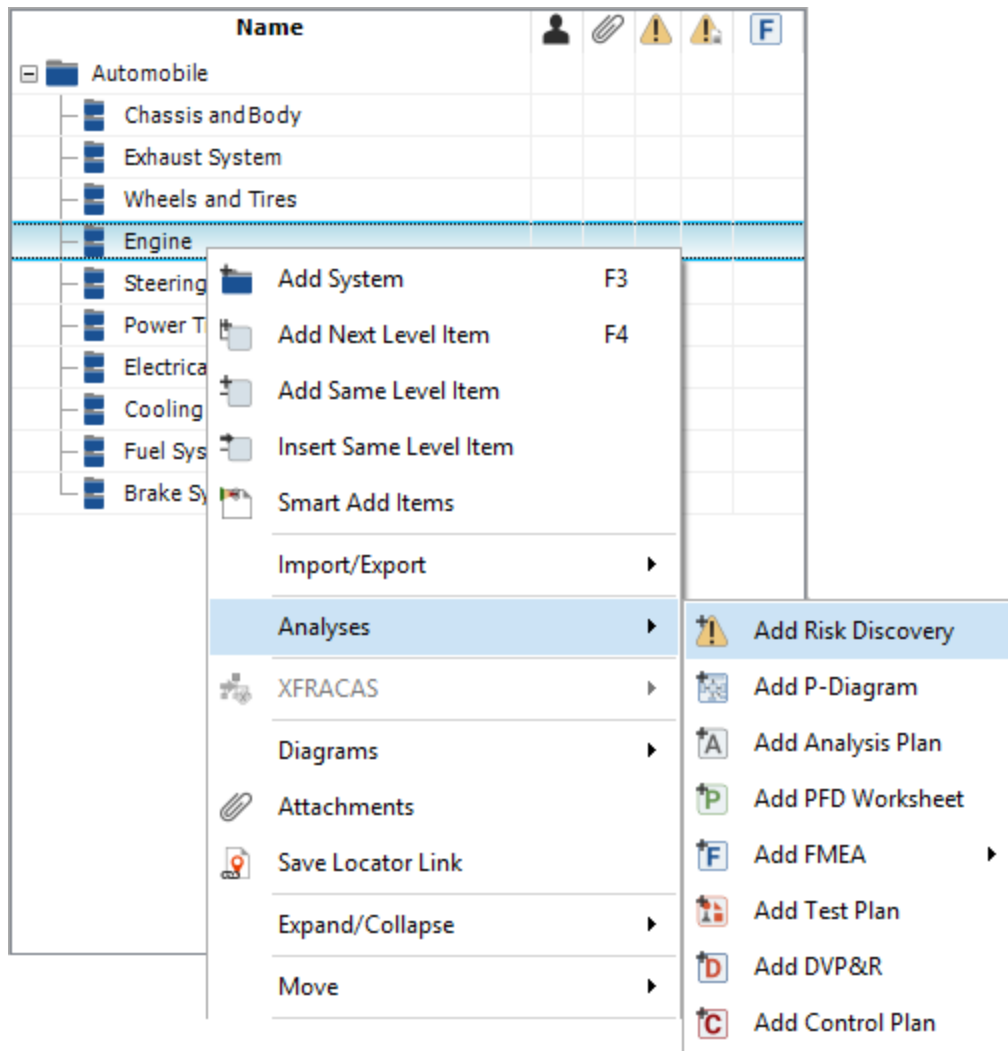


To add items, right-click inside the system hierarchy and choose **Add System**, **Add Next Level Item**, etc.



3. Perform equipment selection

For each system hierarchy item that you want to perform equipment selection for, right-click the item and choose **Analyses > Add Risk Discovery**.



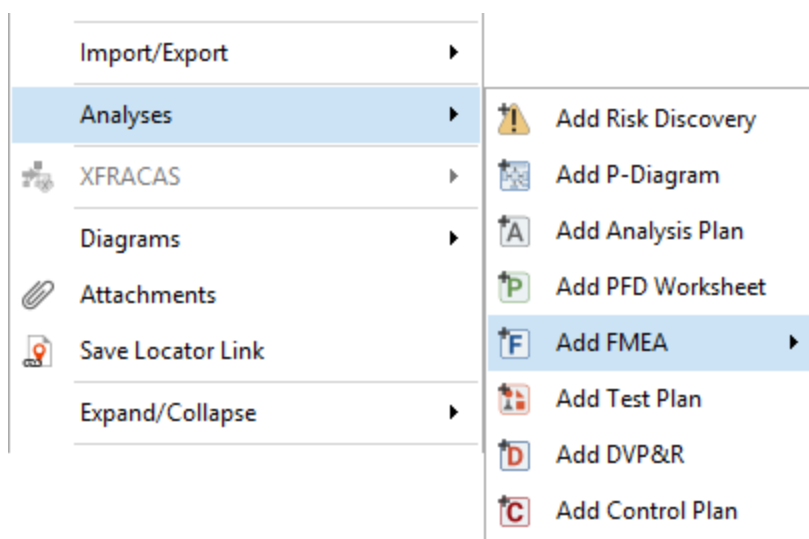
Depending on the configurable settings for the project, this can be a list of yes/no questions or a set of rating scales.

Properties		Risk Discovery	
Label	Question	Response	Comments
Safety	Could failure affect safety or have other hazardous consequences?	Yes	
Detectability	Could failure be undetectable or not likely to be detected during normal operation?	No	
Operational	Could failure have significant operational impact?	Yes	
Economic	Could failure have significant economic impact?	Yes	

☒ Mark item for more detailed analysis

4. Add a new functional failure analysis

Right-click the system hierarchy item that you want to create a functional failure analysis for and choose **Analyses > Add FMEA**.



5. Add functional failure analysis records

When you add the analysis, the Function window will automatically open. Enter the details and click either **Add Function** (to add the next function description), **Add Failure** (to add the first functional failure for this function) or **OK** (to close the window).

Add Function

Home

Add Function
 Add Failure
 Add Effect
 Add Cause

Configurable Settings
 Spelling
 Attachments
 Change Log

Function

Function: To use internal combustion to rotate the crankshaft and camshaft, thereby providing power to the vehicle.

Name: *

Keywords:

Associated Records

Item
Engine

History

Function

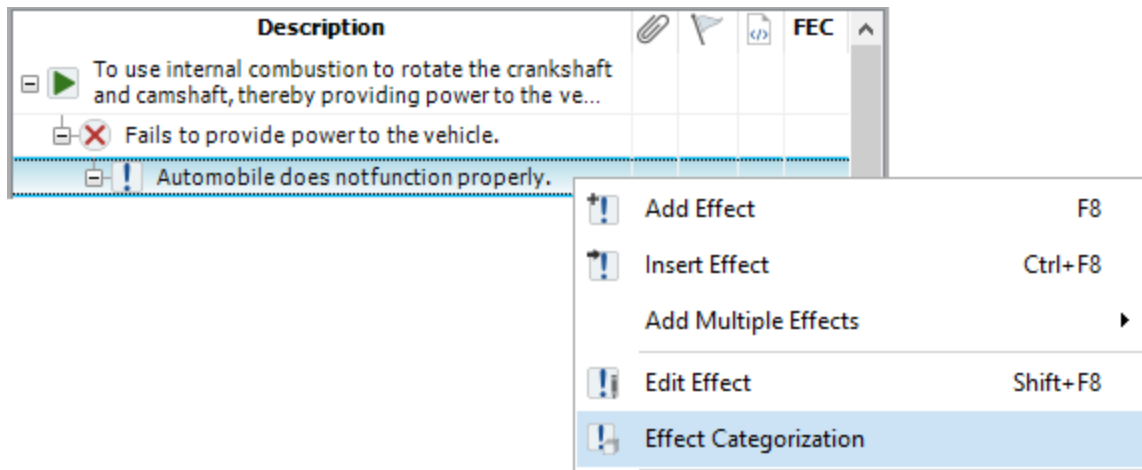
OK Cancel

Creating new function

Continue adding analysis records as needed. Note that RCM failure modes are described using the cause record type.

6. Perform failure effect categorization

Right-click an effect in the functional failure analysis and choose **Effect Categorization**.



The questions and categories depend on the configurable settings for the project.

The 'Failure Effect Categorization' dialog box is shown. It contains a series of questions and a set of category buttons. The questions are:

- Question 1:** Is the occurrence of a functional failure evident to the operator during the performance of normal duties? (Radio buttons: Yes, No)
- Question 2:** Does the functional failure or secondary damage resulting from the functional failure have a direct adverse effect on operating safety or other hazardous results? (Radio buttons: Yes, No)
- Question 3:** Does the hidden functional failure or secondary damage resulting from the functional failure have a direct adverse effect on operating safety or other hazardous results? (Radio buttons: Yes, No)
- Question 4:** Does the functional failure have a direct adverse effect on operating capability? (Radio buttons: Yes, No)
- Question 5:** Does the hidden functional failure have a direct adverse effect on operating capability? (Radio buttons: Yes, No)

Below the questions are six category buttons:

- ES Evident Safety
- EO Evident Operational (highlighted in green)
- EE Evident Economic
- HS Hidden Safety
- HO Hidden Operational
- HE Hidden Economic

On the right side of the dialog, there are input fields for 'Answer 1' through 'Answer 5', a 'Remarks' field, and a 'Category' dropdown menu (currently set to 'EO - Evident Operational'). At the bottom right are 'OK' and 'Cancel' buttons. The status bar at the bottom left says 'Performing Failure Effect Categorization'.

7. Perform maintenance task selection and add a task

Right-click a failure mode (cause) and choose **Task Manager**.

Description					FEC
	To use internal combustion to rotate the crankshaft and camshaft, thereby providing power to the ve...				
	Fails to provide power to the vehicle.				
	Automobile does notfunction properly.				E0
	Engine oil is depleted or dirty; oil filter is dirty.				
	Engine air filter is damaged.				
	Problem with spark plugs.				
	Problem with engine valve clearance.				
	Problem with the timing belt.				

Add Cause F9
 Insert Cause Ctrl+F9
Add Multiple Causes ▶
 Edit Cause Shift+F9
 Task Manager

In the Task Manager, answer the questions by clicking inside the Yes/No column. These questions may or may not be dependent on the failure effect categorization, depending on the task selection logic defined for the project.

Task Manager
□ ×

Add Task
 Add Existing Tasks
 Edit Task
 Delete Task

Edit URD
 Edit Model
 Edit Corrective Task

Effect Categorization
 Simulate

Tasks

Related Records

Tools

FEC: EO - Evident Operational

Question	Yes/No	Explanation
1: Is a scheduled service task (such as lubrication) applicable and effective?	No	
2: Is a scheduled on-condition inspection task applicable and effective?	No	
3: Is a scheduled repair/replacement task applicable and effective?	Yes	
4: Is an up-front one-time task (such as re-design) applicable and effective?	No	

Run to Failure:

Cost per Operating Time (\$/hr)

Availability

Tasks				
Name	Type	Operating Cost	Cost per Operating Time (\$/hr)	Availability

OK

Cancel

Task Manager

To add a task, click **Add Task**.



- Specify the task name and task type, then indicate when the task is to be performed.

Maintenance Task

Task Name
Change oil and check oil filter

Task Type
Service (S)

Task Properties

- Task Scheduling**
 - When is this task performed? Fixed time frame based on calendar time
 - Fixed interval 3
 - Unit Month (mon)
 - ☐ Override task scheduling properties with a task package
- Basic Task Properties**
- Task Consequences**
- Restoration**
- Additional Costs to Consider**
- RCM**

OK Cancel

Creating new scheduled task

- Continue to specify task properties as needed. The configurable fields for traditional RCM are entered under the **RCM** node.

Maintenance Task

Task Name

Change oil and check oil filter

Task Type

Service (S)

Task Properties

Task Scheduling

Basic Task Properties

Task Consequences

Restoration

Additional Costs to Consider

RCM

Status

Proposed Interval

Reference Document

Condition

Zone

Access

Recommended

3 (mon)

OK

Cancel

Creating new scheduled task

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More Analyses and Tools

Analysis Plans

Analysis Plans allow you to keep track of team members, ground rules, estimated completion dates, scheduled work sessions and other details that will help you to plan and manage your FMEA and RCM projects.

1 - Projector: Analysis Plan

Name
Projector

Description

In Progress
Planned Start Date: 11/28/2019
Actual Start Date: 9/24/2019
Due Date: 2/2/2020
Completion Date:

Team | **Analysis Checklist** | **Ground Rules and Assumptions** | **Conditions of Use** | **Work Sessions** | **Quality Survey**

Ground Rules and Assumptions

Assume that parts are made to print
Assume that parts are properly assembled
Assumptions about how the Projector will age:
- Buttons on the user interface become harder to press
- Computer connection loosens
- Dust builds up inside projector
- Plastics become brittle as they age
Assumptions about use conditions:
- Extended use - up to 12 hours
- May be suspended from the ceiling

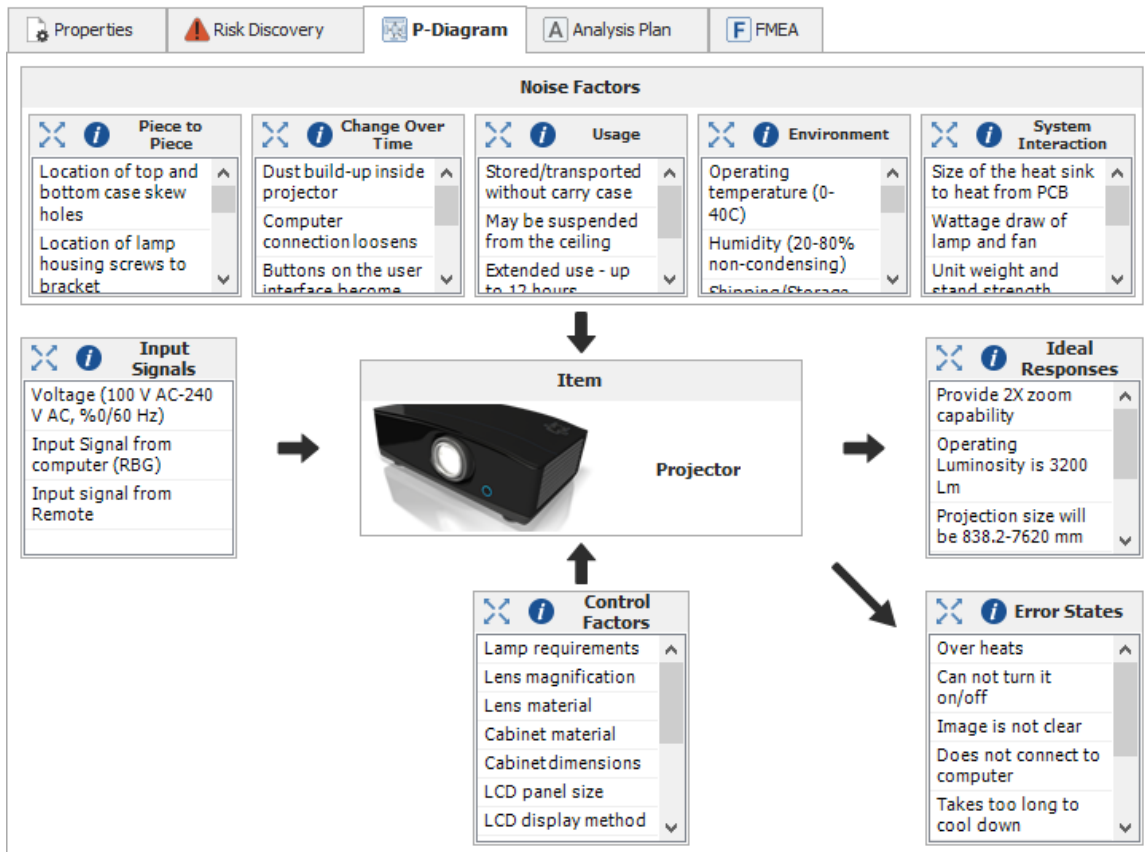
Delete Row | Insert Row | Move Up | Move Down | Select Existing Text

Reset Assumptions from Library:
Save Assumptions in Library

Last Update Date: 9/27/2019 1:55 PM User: User Name

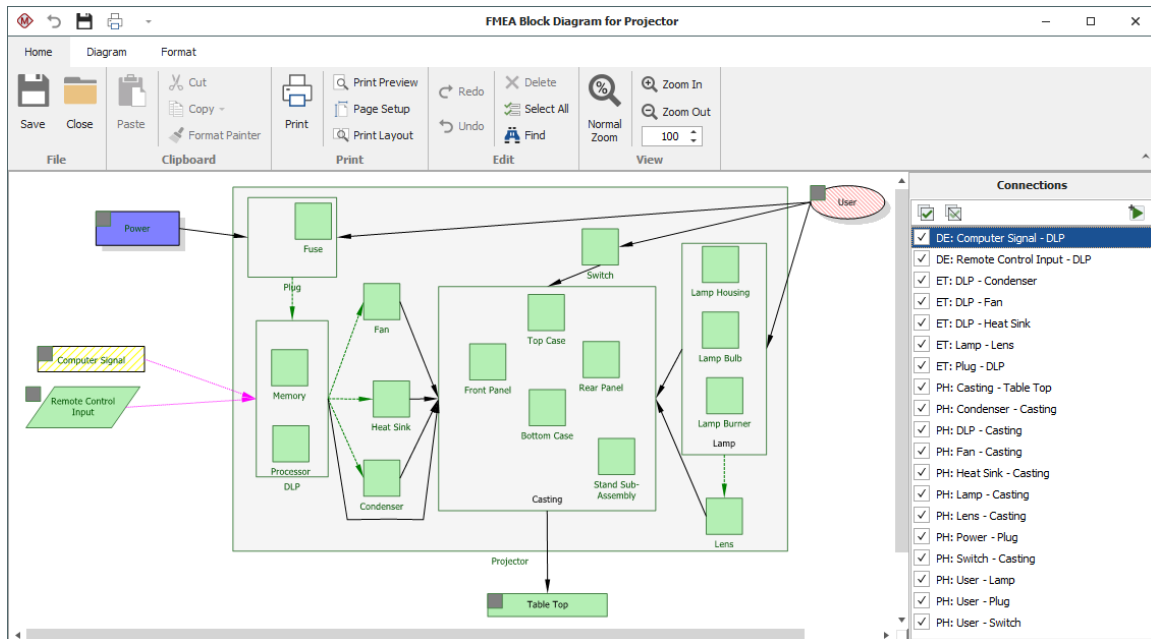
Parameter Diagrams (P-Diagrams)

A Parameter Diagram (P-Diagram) is a structured tool that identifies the inputs from a system and relates those inputs to the desired system outputs, while considering the controlled and uncontrolled factors.



FMEA Block Diagrams

An FMEA Block Diagram visually depicts the system assembly that will be analyzed in a Design FMEA. These diagrams help to define the scope of a particular analysis project and also may provide additional information that will be useful to the analysis team when they attempt to identify potential failure modes.



PFD Worksheets

A PFD worksheet records detailed information, including process characteristics (inputs) and product characteristics (outputs), for each step of the manufacturing or assembly process. The complete PFD worksheet provides a structure for preparing process FMEAs (PFMEAs) and control plans.

Properties		PFD Worksheet						
Op Seq Number	Operation Description	Operation Type	Symbol	Changeover	Class	Significant Product Characteristics (Outputs)	Class	Significant Process Characteristics (Inputs)
1.1.1	Front Door L.H. - Hang Process							
1.1.1.1	Remove door assembly from conveyor using fixture xyz & move to vehicle body	Move	○	P,T				
1.1.1.2	Align hinge attachment holes on door to body & finger start 4 bolts	Fab	◇					
1.1.1.3	Secure alignment fixture to opening & remove transfer fixture	Move	○	P,T				
1.1.1.4	Bring automatic bolt driver to assembly and drive 4 bolts	Fab	◇	T	C	Clamp load between hinge strap and hinge pillar	C	Bolt torque (4)
1.1.1.5	Remove bolt driver when cycle is complete	Move	○					
Header				Worksheet				

Control Plans

Control plans are used to track critical characteristics that must be kept in control during a manufacturing or assembly process, and record the methods for maintaining control.

<div> <div>Properties</div> <div>F FMEA</div> <div>C Control Plan</div> </div>												
Part/ Process Number	Process Name/Operation Description	Machine, Device, Jig, Tools for Mfg	No.	Product	Process	Special Char. Class	Specification/ Tolerance	Evaluation/ Measurement Technique	Sample Size	Sample Frequency	Control Method	Reaction Plan
1	Op 70: Manual application of wax inside door. Cover inner door, lower surfaces with wax to specification thickness.	Wax Sprayer AB12345	1	Wax thickness.	Manually inserted spray head not inserted far enough.	S	Wax thickness must be between X and Y.	Instrument XY12345	10	per Hour	Variables check for film thickness.	Check the insertion of the spray head and re-apply wax to affected units.
							Wax must cover the entire surface of the door panel.	Visual	10	per Hour	Visual check for coverage.	Check the insertion of the spray head and re-apply wax to affected units.
			2		Spray head clogged because viscosity is too high, temperature is too low or pressure is too low.	S	Viscosity must be AA to BB. Temperature must be CC to DD. Pressure must be EE to FF.	Instrument PQ12345		At start-up and after idle periods.	Test spray pattern at start-up and after idle periods.	Spray head maintenance.
			3		Spray head deformed due to impact.	S	Full inspection and cleaning of the spray head.			Monthly	Preventive maintenance program to maintain heads.	
			4		Spray time insufficient.	S	Wax must cover the following critical areas: XXX, YYY and ZZZ.	Visual	10	per Hour	Lot sampling and visual check for coverage of critical areas.	Remind the operator of the appropriate spray time and re-apply wax to affected units.
Header						Worksheet						

Test Plans

A test plan displays a list of actions that describe specific tests that need to be performed.

<div> <div>Properties</div> <div>F FMEA</div> <div>T Test Plan</div> <div>D DVP&R</div> </div>						
<input checked="" type="radio"/> Selected item only <input type="radio"/> Selected item and dependents						
#	Recommended Action(s)	Planned Start Date	Planned Completion Date	Actual Start Date	Actual Completion Date	Specification/Methodology
1	Design of Experiments (DOE) on wax thickness	9/13/2019	9/17/2019	9/13/2019	9/16/2019	Two Level Factorial DOE
2	Laboratory accelerated corrosion test	9/24/2019	9/24/2019			ALT Corrosion Test #AB123
3	Team evaluation using design aid buck and spray head	10/1/2019	10/1/2019			

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