



# **Aras Innovator 12**

## **Variant Management**

### **Sample Application**

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# Document Conventions

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The following table highlights the document conventions used in the document:

Table 1: Document Conventions

Convention	Description
<b>Bold</b>	This shows the names of menu items, dialog boxes, dialog box elements, and commands. Example: Click <b>OK</b> .
Code	Code examples appear in <code>courier</code> font. It may represent text you type or data you read.
Yellow highlight	Code highlighted in yellow draws attention to the code that is being indicated in the content.
Yellow highlight with red text	Red text highlighted in yellow indicates the code parameter that needs to be changed or replaced.
<i>Italics</i>	Reference to other documents.
<b>Note:</b>	Notes contain additional useful information.
<b>Warning</b>	Warnings contain important information. Pay special attention to information highlighted this way.
Successive menu choices	Successive menu choices may appear with a greater than sign (--) between the items that you will select consecutively. Example: Navigate to <b>File --&gt; Save --&gt; OK</b> .

# 1 Overview

---

The Variant Management Sample Application is developed to demonstrate how product variability can be managed, how variability can be applied to product breakdown structures and how these configurable 150% breakdown structures are resolved when a set of options are selected. This sample application uses Aras Innovator Configurator Services APIs and UI Controls to manage product variability.

In this sample application, the variability definition structure is separated from the breakdown structures. This allows for a more robust, scalable and re-usable model where the same variability definition (i.e. features, options, rules) can be applied to more than one breakdown structure.

The Variant Management Sample Application is an Aras Community project. It is not a standard product and should not be deployed to production as-is.

Sample data is provided along with this sample application. Loading the sample data is optional. The purpose of the sample data is to help in following this documentation and provide ideas on how variability definition and breakdown structures can be organized and connected to each other.

## 1.1 Terminology

The following table defines the terms, acronyms, and abbreviations used in this document.

Table 2: Terminology

Term	Definition
Dictionary	Generic term that refers to Features and Options that are used in defining product variability.
Feature	A characteristic of a product, such as Size or Color.
Option	A discrete choice for a product characteristic, such as X-Small, Small, Medium, Large, X-Large choices for the Size feature.
Option Combination	A specific combination of Options associated with multiple Features.
Rule	An item that specifies which Options from various Features can or cannot go together.
Variability Item	An item containing a set of Features and Rules within a specific scope, in addition to all Features and Rules from within its structure. For example, a Frame Assembly Variability Item contains a Frame Variability Item within its structure, therefore the Frame Assembly Variability Item contains both the Features and Rules of the Frame Variability Item as well as its own set of Features and Rules. The Frame Variability Item contains only its own set of Features and Rules.
Relevant Features	Features that are applicable to a given Variability Item, such as a Bicycle Size feature for a Bicycle Variability Item.
Variability Structure	A multilevel item containing the aggregate of all Features and Rules from within its structure.

Term	Definition
Variable Component	An item which is a variability point within a product. The Asset included in the resolved structure of the product will change based on the usage condition.
Assets	All kinds of data used to characterize a product, such as Parts and Documents.
Usage Condition	The condition for which an Asset is valid to be used in a Variable Component. For example, for Shifter used in Bicycle, Part SHF-5876 is valid if Speed is 11-Speed and Handlebar Type is Drop Bar.
Breakdown Item	A single item representing a node in the product breakdown structure. It can have both fixed/common and variable assets, as well as child breakdown items.
Fixed/Common Assets in Breakdown Item	An item, such as Part or Document, which is directly added as the Content of a Breakdown Item and is constant and common across all configurations of the product.
Variable Assets in Breakdown Item	An item, such as Part or Document, which is indirectly added as the Content of a Breakdown Item and may vary across configurations of the product based on usage conditions.
Breakdown Structure	A multi-level structure of Breakdown Items, similar to Part BOM.
Breakdown Structure Resolution	Dynamically configuring a 150% breakdown structure to a 100% (or 120%) structure by providing a set of options. The resolved structure includes breakdown items, all fixed/common assets and only the variable assets with usage conditions that meet the selected options.

## **2 Description of the Sample Application**

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The Variant Management Sample Application demonstrates how product variability can be defined, how breakdown structures driven by modular architecture concepts can be managed with their fixed/common and variable contents, and how these configurable breakdown structures can be resolved to a specific configuration by selecting options from the list of features that are relevant to the breakdown structure. The sample application enables you to:

1. Define Features and Options for the variability dictionary.
2. Manage variability items that contain relevant features and rules for a specific scope of the product. For example, the “Frame” variability item contains the set of features and rules for bicycle Frame’s variability.
3. Manage variability structures that aggregate features and rules. For example, the “Frame Assembly” variability item aggregates features and rules from Frame, Fork, Stem and Rear Shocks. Subsequently, the “Bicycle” variability item aggregates features and rules from the Frame Assembly, Wheel System, and Transmission, variability items.
4. Help validate the accuracy of the variability definition.
5. Check if the selected options are valid based on variability definition.
6. For an invalid option combination, find the rule(s) that invalidate that combination.
7. Manage configurable, multi-level 150% breakdown structures.
8. Manage fixed assets, such as Parts and Documents, in the breakdown structure that are common to all configurations irrespective of selected options.
9. Provide variability points in the breakdown structure where the assets to be used, such as Parts and Documents, depend on the selected options.
10. Manage variable components with their assets and corresponding usage conditions. Usage conditions identify when an asset is valid for use in a configuration.
11. Resolve a 150% breakdown structure to a 100% configured structure by selecting an option for each feature relevant to the structure. It returns breakdown items, fixed/common assets, and variable assets that match selected options.
12. Partially resolve a 150% breakdown structure by selecting options from some, but not all, features relevant to the structure.

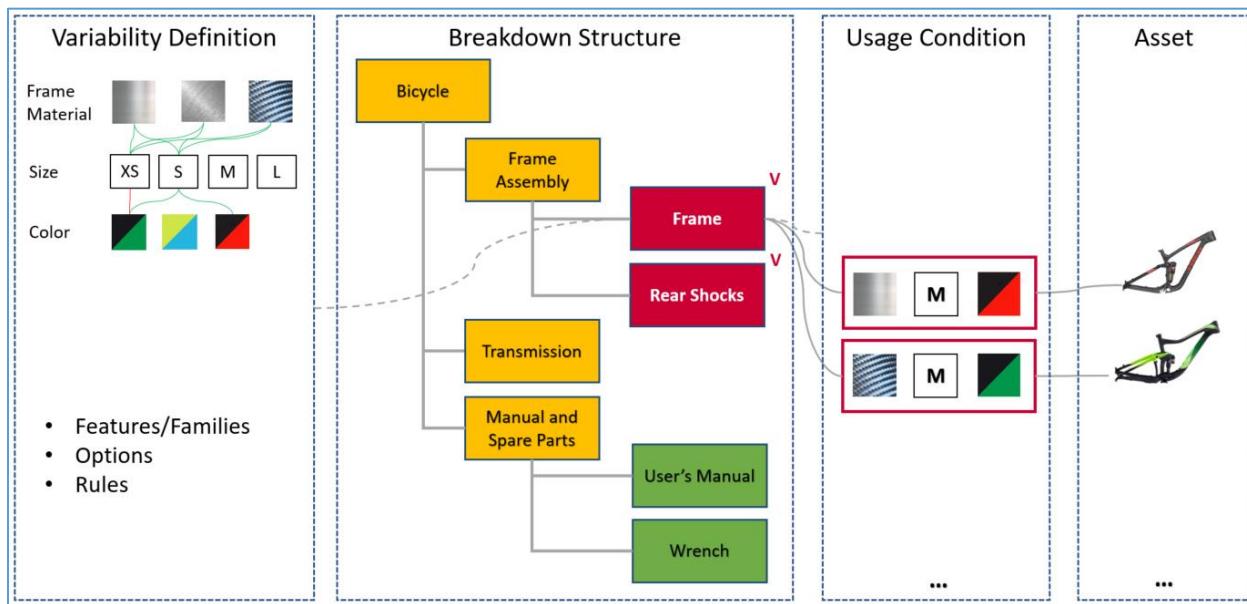


Figure 1.

Figure 1 shows that the Variability Definition is managed independently of the Breakdown Structure. The variability is then applied to the Breakdown Structure at its variability points. The yellow boxes depict Breakdown Items. The red boxes are the Variable Components that have a number of Assets with their usage conditions. The green boxes depict fixed Assets that are common across all configurations.

## 2.1 Feature Highlights

The following features are included in this version of the Variant Management Sample Application:

- **Text Rule Editor**

Used for managing rules for a particular Variability definition scope. The Text Rule Editor uses Features and Options within the specified scope and provides guidance for creating rules. It supports IF, AND, OR, NOT, THEN, EQUAL, EXACTLY-ONE, AT-MOST-ONE, AT-LEAST-ONE Boolean expression nodes.

- **Table Rule Editor**

Used for managing rules within a particular Variability definition scope. The Table Rule Editor uses Features and Options within the scope. It displays the rules in a table showing primary and secondary constraint Features.

- **Usage Condition Expression Editor**

Used for managing Usage conditions of Assets on Variable Components. The Usage Expression Editor uses Features and Options that are within a particular Variability definition scope and provides guidance for creating usage conditions. It supports AND, OR, NOT Boolean expression nodes.

- **Variant Tree**

Displays the valid configurations for a Variability definition in a Tree view.

- **Selecting Options to Resolve a Structure**

Displays a list of Features used in a specific scope. You can select Options from the list for each Feature. Invalid Options appear in red.

- **Validate Option Selections**

Checks to see if the selected Options are valid based on the Rules.

- **Get Reasons for Invalid Option Selections**

Displays a UI representation of Rule(s) that are the cause of invalid option combinations.

- **Resolve Structure**

Resolves the breakdown structure based on the selected Options. The resolution includes the breakdown structure, fixed and variable Assets whose usage conditions meet the criteria, i.e. selected options.

## 2.2 Sample Data

The sample application installation package also includes optional sample data. The sample data includes features, options, rules, variability items and structures, breakdown items and structures with fixed assets and variable components, that are referenced in this documentation. Refer to the sample application installation instructions for the steps to load the optional sample data.

## 3 Dictionary for Product Variability

The consistency and re-use of variability across the entire product life cycle with its different disciplines and product stages is maximized by managing variability in a common place. One of the fundamental steps in managing variability is to define the variability Dictionary.

The Variability Dictionary consists of Features and Options. A Feature is a characteristic, for example Bicycle Type or Bicycle Size. An option is a choice associated with Features. For example, Road Bicycle, Mountain Bicycle and Fat Bicycle are options for the Bicycle Type feature.

### 3.1 Creating a Feature

Use the following procedure:

1. Select **Variant Management → Dictionary**. The following menu appears:

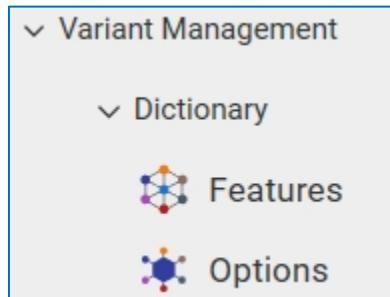


Figure 2.

2. Click **Features**. The following menu appears:

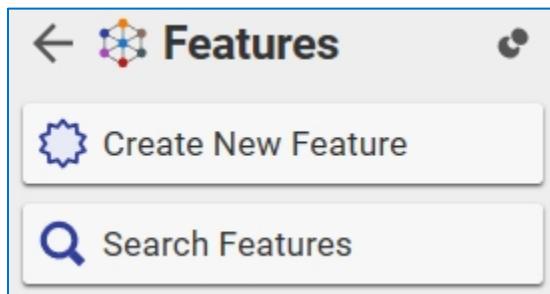


Figure 3.

3. Click **Create New Feature**.

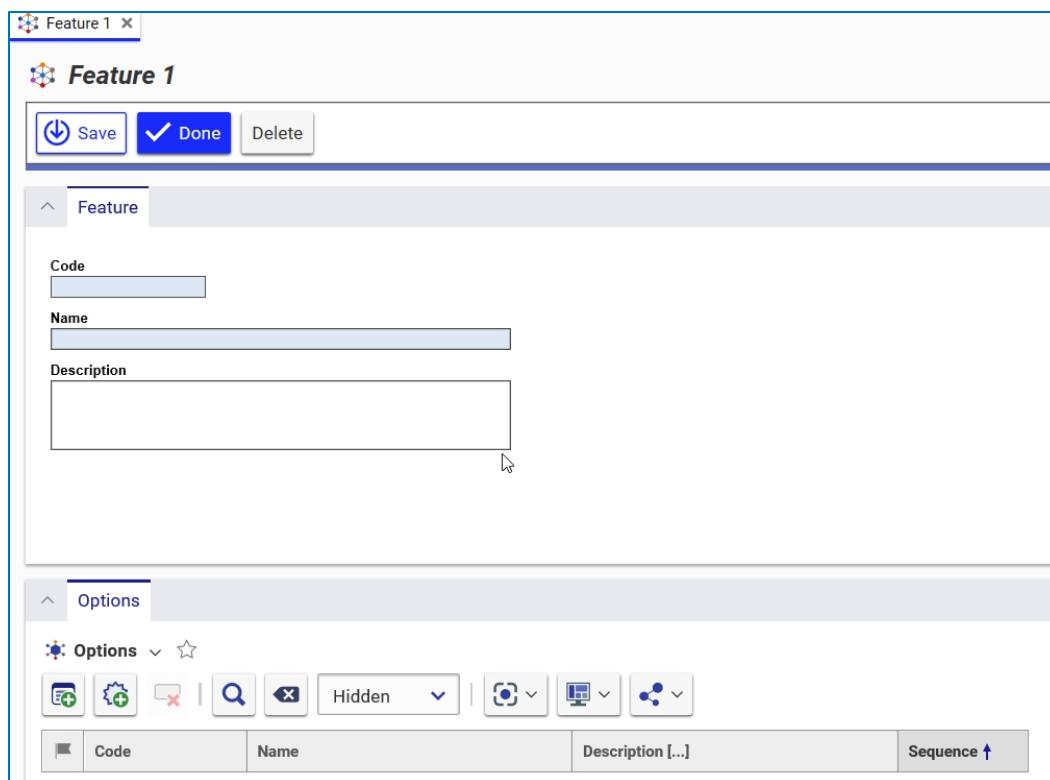


Figure 4.

4. Enter the Feature Code and Name in the appropriate fields. The Description field is optional.



5. Click the **Add Options** button to add existing Options to the Feature.



6. Click the **New Option** button to create an option to add to the Feature.



7. Update **Sequence** to arrange the sub-level Variability items in the desired display order.

8. Click **Done** to save and unclaim the item. The following screenshot shows the Bicycle Size Feature and its Options.

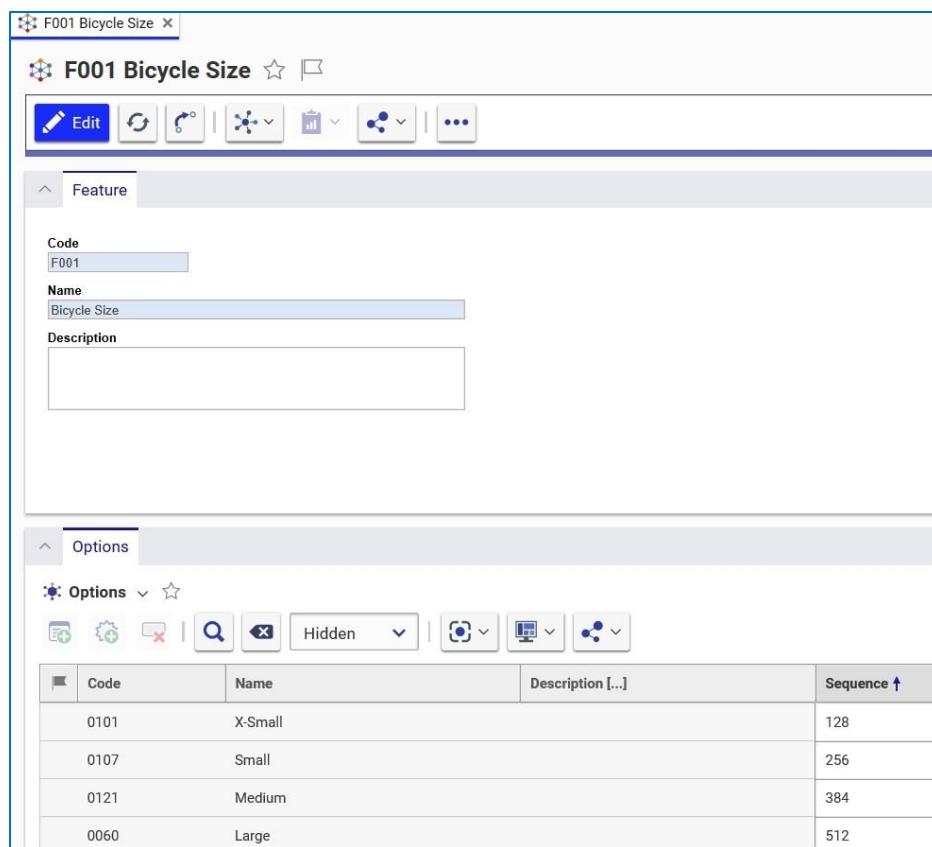


Figure 5.

## 3.2 Creating an Option

There are three ways to create options:

- Open a Feature and click the **New Option** button  on the Options tab.
- Select **Variant Management → Dictionary → Options**.
- Click the **New Option** icon  on the Options toolbar.

Use the following procedure:

1. Enter the Option Code and Name in the appropriate fields. The Description field is optional.

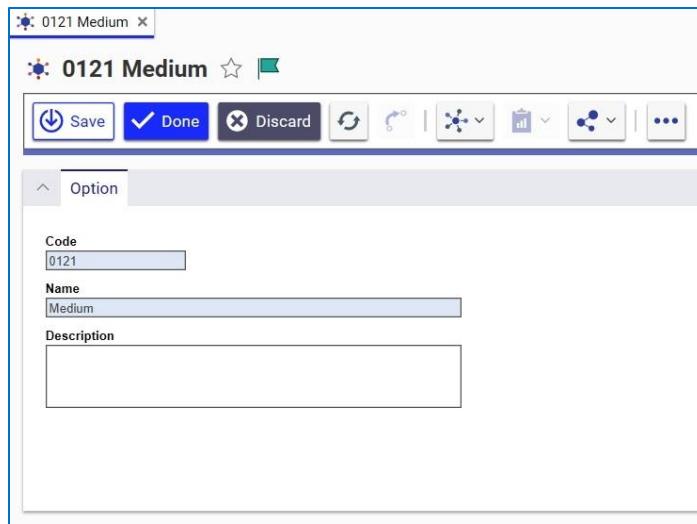


Figure 6.

2. Click **Done** to save and unclaim the item.

### 3.2.1 Adding Options to Features

A Feature can have one or more Options, an Option can be used in one or more Features. To add Options to Features, use the following procedure:

1. Select **Variant Management** → **Features** → **Search Features**. The Features search grid appears.
2. Click **Search** in the Search grid to run a search for all Features.
3. Double-click the desired Feature. In the following example, we use the F015 Frame Material Feature. The Options listed on the Options tab are already related to the Feature.

	Code	Name	Description [...]	Sequence ↑
0085	Aluminum Alloy			128
0015	Carbon Fiber			256
0038	Stainless Steel			384

Figure 7.

4. Click **Edit** to claim the Feature.



5. Click the **New Option** icon to create a new option. Click the **Add Option** icon to add an existing option to the feature. The Select Items dialog appears:

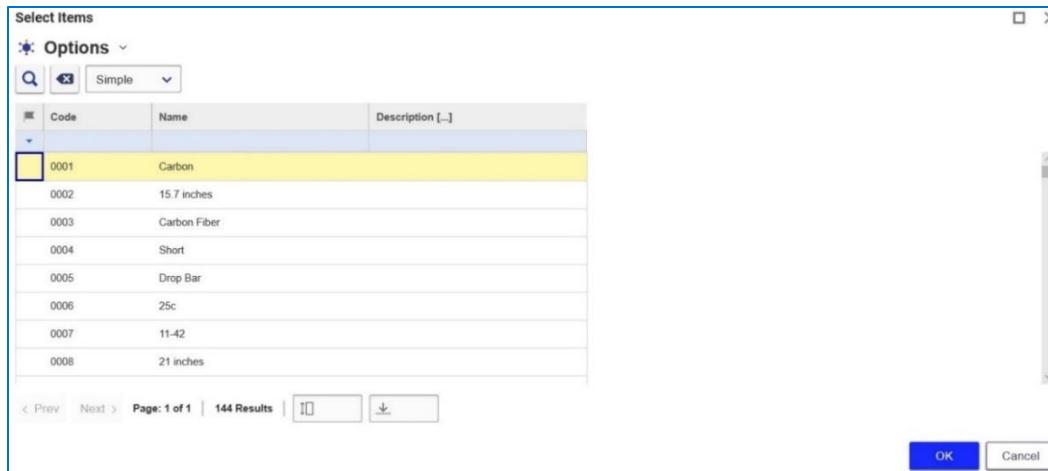


Figure 8.

6. Select the appropriate Options and click **OK**.

## 4 Variability Items

Variability Items in the Variant Management Sample Application are used to define product variability. They are associated with their relevant features, and contain rules that specify what options are allowed, and what option combinations across multiple features can go or cannot go together.

It is possible to have a multi-level structure of Variability Items to manage layers of variability. This approach allows for divide-and-conquer of the variability definition, depending on the complexity. For example, instead of putting all features and rules directly under Frame Assembly, it is possible to break the variability down to Stem, Fork, Frame and Rear Shocks, and then aggregate them at the Frame Assembly level.

### 4.1 Creating a Variability Item

Use the following procedure:

1. Select **Variant Management → Variability Items**. The Variability Items menu appears.

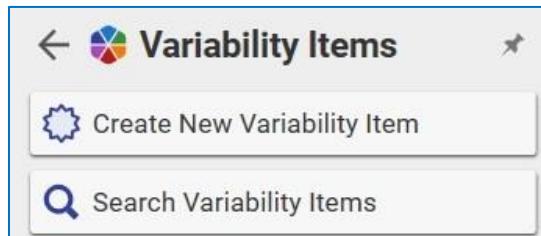


Figure 9.

2. Click **Create New Variability Item**. The following form appears.

Figure 10.

3. Enter a Code and a Name in the appropriate fields. The Description field is optional.
4. Add the appropriate sub-level variability items to the Variability Items tab by clicking either the **Add Variability Items** or the **New Variability Item** icons. In the following example, the main variability item is Bicycle.
5. Update **Sequence** to arrange the sub-level Variability items in the desired display order.

The screenshot shows the Aras Innovator Variant Management interface. At the top, there's a toolbar with various icons like Edit, Refresh, and Share. Below the toolbar, the main area displays the 'V012 Bicycle' item. On the left, there's a vertical sidebar with icons for Home, Variability Item, Variability Structure, and Relevant Features. The main content area has two tabs: 'Variability Item' and 'Variability Items'. The 'Variability Item' tab shows the item's code (V012), name (Bicycle), and an empty description field. The 'Variability Items' tab shows a list of sub-level variability items:

	Code	Name	Description [...]	Sequence ↑
	V024	Control		128
	V002	Seat Assembly		256
	V003	Wheel System		384
	V016	Transmission		512

Figure 11.

The variability items that appear on the Variability Items tab show the sub-level Variability Items associated with Bicycle.

6. Click to save your changes and unclaim the item.

#### 4.1.1 Description of Sidebar Icons

For Variability Items, the following icons are available in the sidebar.

Table 3: Icon Descriptions

Icon	Icon Name	Description
	Form of Variability Item	The form for the Variability Item. In the case of Variability Items with a structure, the child Variability Items are related under the “Variability Structure” tab.
	Table Rule Editor	View, create or modify Rules associated with the Variability Item using a Table view.
	Text Rule Editor	View, create or modify Rules associated with the Variability Item using a Text view with guided editing.
	Variant Tree	Displays valid Option combinations in a tree view for a Variability Item.
	Validation	Select and validate Option combinations, find Rules that disallow an Option combination, and validate the Variability Item scope.

## 4.2 Variability Structures

A Variability Item can have a multi-level Variability Structure. In this case, all relevant features and rules from the Variability Item and its structure are aggregated.

As an example, a leaf level variability item “Frame” contains the set of features and rules for a bicycle Frame’s variability. On the other hand, the “Frame Assembly” variability item aggregates features and rules from Frame, Fork, Stem and Rear Shocks. Subsequently, the “Bicycle” variability item aggregates features and rules from the Frame Assembly, Wheel System, and Transmission variability items. If you use the Table Rule Editor to add rules for “Bicycle”, you not only see features like Bicycle Size and Bicycle Type that are immediately relevant to Bicycle, but also Features related to other Variability Items in its structure, like Frame Size, Frame Material, and Frame Color.

The “Variability Structure” tab is a graphical representation of all the Variability Items, Features, and Options that are used in a scope such as a bicycle, as shown in the following example:

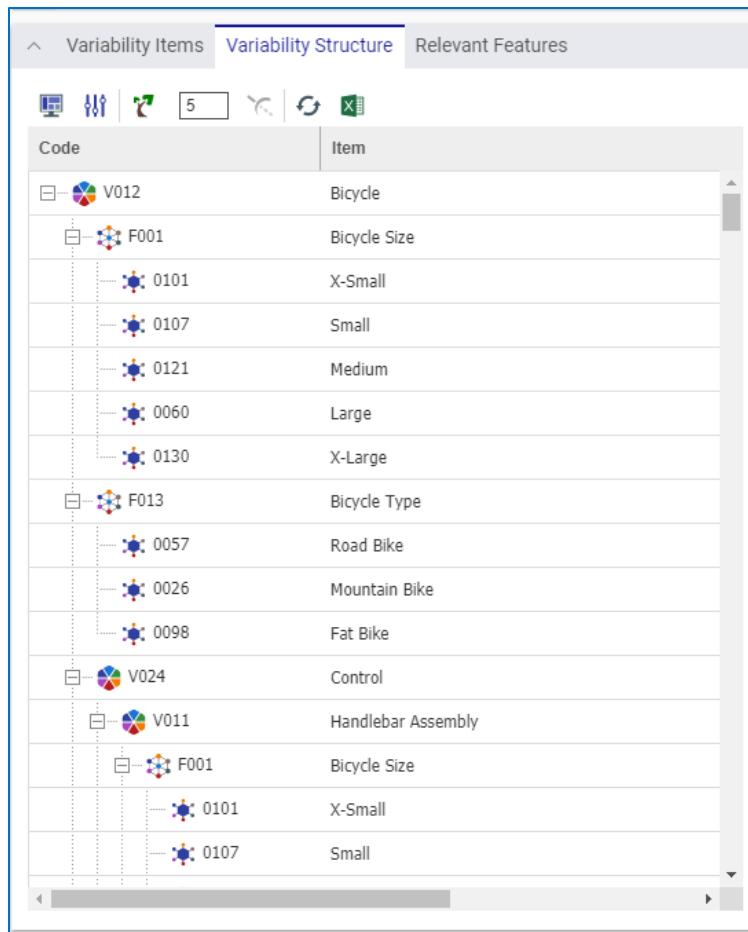


Figure 12.

The Variability Structure is a read-only view that displays relevant features and their options as well as the related Variability Items. All the relevant features associated with the related Variability are also displayed. This view can be expanded to any desired level. In Figure 12, 5 levels are expanded as specified in the toolbar.

1. If you only want to view the Variability Items in the Variability Structure, click the **Display Settings** icon . The Display Settings dialog appears.
2. Click on the **Toggle visibility** icon to turn off visibility for Features, as shown in the following figure:

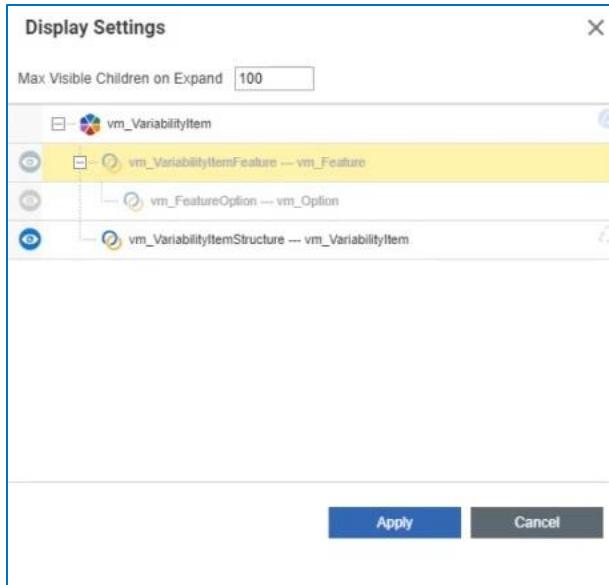


Figure 13.

3. Click **Apply**. Now the Variability Structure only displays the Variability Items. The Features and Options are hidden.

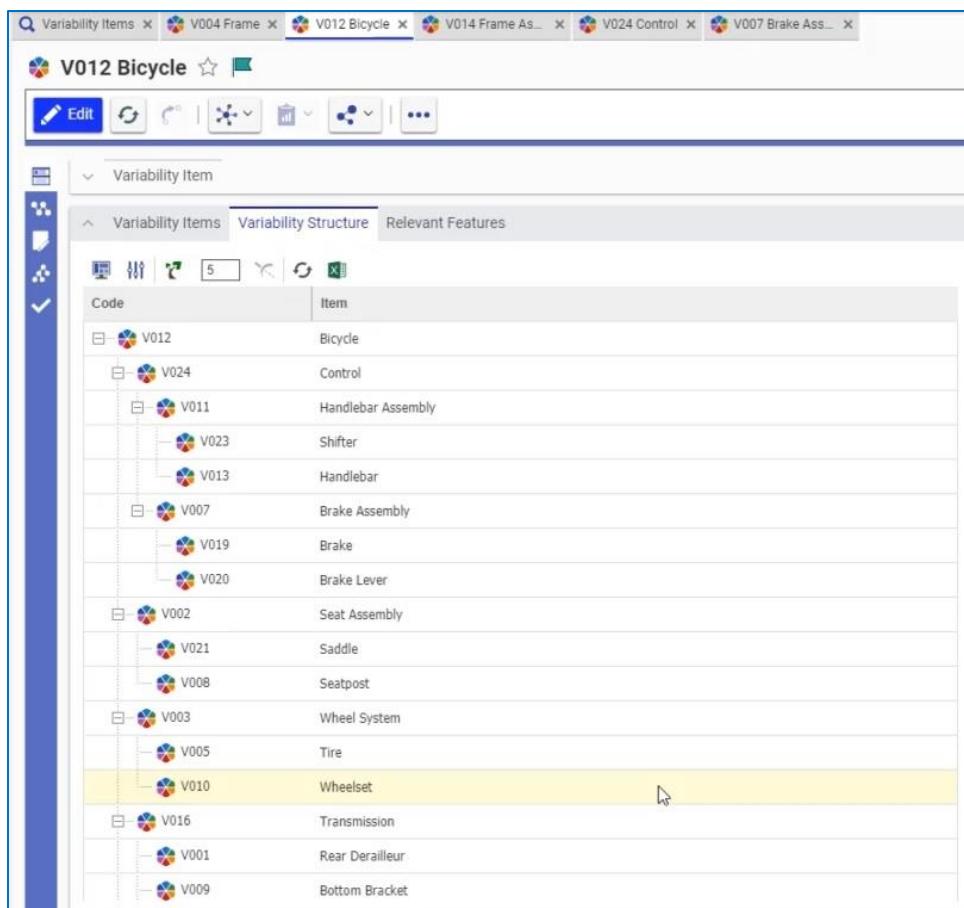


Figure 14.

## 4.3 Managing Rules on Variability Items

The Variability definition includes rules that specify which Options from the relevant Features are allowed or disallowed to go together. Use the Text Rule Editor and the Table Rule Editor to view and maintain (create, update, delete) Rules.

### 4.3.1 Using the Table Rule Editor

The Table Rule Editor provides a graphic interface to view and manage Rules.



1. Open a Variability item and click the Table Rule Editor icon in the sidebar.

The list of rules shown in the Table Rule Editor comes directly from the current Variability item, and not its structure.

The Features Tree shows relevant features from the current Variability Item as well as all Variability Items within its structure. This enables you to add rules which do not belong in lower levels.

For example, a rule that goes across Frame and Stem features can be managed one level up on the “Frame Assembly” Variability item. A rule that restricts a combination of Frame Size: 50 cm and Stem Length: 2 inches can be managed on Frame Assembly, and not on Frame or Stem.

2. Click on a Rule to see its rule expression:

The screenshot shows the Aras Innovator interface for managing rules. On the left, the 'Features Tree' pane displays a hierarchy of variability items: 'Bicycle Size' (X-Small, Small, Medium, Large, X-Large), 'Bicycle Type' (Road Bike, Mountain Bike, Fat Bike), and 'Frame Color' (Black/Yellow). The 'Medium' option under 'Bicycle Size' is selected and highlighted in yellow. On the right, the 'Rules List' pane shows several rule expressions. One rule is highlighted in blue, indicating it is the selected rule. The rule expression is:

```

IF [Bicycle Type] = [Road Bike] THEN [Frame Color] = Red OR [Frame Color] = Orange OR [Frame Color] =
IF [Bicycle Type] = [Road Bike] THEN [Frame Size] = 40cm OR [Frame Size] = [46.5cm] OR [Frame Size] =
IF [Bicycle Type] = [Fat Bike] THEN [Frame Size] = [17 inches] OR [Frame Size] = [19 inches] OR [Frame Size] =
IF [Bicycle Type] = [Fat Bike] THEN [Frame Color] = Red OR [Frame Color] = [Black/Yellow] OR [Frame Color] =
IF [Bicycle Type] = [Road Bike] THEN [Frame Material] = [Aluminum Alloy] OR [Frame Material] = [Carbon Fiber]
IF [Bicycle Type] = [Mountain Bike] THEN [Frame Color] = [Glossy Black] OR [Frame Color] = [Black/Yellow]
IF [Bicycle Type] = [Mountain Bike] THEN [Frame Material] = [Aluminum Alloy]
  
```

Figure 15.

3. Select Principal Groups and Constrained Groups to view the Rules in a table format.

The letter “I” in the table means that the intersecting option combination is included, i.e.

allowed. The letter “E” means the intersecting option combination is excluded, i.e. disallowed. The selected rule in the Rules List is highlighted in the table.

It is possible to right-click on a rule in the Rules List and select **Build Table on Rules** from the context menu.

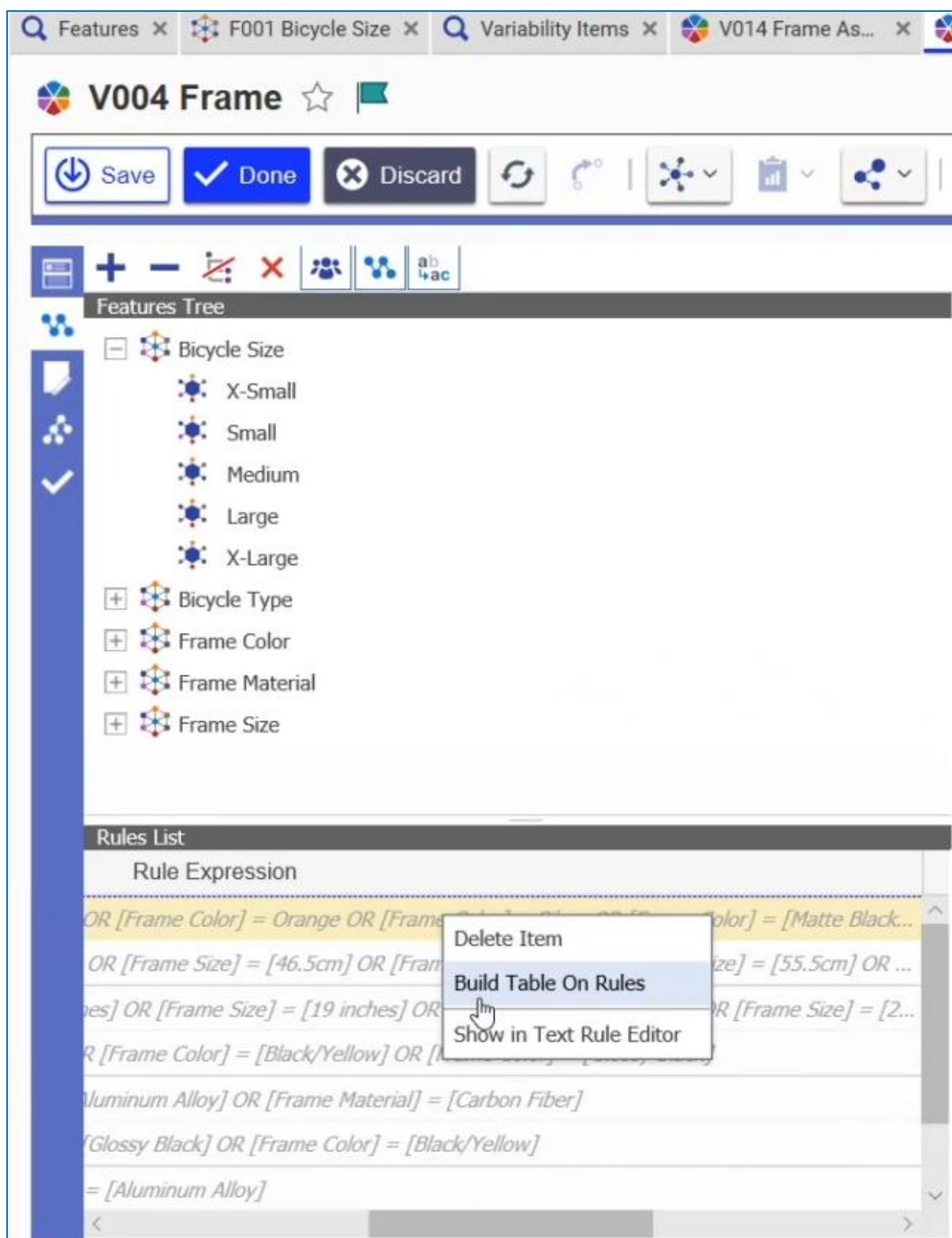


Figure 16.

The Table Rule Editor displays the Features and Options used in the rule which was used to initiate the **Build Table on Rules** action:

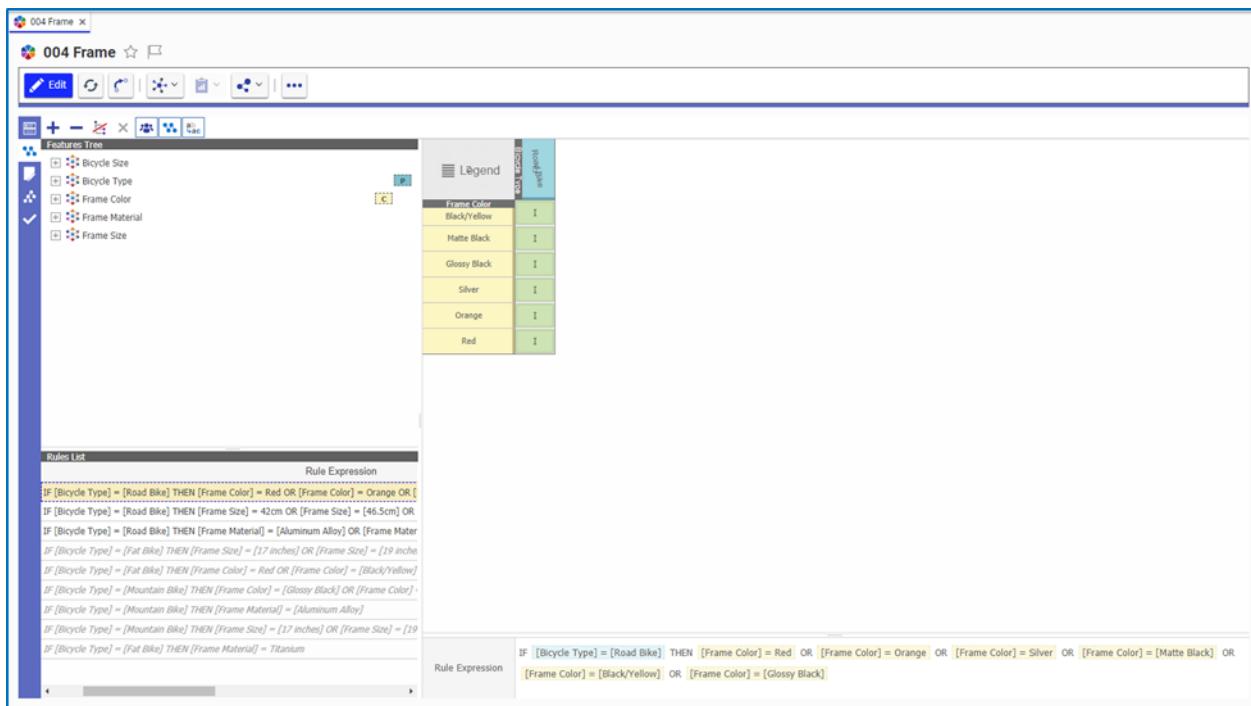


Figure 17.

4. To create a new Rule, select on the Variability Item form. The Features tree displays the features and options. Choose the necessary features and options as the Principle Group (for the Condition part of the rule) and another set of Features and options as the Constraint Group (for the consequence part of the rule). In the table, select from Include or Exclude choices to create the Rules.
5. Click to save and unclaim the item.

In the following figure, if "I" (Include) is selected for the Mountain Bike and Aluminum Alloy intersection on the table, the following rule is constructed:

IF [Bicycle Type] = [Mountain Bike] THEN [Frame Material] = [Aluminum Alloy]

Instead of "I", if "E" (Exclude) is selected, the following rule is constructed:

IF [Bicycle Type] = [Mountain Bike] THEN NOT [Frame Material] = [Stainless Steel]

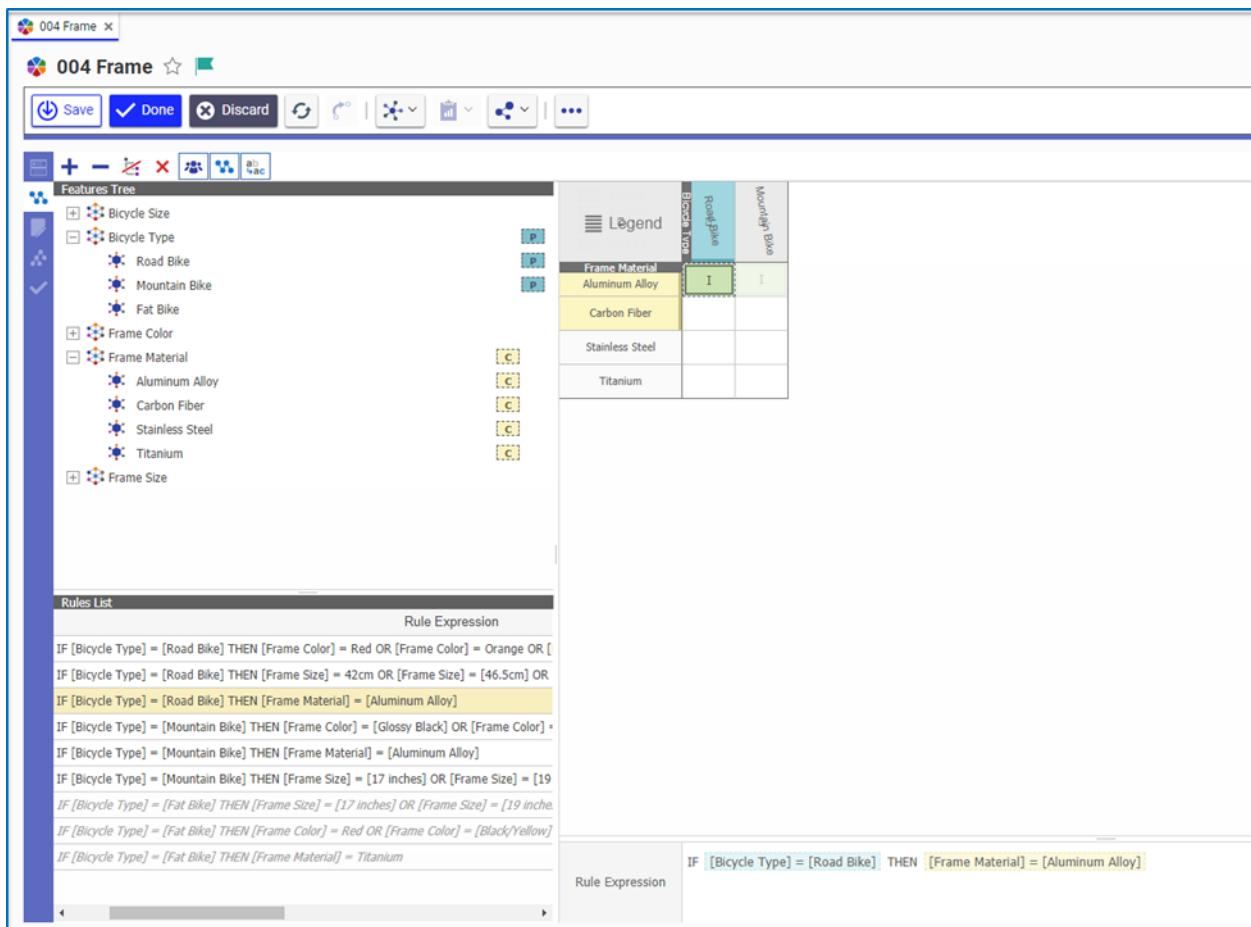


Figure 18.

#### 4.3.2 Using the Text Rule Editor

The Text Rule Editor shows existing rules in text within a grid. When creating or editing a rule, it provides guided editing.

Use the following procedure:

1. Click  to open a Variability item and click the Text Rule Editor  icon in the sidebar. A list of existing rules related directly to the current Variability Item appears in the grid. When you select a rule in the grid the rule definition appears in the expression editor.

Code	Rule Expression	Description
00000004	IF [Bicycle Type] = [Road Bike] AND [Bicycle Size] = Medium THEN [Frame Size] = 50cm	Road Bike Medium Frame
00000006	IF ([Bicycle Type] = [Mountain Bike] OR [Bicycle Type] = [Fat Bike]) AND [Bicycle Size] = [X-Large] THEN [Frame Size] = [23 inches]	Mtn/Fat Bike X-Large Frame
00000007	IF [Bicycle Type] = [Road Bike] THEN [Frame Color] = Red OR [Frame Color] = Orange OR [Frame Color] = Silver OR [Frame Color] = [Matte Black...]	Road Bike Frame Colors
00000010	IF [Bicycle Type] = [Road Bike] AND [Bicycle Size] = Small THEN [Frame Size] = [46.5cm]	Road Bike Small Frame
00000011	IF [Bicycle Type] = [Road Bike] THEN [Frame Size] = 42cm OR [Frame Size] = [46.5cm] OR [Frame Size] = 50cm OR [Frame Size] = [55.5cm] OR ...	Road Bike Frame Sizes
00000017	IF [Bicycle Type] = [Road Bike] AND [Bicycle Size] = [X-Small] THEN [Frame Size] = 42cm	Road Bike X-Small Frame
00000019	IF ([Bicycle Type] = [Mountain Bike] OR [Bicycle Type] = [Fat Bike]) AND [Bicycle Size] = Small THEN [Frame Size] = [17 inches]	Mtn/Fat Bike Small Frame
00000023	IF [Bicycle Type] = [Fat Bike] THEN [Frame Size] = [17 inches] OR [Frame Size] = [19 inches] OR [Frame Size] = [21 inches] OR [Frame Size] = [2...]	Fat Bike Frame Sizes

Figure 19.

2. Highlight the section of the rule that you want to change and update it.
3. Click the icon to save your changes. Click the Delete icon to reset your changes.
4. Click the View XML Expression icon to see the XML for the rule. Click the icon again to toggle back to the text.

```

<expression>
  - <IMPLICATION>
    - <CONDITION>
      - <AND>
        - <EQ>
          <variable id="53005649877549C0BAEC58960AA0FAF8"/>
          <named-constant id="6D433897A17E44408D6CE1AED0396EDF"/>
        - <EQ>
          <variable id="00C7C877F0E945EE817314F8712AA7E4"/>
          <named-constant id="E1CCB25E1E0F48FDA603A990A5038A5E"/>
        - </EQ>
      - </AND>
    - </CONDITION>
    - <CONSEQUENCE>
      - <EQ>
        <variable id="2348FEDB34DE42D3B7A70F17C0DBB36F"/>
        <named-constant id="2D4ADBD9709C467F8AD29CD359279FAB"/>
      - </EQ>
    - </CONSEQUENCE>
  - </IMPLICATION>
</expression>

```

Figure 20.

5. Click the **Create New** icon to create a new rule. A row is added to the rule list:

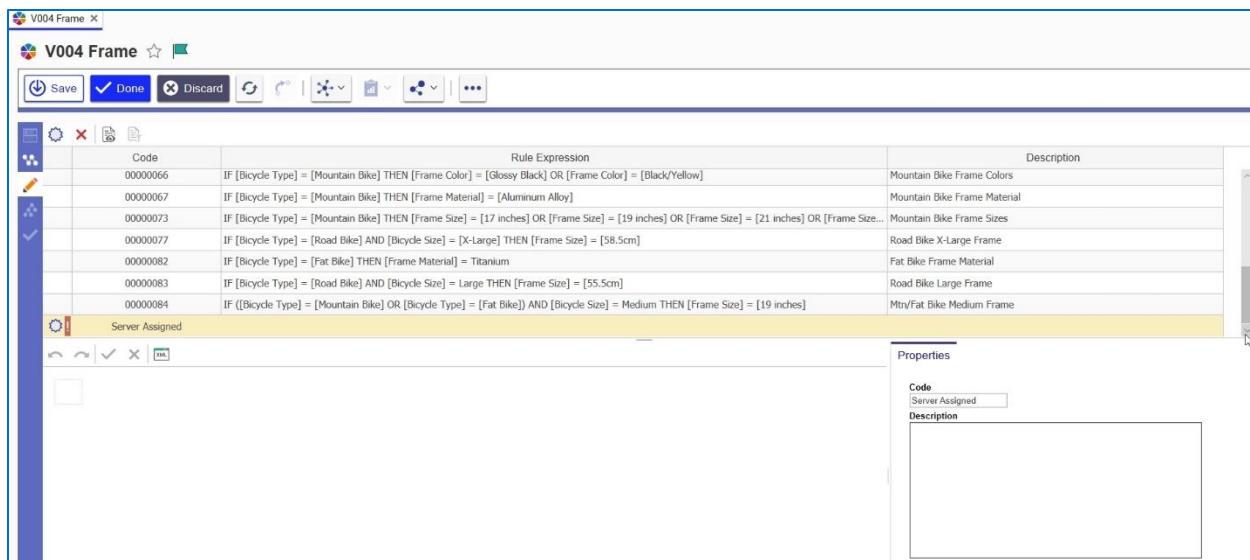


Figure 21.



- Enter the new rule and click **Done** to save and close the rule. When you create or edit a rule, the Rule Expression Editor suggests nodes and values. While editing a rule, the Rule Expression Editor suggests Boolean Expression nodes (e.g. IF, THEN, NOT), Feature and Option names. Suggested Features are relevant Features from the current Variability Item as well as all Variability Items within its structure. This makes it possible to add rules which do not belong to the lower levels. For example, a Rule that goes across Features from Frame and Stem will be managed on the Frame Assembly Variability Item. If the Frame Size 50 cm and Stem Length 2 inches combination is not allowed, this rule is managed on Frame Assembly, not on Frame or Stem.

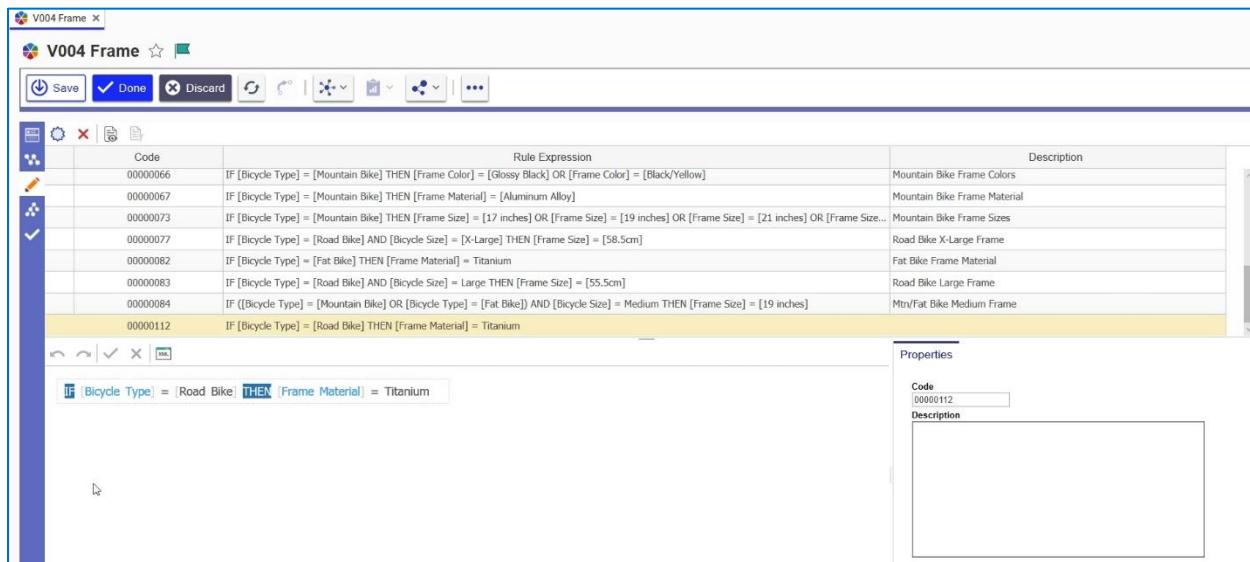


Figure 22.

- Click the icon on the Rules table to delete a rule.

8. Choose the Set Filter  icon to filter out rules by deselecting options in the Filter Settings dialog:

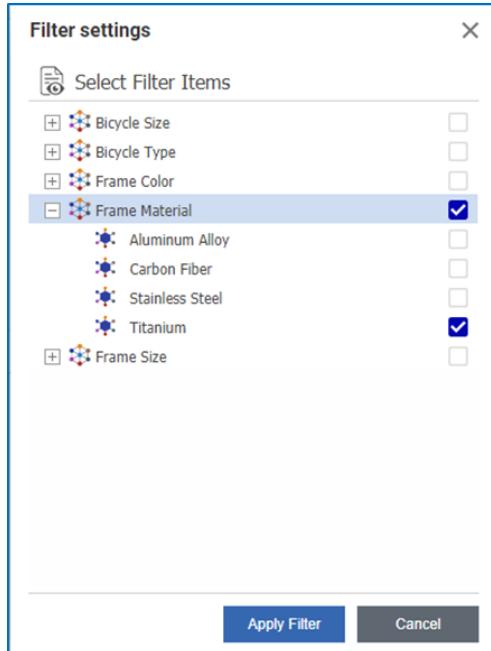


Figure 23.

9. Click **Apply Filter** to view a list of rules that contain the selected Features and Options on the Filter Settings dialog.

Code	Rule Expression	Description
00000082	IF [Bicycle Type] = [Fat Bike] THEN [Frame Material] = Titanium	Fat Bike Frame Material

Figure 24.

10. Click the Clear Filter  icon to go back to the unfiltered, complete list of rules.

## 4.4 Variant Tree

The Variant Tree displays valid Option combinations in a tree view. Use the following procedure to view the Variant Tree:

1. Select a Variability Item. This can be a Variability Item with a Variable structure or a leaf level Variability Item.
2. Click the Variant Tree icon  in the sidebar. The **Variant Tree Settings** dialog box appears. It displays the Features and Options available for the current Variability Item and its structure. Select/Unselect desired Features and Options. You can also right-click on an item in the dialog box and select either **Select All** or **Unselect All** from the context menu. Change the display order of the Features using the **Up** and **Down** buttons.

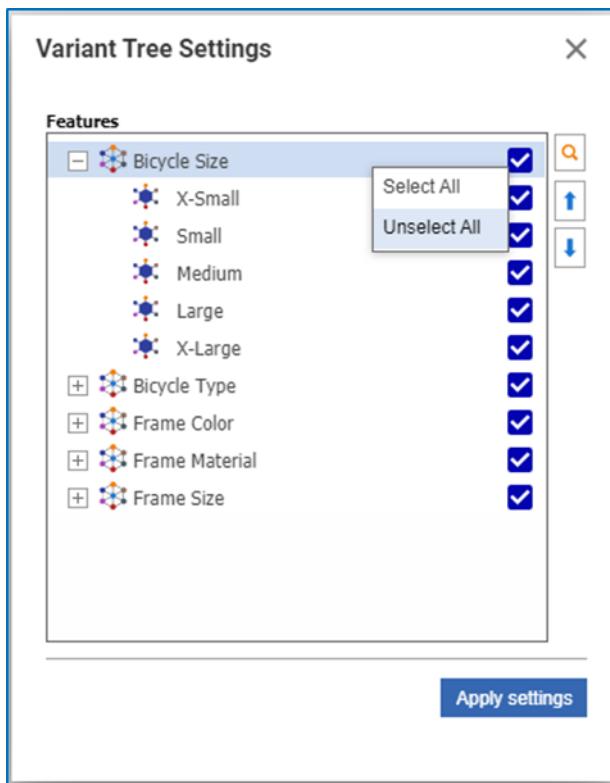


Figure 25.

3. Click **Apply Settings**. The Variant Tree and the number of valid combination counts are displayed based on the selections in **Variant Tree Settings**.

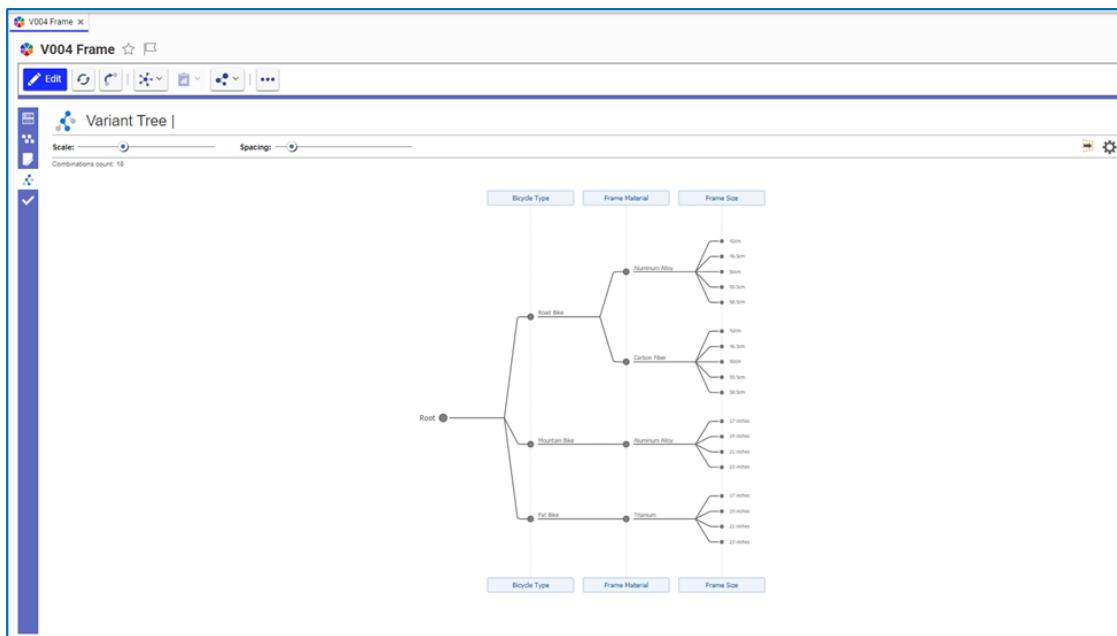


Figure 26.

4. Use **Scale:** to zoom in and zoom out.
5. Use **Spacing:** to increase or decrease spacing between tree branches.
6. Click in the Tree View to collapse and re-expand a branch. When collapsed, the count of valid options on lower-branch features is displayed. In the following figure, the "Road Bicycle" branch has been collapsed.

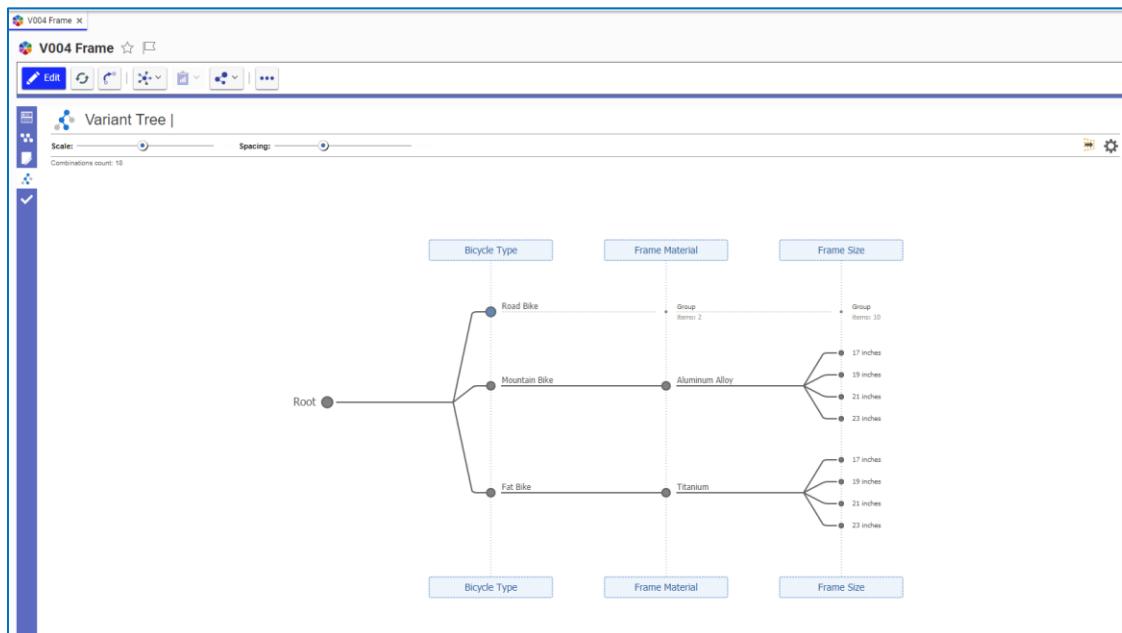


Figure 27.

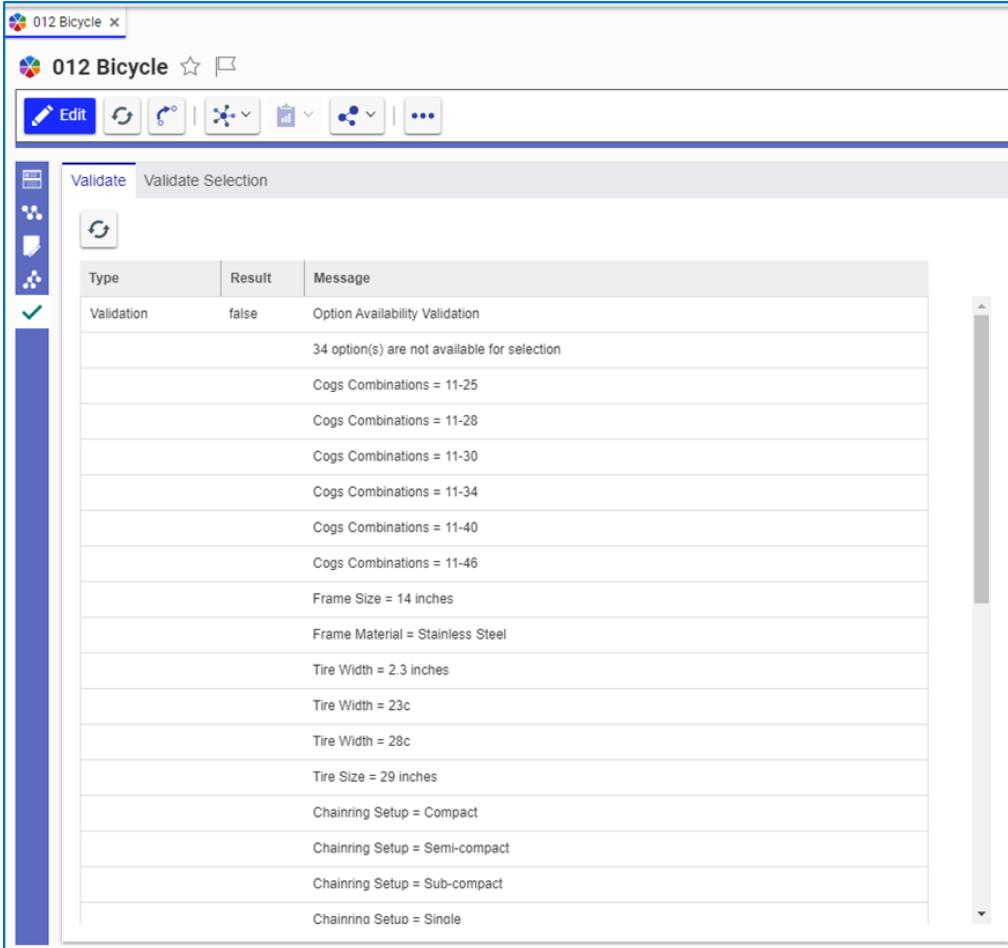
7. Click the **Export to html** icon  to create an HTML version of the Variant Tree using the specified Variant Settings. The HTML file is created and downloaded to the default download location. HTML has the same features as the Variant Tree, such as scale, spacing, collapse/expand branch.
8. Click the **Change Settings** icon  to display the Variant Tree Settings dialog and select/deselect different features and options.

## 4.5 Variability Validations

The **Validate** tab looks at the variability definition and checks to see if there are any options that are not available for selection because of rules that prevent certain options or option combinations.

Use the following procedure:

1. Click the Validation icon  in the sidebar. The following appears:



Type	Result	Message
Validation	false	Option Availability Validation 34 option(s) are not available for selection
		Cogs Combinations = 11-25
		Cogs Combinations = 11-28
		Cogs Combinations = 11-30
		Cogs Combinations = 11-34
		Cogs Combinations = 11-40
		Cogs Combinations = 11-46
		Frame Size = 14 inches
		Frame Material = Stainless Steel
		Tire Width = 2.3 inches
		Tire Width = 23c
		Tire Width = 28c
		Tire Size = 29 inches
		Chainring Setup = Compact
		Chainring Setup = Semi-compact
		Chainring Setup = Sub-compact
		Chainring Setup = Single

Figure 28.

The **Validate Selection** tab displays the relevant features and options for the Variability Item and its structure.

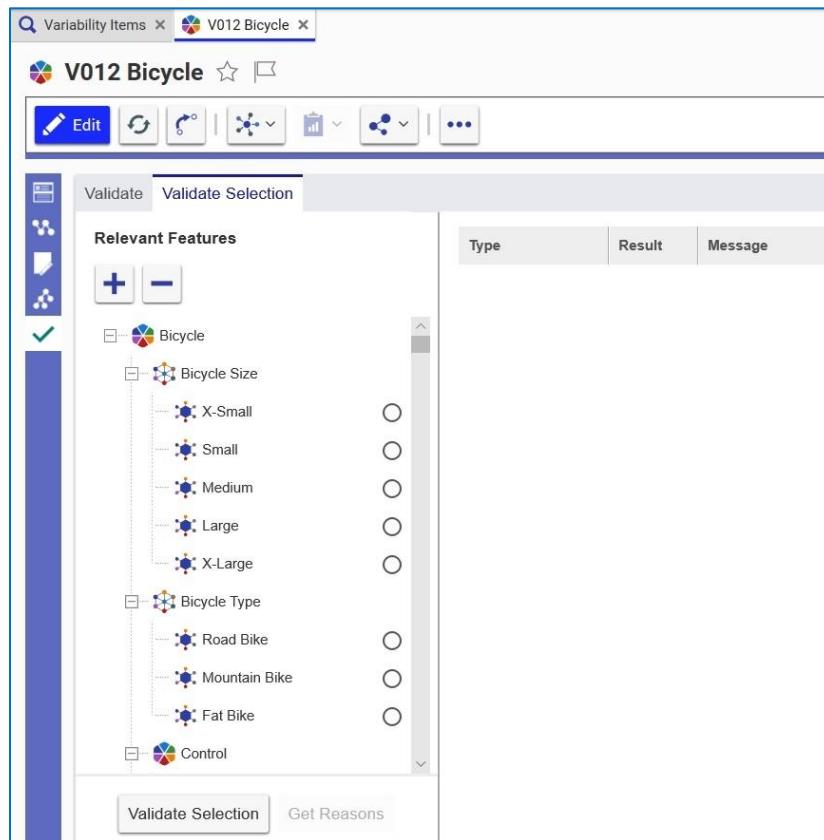


Figure 29.

2. Select the appropriate features and options.

Validate Selection

3. Click **Validate Selection**. If the validation is successful, a message similar to the following appears:

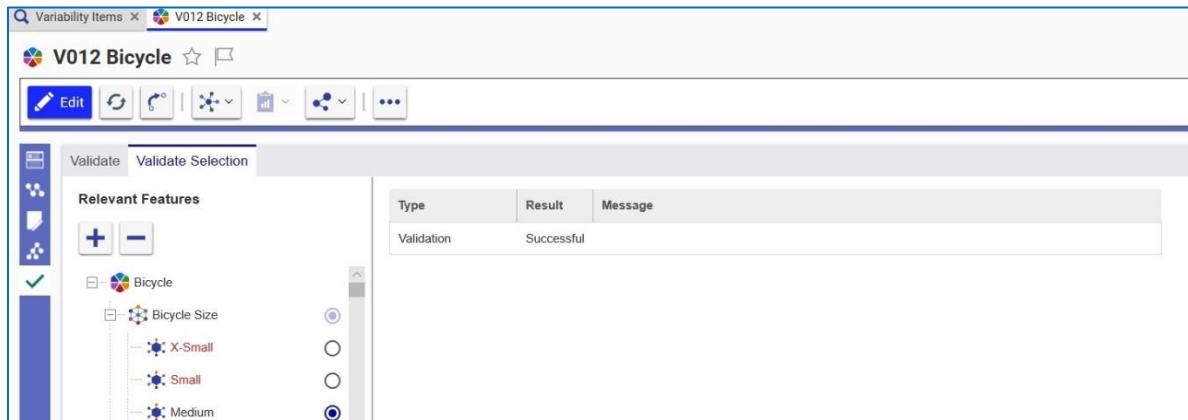


Figure 30.

Invalid options appear in red text indicating that they are not available for selection because of rules that prevent certain options or option combinations. If the Validation is unsuccessful, a message similar to the following appears:

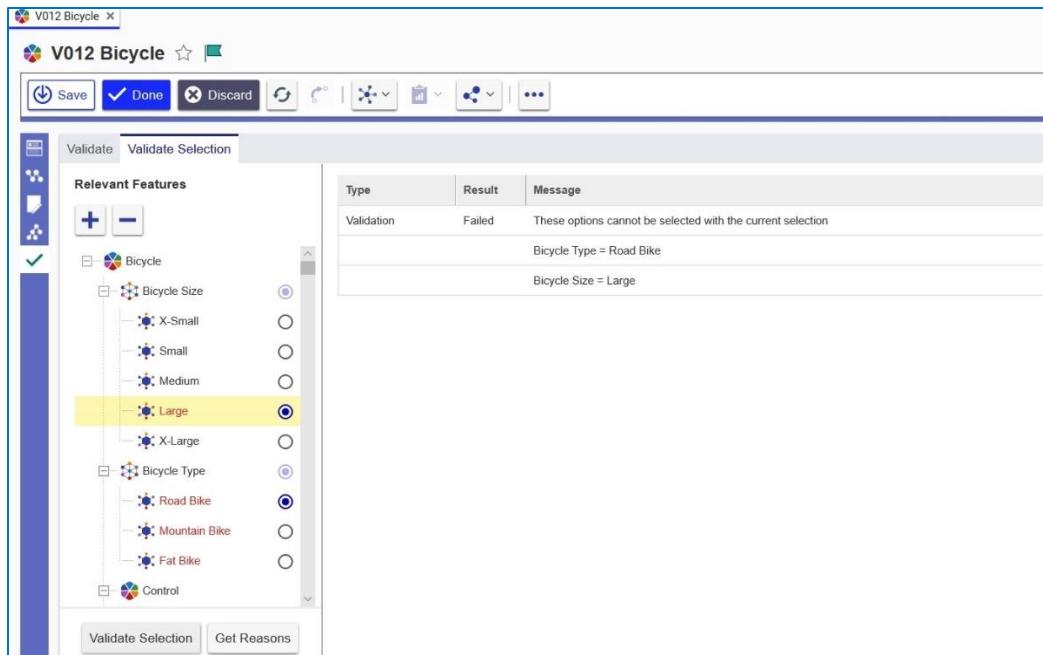


Figure 31.

If you select an invalid option (it appears in red) the **Get Reasons** button is activated and a diagram similar to the following appears:

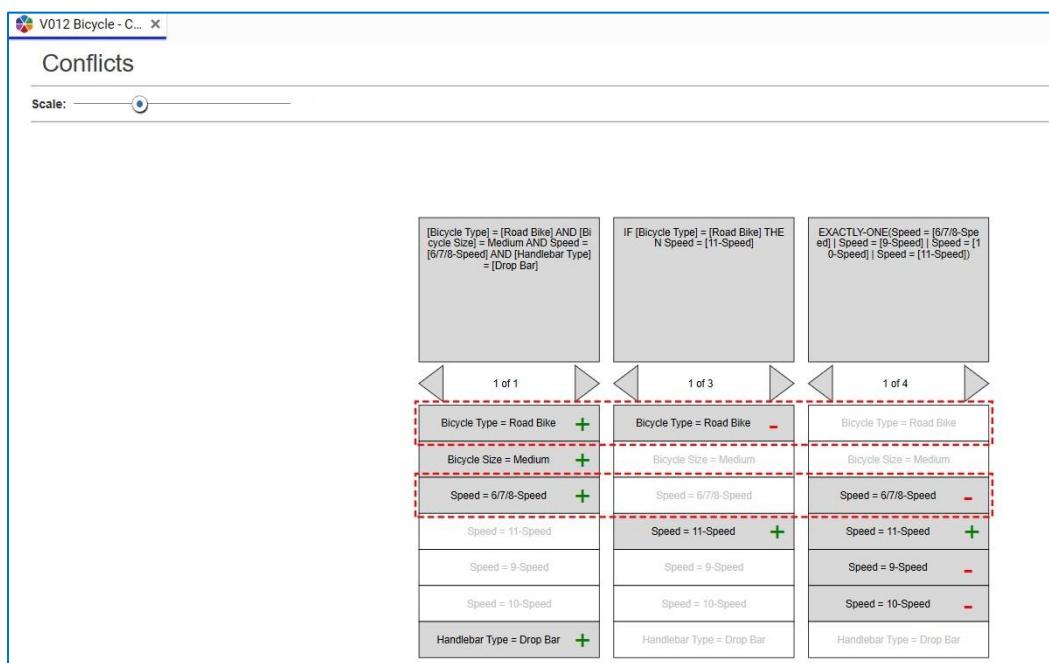


Figure 32.

In this example, the diagram displays three columns. Each column represents a Condition (selected Condition, Rule, or Feature Restriction). There is a row for each equivalence used in all of the Conditions that appear in the diagram. Equivalences that are grayed out are not used in the current Condition column. Each equivalence has a sign associated with it. The plus sign  indicates that the equivalence is true. The minus sign  indicates that the equivalence is false. For example, if you have a Rule that says Rule [Color] = [Red], the equivalence [Color] = [Red] will always be  for that rule. The same equivalences should use the same sign in each column in order for the Scope to be valid. Rows containing different signs are highlighted.

## 5 Variable Components

A Variable Component represents a variability point where the usage of an Asset is conditional. Each Asset in a Variable Component has a Usage Condition that identifies when it is valid to be used in a structure, which is resolved by providing a list of Options to select from.

The following figure depicts a Variable Component that is included in a Breakdown Structure. The Variable Component has three (3) different assets: Part2, Part3 and Part4. Each of these assets has its usage condition. Asset Part2 is valid if Color is Red, Part3 is valid if Color is Blue, and Part4 is valid if Color is Green.

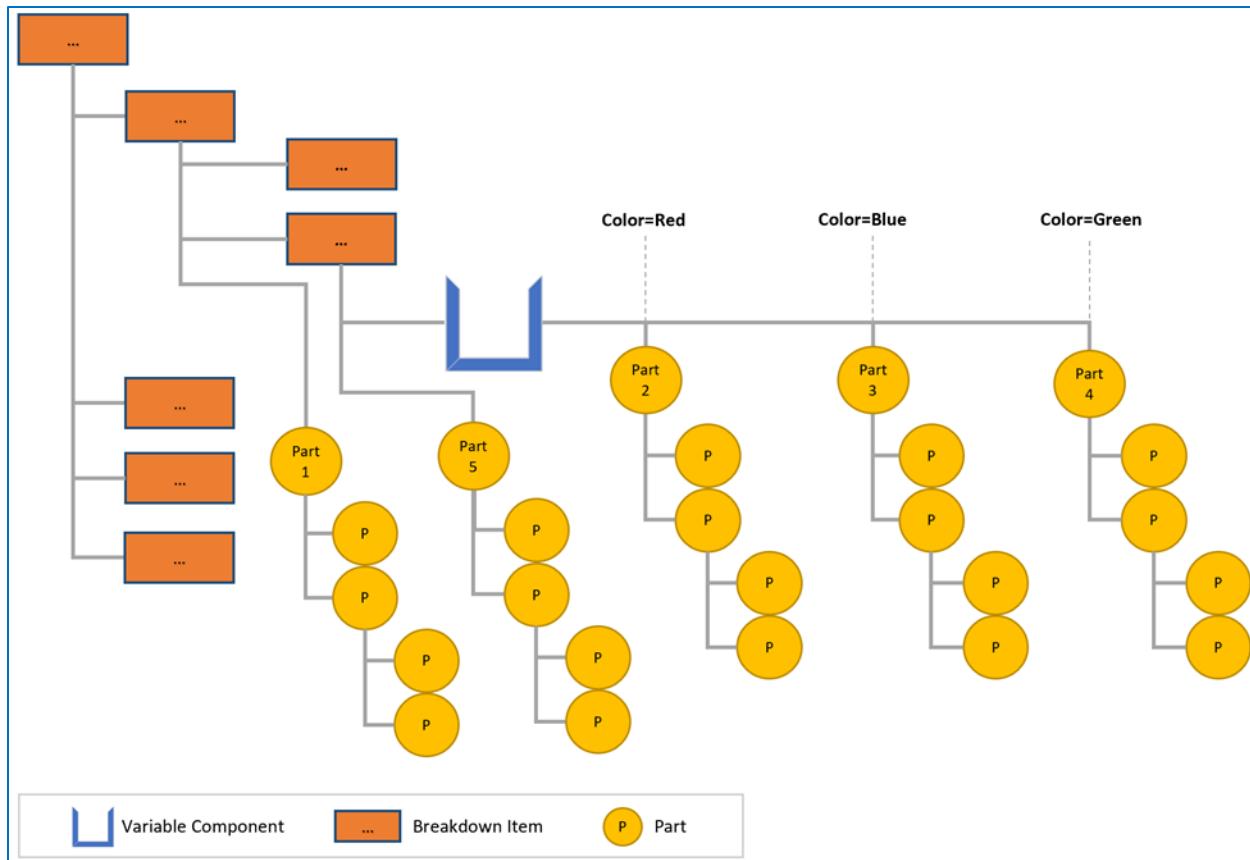


Figure 33.

The following figure depicts how a specific Asset (Part2) from the Variable Component is included in the resolved structure when a specific Option (Color=Red) is selected for resolution.

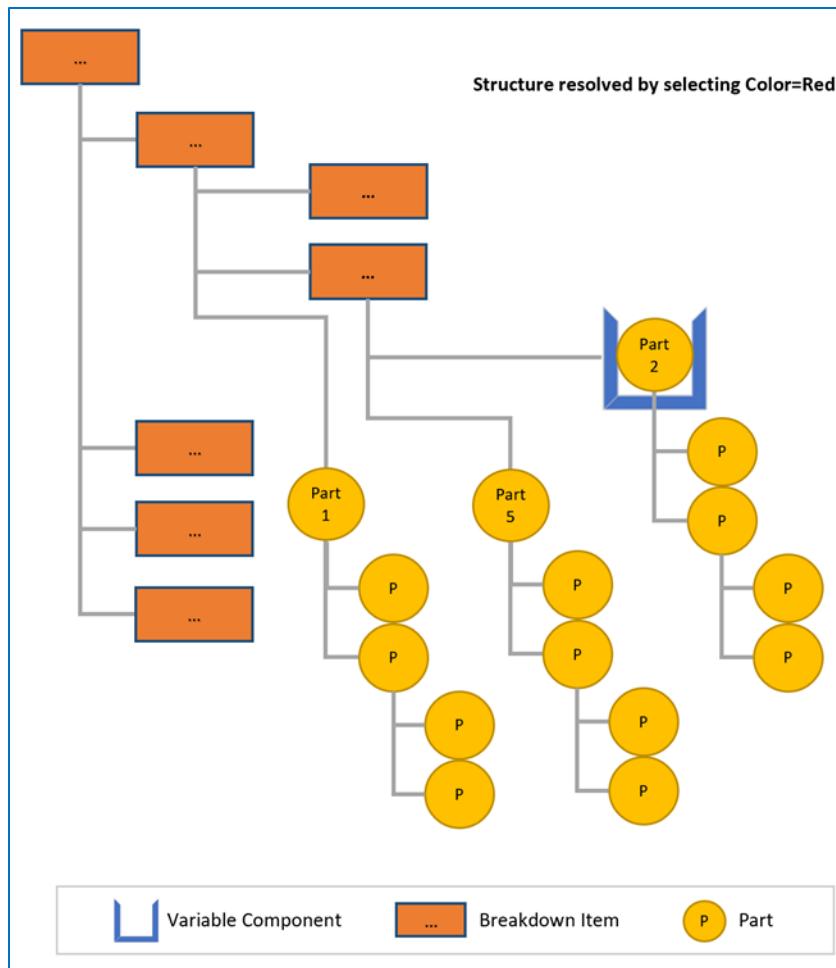


Figure 34.

## 5.1 Creating a Variable Component

1. Select **Variant Management** → **Variable Components** from the Table of Contents. The following menu appears:

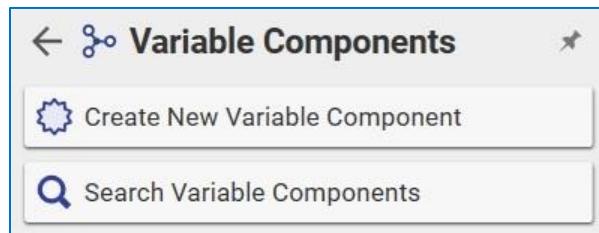


Figure 35.

2. Click **Create New Variable Component**. The following form appears:

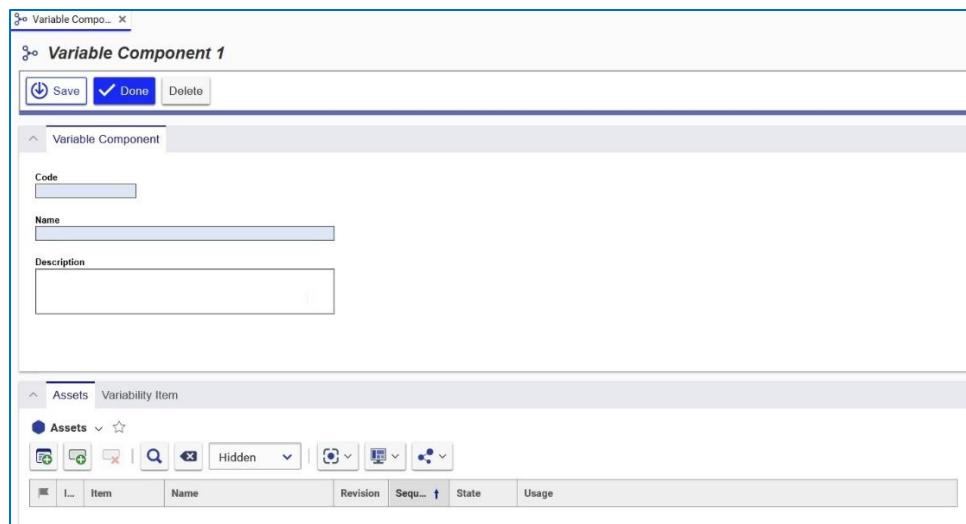


Figure 36.

3. Enter the component **Code** and **Name** in the appropriate fields. The Description field is optional.
4. Click  to save and unclaim the item.

### 5.1.1 Adding a Default Variability Item to a Variable Component

A Variable Component can have a default Variability Item, which provides convenience when creating Usage Conditions on Assets associated with the Variable Component.

To relate a default Variability Item to a Variable Component, use the follow procedure:

1. Click  on the Variable Component to claim the item.
2. Click the **Variability Item** tab to add the appropriate Variability Item.
3. Click the **Add Variability Items** icon  to add an existing Variability item. The Variability Items dialog box appears.

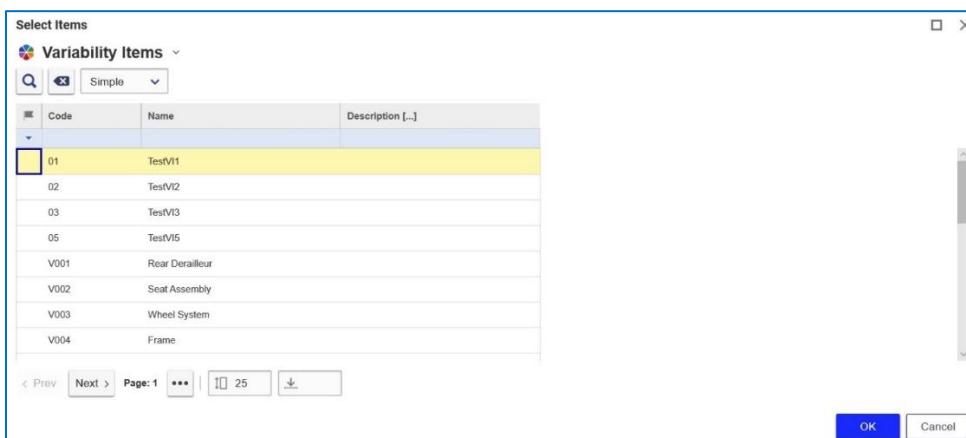


Figure 37.

4. Select one Variability Item and click **OK**.



5. Click **Done** to save the changes and unclaim the item.

**Note:** Only one Variability Item is allowed as default for a Variable Component.

### 5.1.2 Adding Assets to Variable Components

Variable Components have a number of Assets associated with them. For example, the following figure shows Assets for the Handlebar Variable Component.

	I...	Item	Name	Revision	Sequ...	State	Usage Condition
[Icon]	HB-1623	17.3" Aluminum Drop Bar	A	384		Preliminary	[Handlebar Type] = [Drop Bar] AND [Handlebar Width] = [17.3 inches]
[Icon]	HB-8948	24.4" Aluminum Flat Bar	A	896		Preliminary	[Handlebar Type] = [Flat Bar] AND [Handlebar Width] = [24.4 inches]
[Icon]	HB-2303	16.5" Aluminum Drop Bar	A	1024		Preliminary	[Handlebar Type] = [Drop Bar] AND [Handlebar Width] = [16.5 inches]
[Icon]	HB-9456	15.7" Aluminum Drop Bar	A	1152		Preliminary	[Handlebar Type] = [Drop Bar] AND [Handlebar Width] = [15.7 inches]
[Icon]	HB-9556	30.7" Aluminum Riser Bar	A	1280		Preliminary	[Handlebar Type] = [Riser Bar] AND [Handlebar Width] = [30.7 inches]

Figure 38.

The Assets tab displays the Asset – in this case Part - Numbers for the Variable Component. Each Part has its Usage Condition, which determines when the Part is valid to be used. For example, Part number HB-1623 has the following Usage condition associated with it:

[Handlebar Type] = [Drop Bar] AND [Handlebar Width] = [17.3 inches]

To add an Asset(s) to a Variable Component, use the following procedure:



1. Click **Edit** on the Variable Component to claim the item.



2. Click the **Add Assets** icon on the Assets tab to add existing assets to the Variable



Component. Click the **New Asset** icon to create a new asset.

3. When you click the **Add Assets** icon, the Assets dialog box appears.

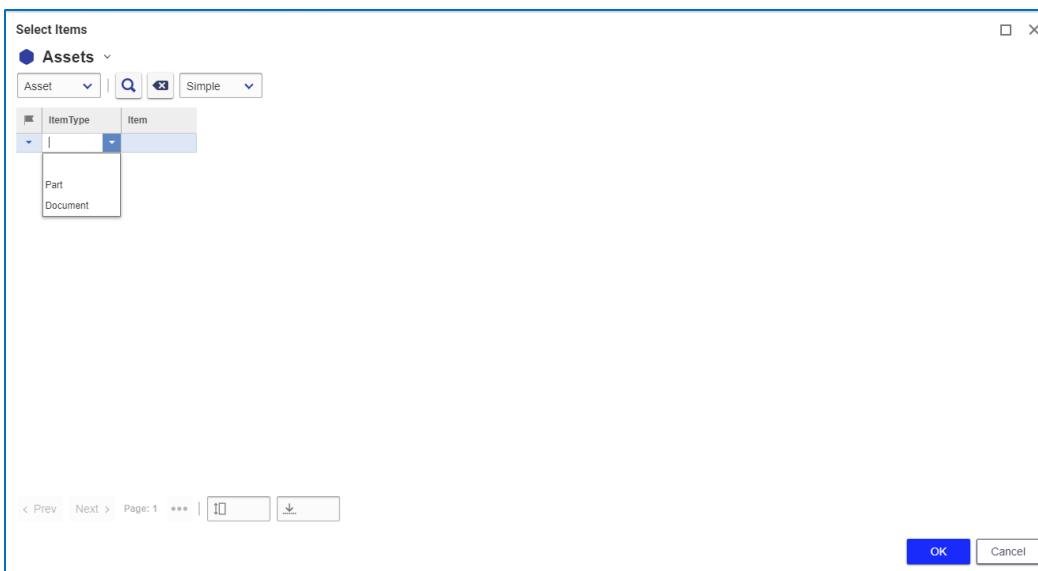


Figure 39.

4. Click the down arrow in the **ItemType** column and select the appropriate ItemType. If you select the Run Search icon without specifying an ItemType, you will get a list of Parts and Documents.
5. Select the appropriate Asset(s) and click **OK**.

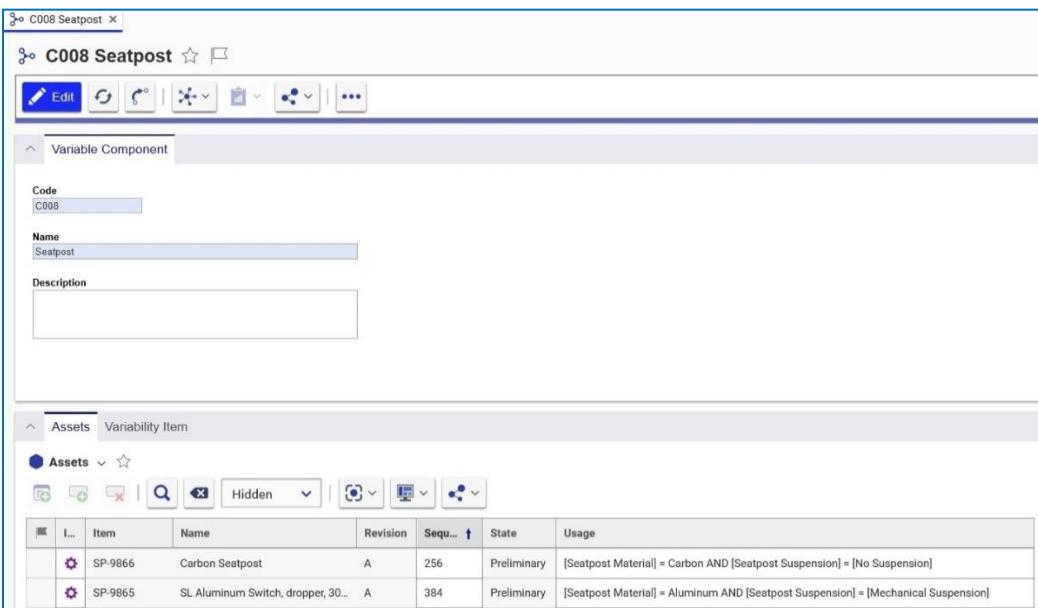


Figure 40.

6. Click  to save the changes and unclaim the item.

### 5.1.3 Usage Conditions on Assets

Usage Conditions specify the conditions for which an Asset is valid to be used in a Variable Component. It is possible to have multiple Usage Condition items for an Asset, if necessary. In this case, if any of the Usage Conditions meet the selected options, the Asset will be included in resolved breakdown structure.

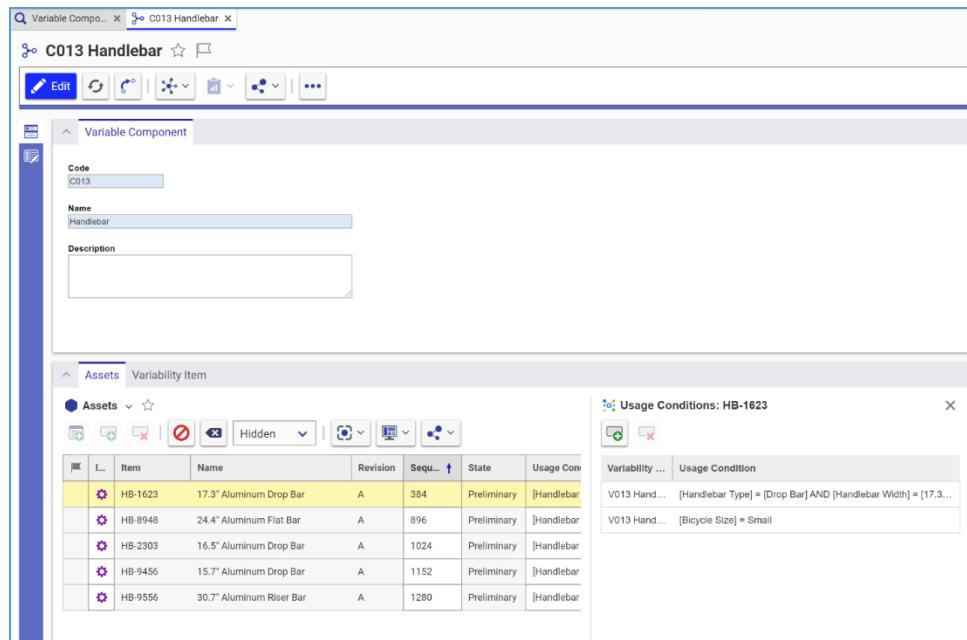


Figure 41.

#### 5.1.3.1 Viewing Usage Conditions

Usage Condition(s) for each Asset are displayed on the Usage Condition column. Additionally, Usage Conditions can be viewed/edited in the Usage Condition split pane. The Usage Condition split pane is displayed by default upon opening a Variable Component:

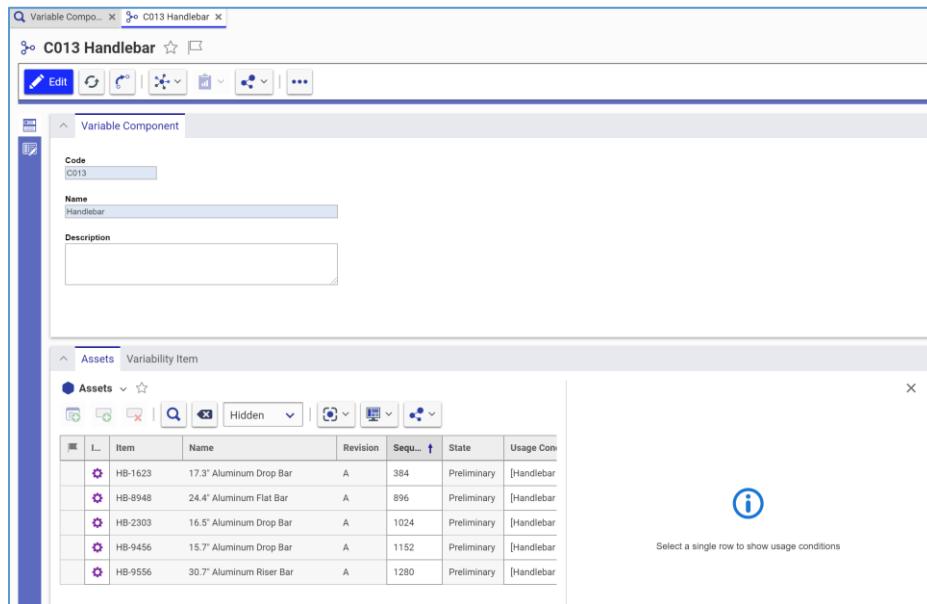


Figure 42.

Usage Conditions can be viewed in the Usage Condition split pane by selecting any single Asset row.

If the Usage Condition window is closed, it can be reopened using the following procedure:

1. In the Assets tab, right-click on an Asset and choose **View Usage Condition** from the context menu to display the Usage Condition in a split pane.

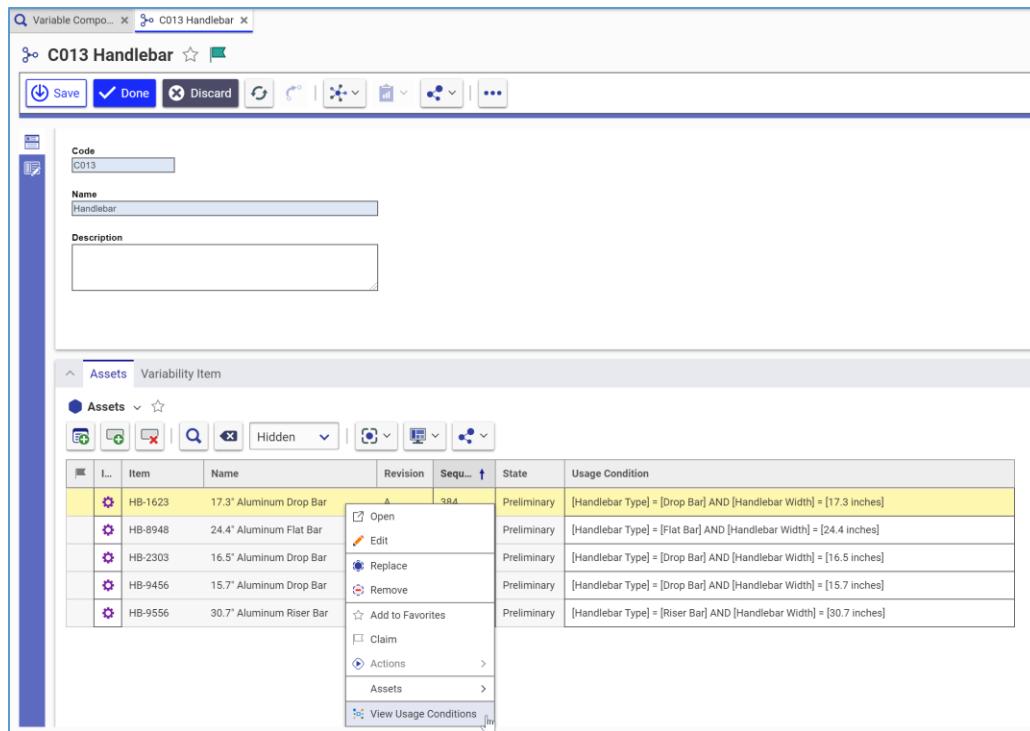


Figure 43.

- Right-click a Usage Condition row in the split pane to see the context menu.

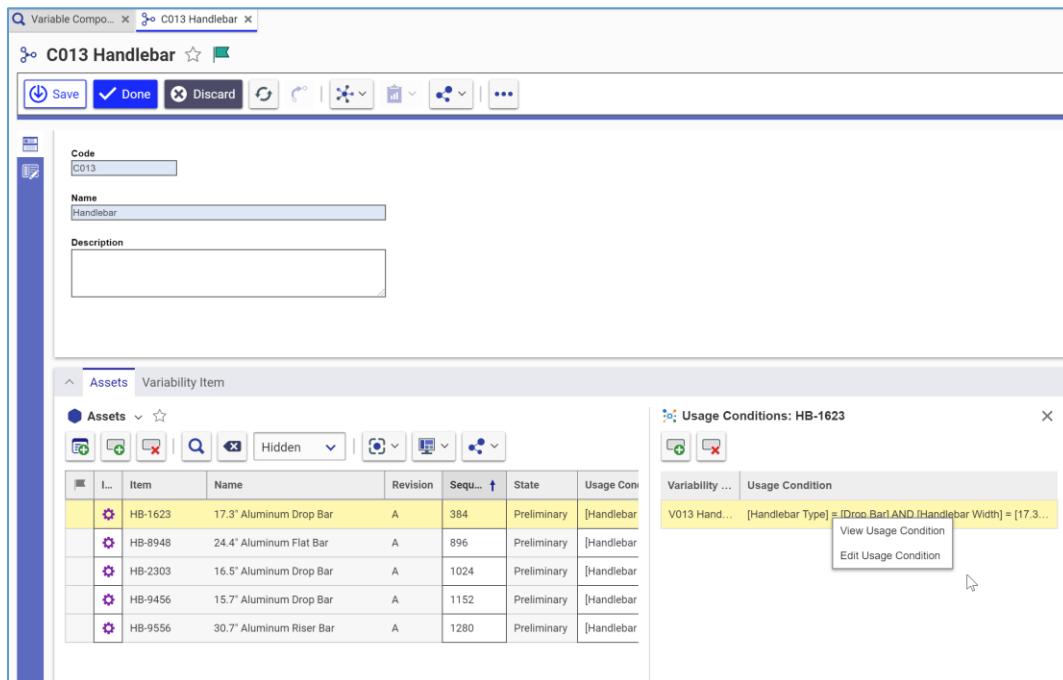


Figure 44.

- Select **View Usage Condition**. The Usage Condition dialog box appears:

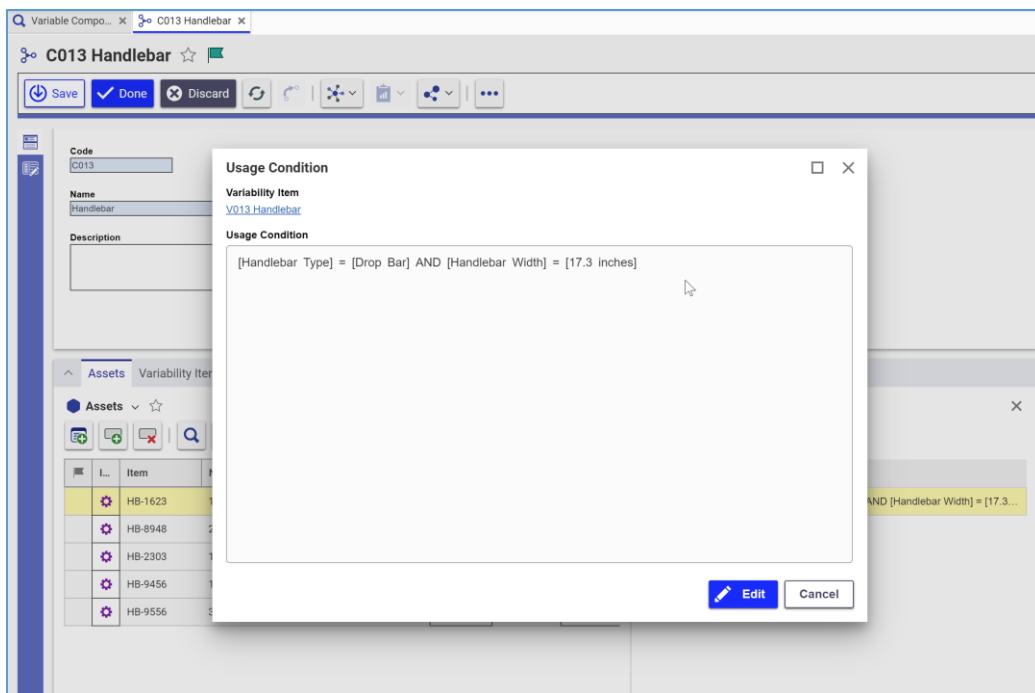


Figure 45.

#### 5.1.3.2 Adding Usage Conditions

To add a Usage Condition to an Asset, use the following procedure:

1. In the Assets tab, select an Asset row.



2. In the Usage Condition split pane, select **Create usage condition**. The Usage Condition dialog box appears:

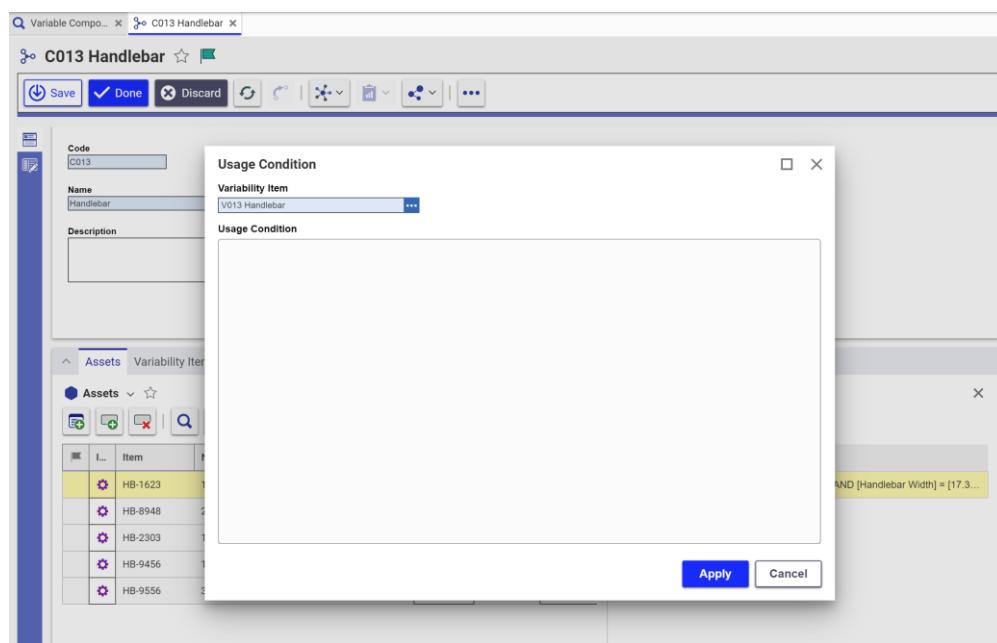


Figure 46.

3. Create the Usage Condition using guided editing and select **Apply**.

#### **5.1.3.3 Editing Usage Conditions**

To edit an Asset's usage conditions, use the following procedure:

1. In the Assets tab, select an Asset row.
2. In the Usage Condition split pane, select **Edit Usage Condition**. The Usage Condition dialog box appears:

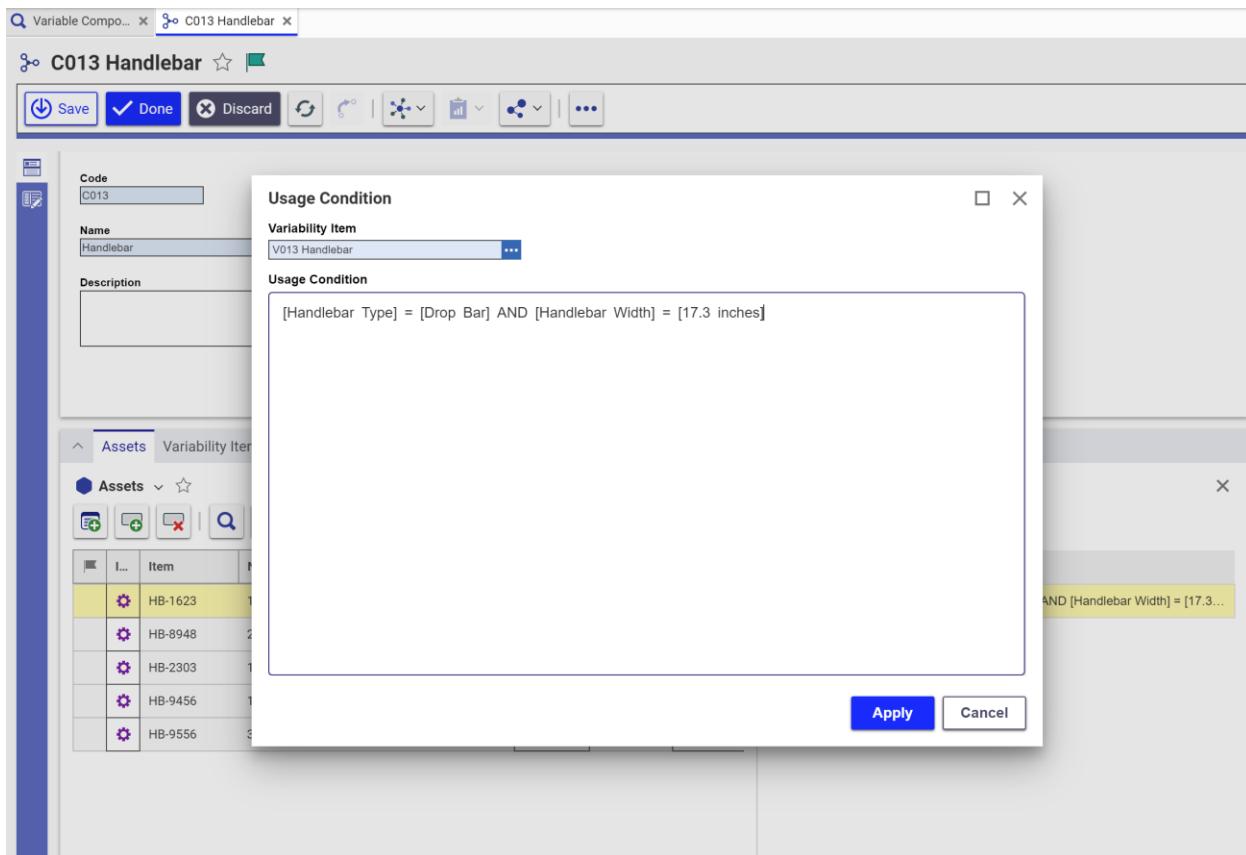


Figure 47.

3. Make the necessary changes using guided editing and select **Apply**.

## 6 Breakdown Items

Breakdown Items are used for creating a multi-level structure representing the upper levels of a product structure. They are typically driven by the modular architecture of the product. This structure contains both fixed/common Assets (e.g. Parts, Documents) as well as Variable Assets, which indicate a variability point in the structure where the Asset is conditional based on options.

### 6.1 Creating a Breakdown Item

To create a Breakdown Item, use the following procedure:

1. Click **Variant Management** → **Breakdown Items** → **Create New Breakdown Item**. The following form appears:

The screenshot shows a software interface for creating a new Breakdown Item. At the top, there's a toolbar with 'Save' (blue button), 'Done' (blue button with checkmark), and 'Delete'. Below the toolbar, the title 'Breakdown Item 1' is displayed. The main area contains three input fields: 'Code' (with a placeholder 'B001'), 'Name' (with a placeholder 'Breakdown Item'), and 'Description' (an empty text area). To the left of these fields is a vertical sidebar with a blue header and a checkmark icon. At the bottom of the main area is a navigation bar with tabs: 'Breakdown Items' (selected), 'Breakdown Structure', 'Contents', and 'Variability Item'. Below the navigation bar is a toolbar with various icons for managing items. A footer row at the very bottom includes columns for 'Code', 'Name', 'Description [...]', 'Rev...', and 'Sequence ↑'.

Figure 48.

2. Enter a **Code** and a **Name** for the Breakdown item. The Description field is optional.

3. Click **Done** to save and unclaim the item.

### 6.1.1 Description of Sidebar Icons

The following table describes the icons that appear in the sidebar of the Breakdown Item form.

Table 4: Icon Descriptions

Icon	Icon Name	Description
	Form of Breakdown Item	The form for the Breakdown Item.
	Resolution	Resolve the Breakdown Structure dynamically by selecting a set of options.

### 6.1.2 Creating Breakdown Structures

To add a Breakdown Item to a Breakdown Item, use the following procedure:

1. Click  on the Breakdown Item to claim the item.
2. On the Breakdown Items tab, click the **Add Breakdown Items** button  to add existing items or click the **New Breakdown Item** button  to create and add a new Breakdown item.
3. Click  to save the changes and unclaim the item.

### 6.1.3 Adding a Default Variability Item to a Breakdown Item

A Breakdown Item can have a default Variability Item, which provides convenience when resolving the structure accessed by selecting Resolve  in the sidebar. The default Variability Item is selected automatically when the Resolve page is accessed.

To relate a default Variability Item to a Breakdown Item, use the follow procedure:

1. Click  on the Breakdown Item to claim the item.
2. Click the **Variability Item** tab to add the appropriate Variability Item.
3. Click the **Add Variability Items** icon  to add an existing Variability item. The Variability Items dialog box appears.

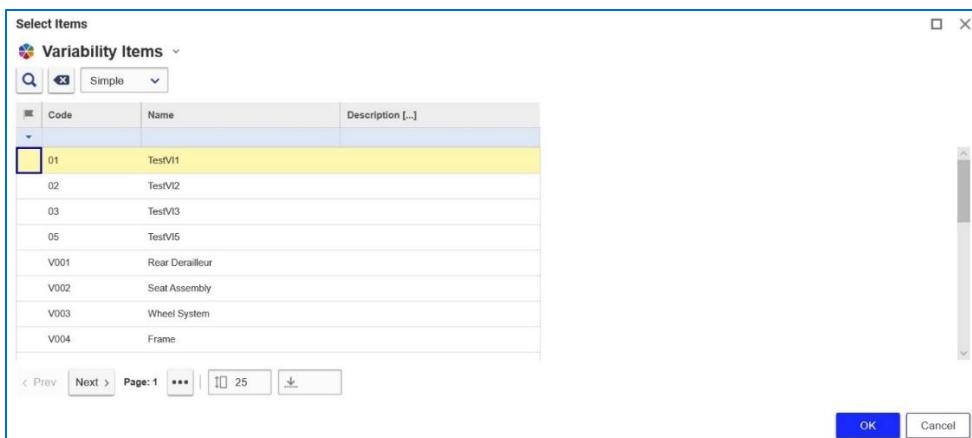


Figure 49.

4. Select one Variability Item and click **OK**.



5. Click **Done** to save the changes and unclaim the item.

**Note:** Only one Variability Item is allowed as default for a Breakdown Item.

## 6.2 Contents of a Breakdown Item

Contents for a Breakdown Item can consist of Parts, Documents and Variable Components. A Part or Document directly added to a Breakdown Item will not have a usage condition and is considered fixed/common content. Fixed content will always be included in the resolved structure because it is common across all configurations. A Variable Component in a Breakdown Item indicates a variability point where the Asset is conditional based on options.

### 6.2.1 Adding Content to Breakdown Items

To add Content to Breakdown Items, use the following procedure:



1. Click **Edit** on the Breakdown Item to claim the item.
2. Click the **Contents** tab to relate Parts, Documents and/or Variable Components. Click the **Add Components** button to add existing items or the **New Component** icon to create and add a new item.
3. Click **Done** to save the changes and unclaim the item.

## 6.3 Viewing Breakdown Structures

A Breakdown Item can have a multi-level Breakdown Structure. A Breakdown Item at any level of this structure can have its associated fixed/common assets (such as Parts and Documents) and Variable Components, which in turn has their associated assets.

To view the Breakdown Structure, use the following procedure:

1. Open a Breakdown Item, and go to the **Breakdown Structure** tab.

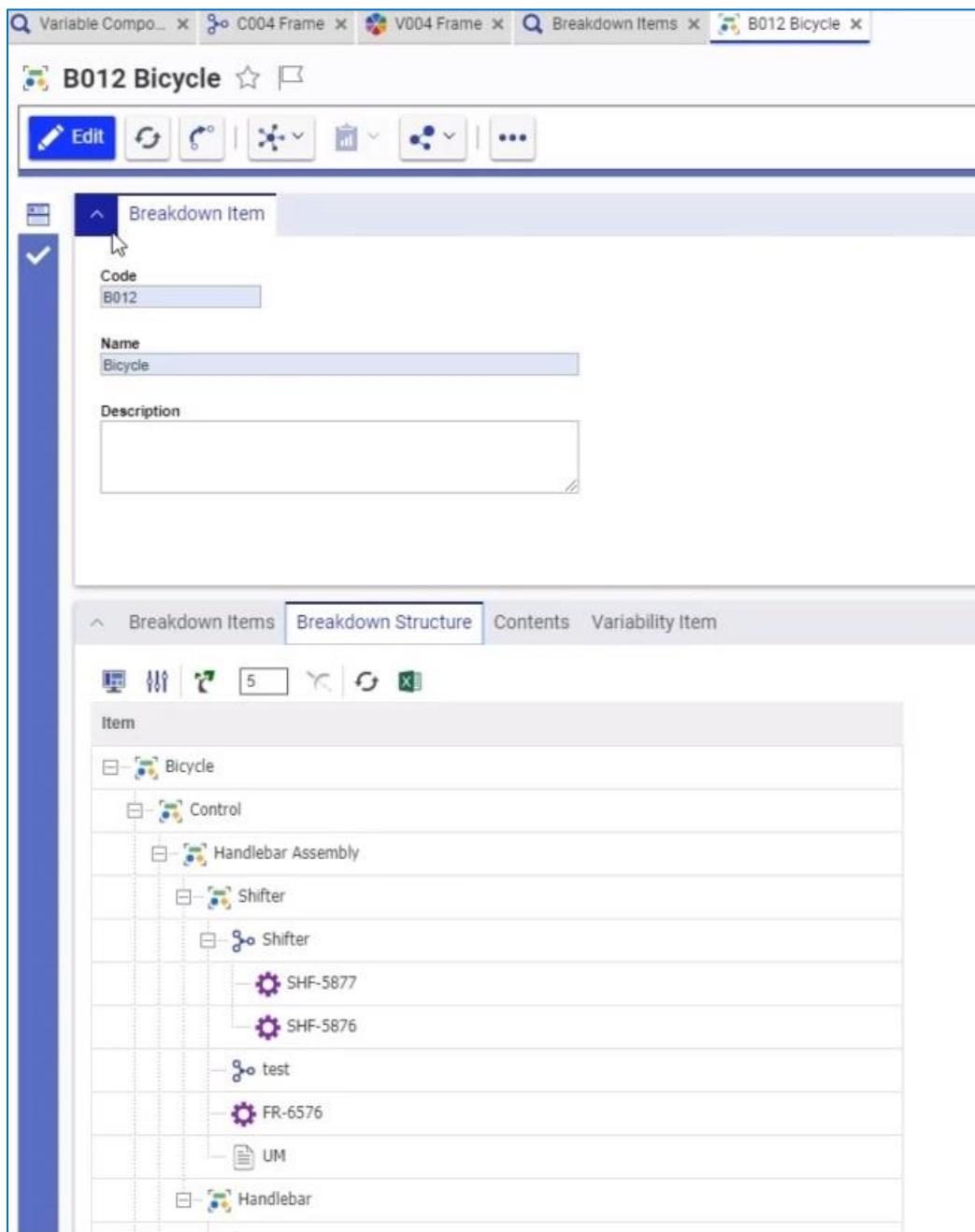


Figure 50.

2. To hide any relationship types in this view, click the Display Settings icon . The Display Settings dialog box appears.

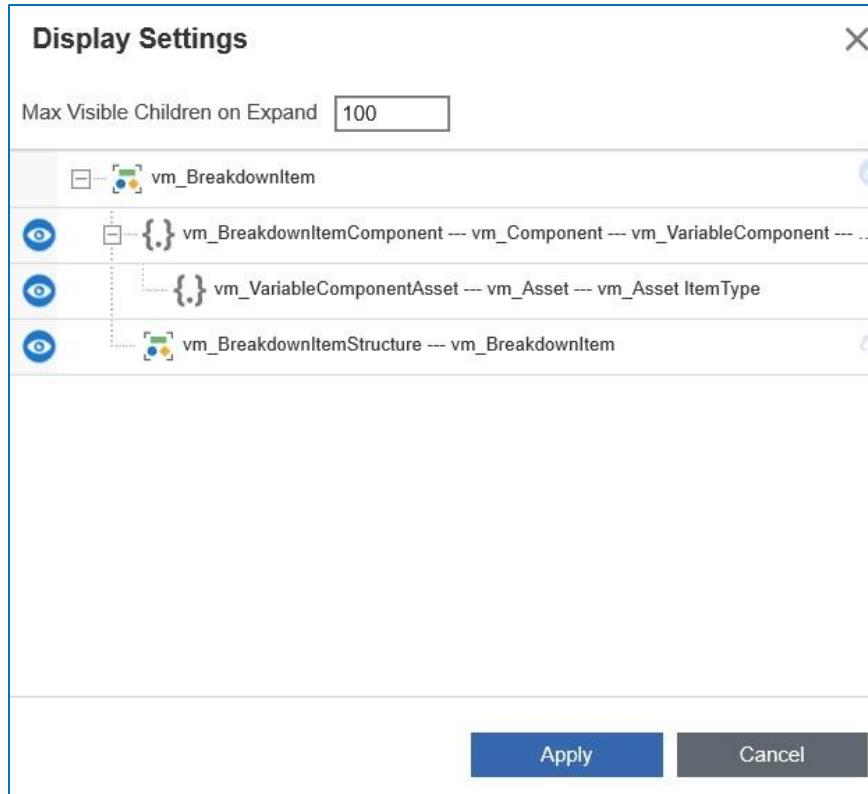


Figure 51.



3. Click the **Toggle Visibility** icon to change the Breakdown Structure display. For example, de-selecting the first two visibility icons in the list changes the Tree View to display only Breakdown Items:

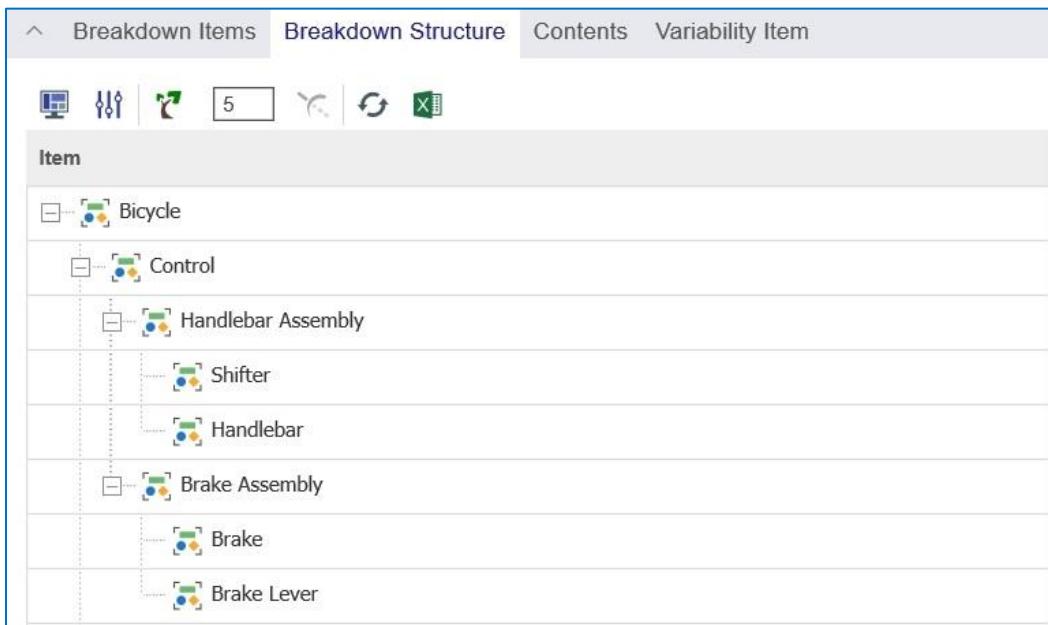


Figure 52.

## 6.4 Breakdown Resolution

A 150% Breakdown Structure can be dynamically resolved to a 100% (or 120%) structure by providing a set of options. If an option is selected for every feature used in the Breakdown Structure, then the resolved structure is a fully-configured structure, i.e. 100%. Alternatively, if options for some features are not selected, then the resolved structure is partially configured, i.e. 120%. A dynamically resolved structure includes Breakdown Items, all fixed/common Assets and variable Assets with Usage Conditions that meet the selected options.

### 6.4.1 Resolving a Breakdown Structure

To resolve a Breakdown Structure, such as Bicycle, use the following procedure:

1. Open a Breakdown Item and click the Resolution icon . The Variability Item Selection screen appears. If the Breakdown Item has a default Variability Item, it is automatically selected

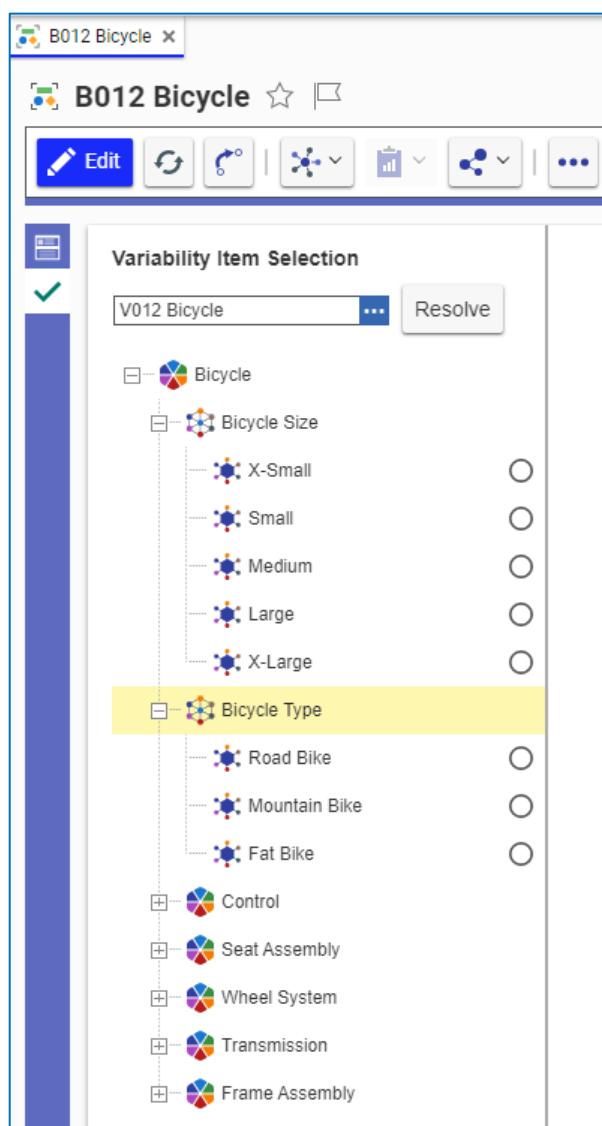


Figure 53.

2. Select options for resolution. Invalid options appear in red, if rules prevent them from being selected in combination with other selected options.

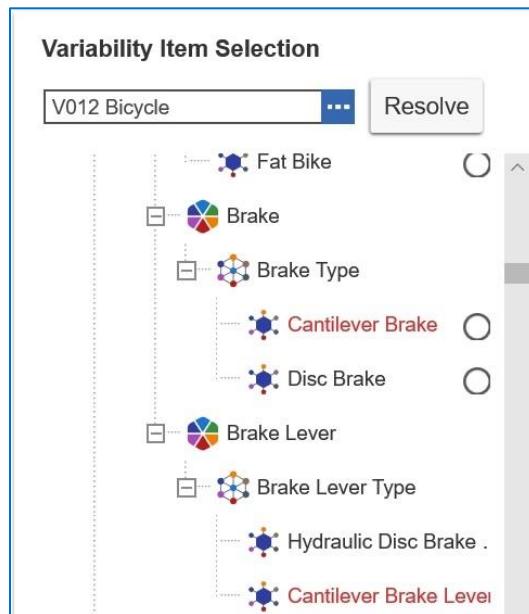


Figure 54.

3. Click **Resolve** to resolve the structure based on selected options. The Resolved structure appears in the right pane:

**Note:** The Resolve button is active only when the selected option combination is valid, i.e. the option combination does not conflict with the rules. The Resolve button becomes inactive if any invalid option is selected.

Number	Name	Revision	Status
B012	Bicycle	A	Pending
BB-9090	Non-Threaded 63mm Bottom Bracket	A	Pending
B024	Control	A	
B011	Handlebar Assembly	A	
B023	Shifter	A	
SHF-5877	X1 11-Speed Trigger Shifter	A	Pending
B013	Handlebar	A	
HB-9556	30.7" Aluminum Riser Bar	A	Pending

Figure 55.

In the resolved structure, Breakdown Items and all fixed/common Assets are displayed. For a Variable Component, if there is an Asset that meets the selected options, then the Asset is displayed directly under the Breakdown Item, i.e. without the Variable Component. If there is no qualifying Asset, then the Variable Component is displayed directly under the Breakdown Item with no Assets under it.

#### 6.4.2 Resolved Structure Display Settings

1. Click the Display Settings icon  to view the display settings associated with the Resolved Breakdown Structure.

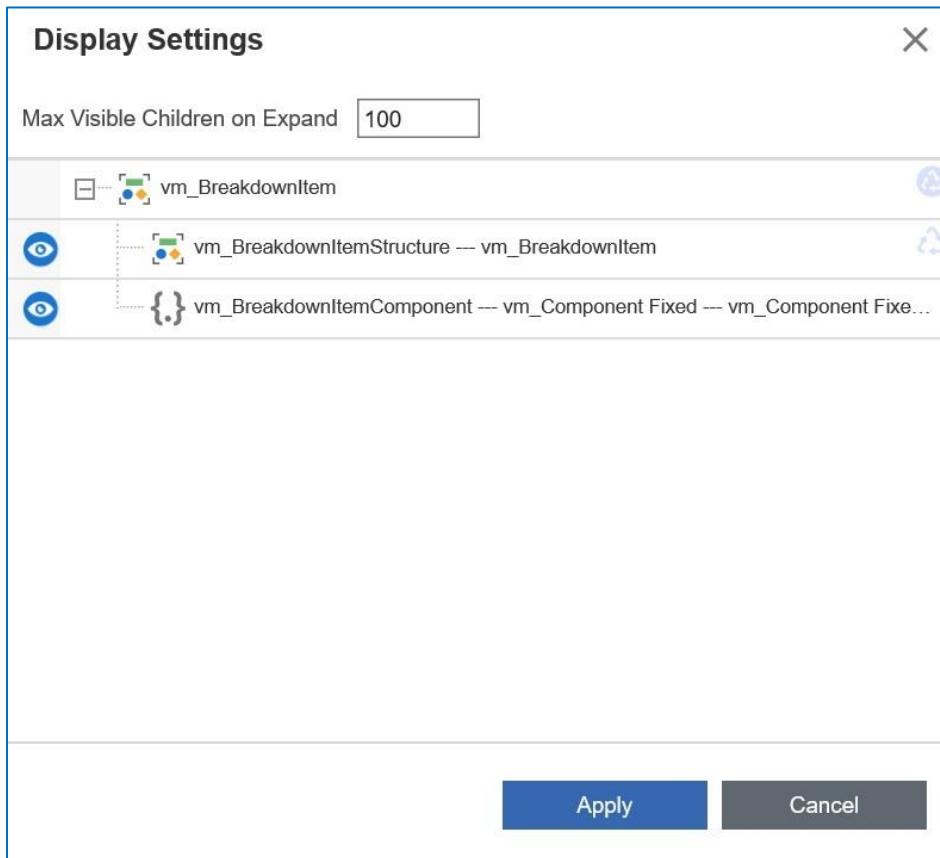


Figure 56.

2. Click the **Toggle Visibility** icon to change the display and click **Apply**. The Resolved Breakdown Structure in this example changes to show only the Breakdown Items:

Resolved Structure				
	Number	Name	Revision	Status
□	B012	Bicycle	A	
□	B024	Control	A	
□	B011	Handlebar Assembly	A	
□	B023	Shifter	A	
□	B013	Handlebar	A	
□	B007	Brake Assembly	A	
□	B019	Brake	A	
□	B020	Brake Lever	A	

Figure 57.

#### 6.4.3 Expanding the Resolved Structure

1. Expand the resolved structure to the desired level by entering a number in the field and clicking the **Grow** icon.

Resolved Structure				
	Number	Name	Revision	Status
□	B012	Bicycle	A	
□	BB-9090	Non-Threaded 63mm Bottom Bracket	A	Prelim
□	B024	Control	A	
□	B002	Seat Assembly	A	
□	B003	Wheel System	A	
□	B016	Transmission	A	
□	B014	Frame Assembly	A	
□	B027	Manuals and Spare Parts	A	

Figure 58.

#### 6.4.4 Exporting Resolved Structure to Excel

1. Click the **Export to Excel** icon  to export the resolved Breakdown Structure to an Excel spreadsheet. The following dialog box appears:



Figure 59.

2. Click **Open** to view the spreadsheet:

A	B	C	D	E	F
1	Level	Number	Name	Revision	State
2	- 1	B012	Bicycle	A	
3	2	BB-9090	Non-Threaded 63mm Bottom Bracket	A	Preliminary
4	- 2	B024	Control	A	
5	- 3	B011	Handlebar Assembly	A	
6	- 4	B023	Shifter	A	
7	5	SHF-5877	X1 11-Speed Trigger Shifter	A	Preliminary
8	- 4	B013	Handlebar	A	
9	5	HB-9556	30.7" Aluminum Riser Bar	A	Preliminary
10	- 3	B007	Brake Assembly	A	
11	- 4	B019	Brake	A	
12	5	BR-4069	SLX Hydraulic Disc Brake	A	Preliminary
13	- 4	B020	Brake Lever	A	
14	5	BL-3757	SLX Hydraulic Disc Brake Lever	A	Preliminary
15	- 2	B002	Seat Assembly	A	
16	- 3	B021	Saddle	A	
17	4	SD-7457	SMP Well Black Nylon Saddle	A	Preliminary
18	- 3	B008	Seatpost	A	
19	4	SP-9865	SL Aluminum Switch, dropper, 30.9mm	A	Preliminary

Figure 60.

3. Click **Save** to download the spreadsheet.