

ACE 2024

STUDENT TRAINING GUIDE

Extending Variability with Variant Management

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Extending Variability – EBike Conversion

Overview

You should be familiar with the basic functionality and design of Aras Variant Management at this point in the course. We will now configure additional variability into the Bicycle data model to support EBike Conversions of pedal-driven bicycles into motor-driven variants.


Objectives

- Create additional Features and Options to support new EBike bicycle type variants.
- Add Breakdown items, Variable Components, and Assets for resolution of discreet EBike BOMs.
- Define Rules to constrain Option choices during selection of variant Options.
- Interactively resolve EBike variants using the Breakdown Item Resolution sidebar.




Add Additional Features and Options for EBikes

- To extend Bicycle variability new Features and Options are required



- ☐ EBIke Battery Pack
 - 36v 14Ah
 - 52v 20Ah
- ☐ EBIke Controller
- ☐ EBIke Motor
 - Hub Drive
 - Gear Drive
- ☐ EBIke Throttle
 - Thumb
 - Twist Grip


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New Features and Options for EBike Variants

Selection of EBike variants of the bicycle product family requires that new Features and Options are added into the variable configuration. We will begin by adding these EBike-specific Features and Options to support extended variability of the bicycle.

Try It – Creating Features and Options

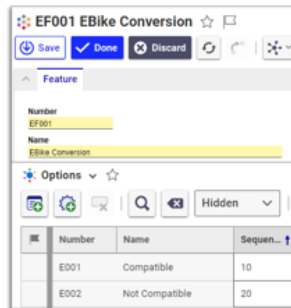
Create new Features and Options to support EBike variability in the Bicycle structure:

1. While logged as Admin, navigate to Variant Management/Dictionary in the TOC to display Features and Options.
2. Create the following Features as shown in the table below.
3. For each Feature, use the ‘Add Option’ button on the Options tab toolbar to add existing Options as shown in the table below. You can filter Options using ‘E*’ if you wish.
4. Click ‘Done’ for each Feature and close their tabs when completed.

Feature “EF002 EBike Motor” <ul style="list-style-type: none"> • Option “E002 Hub Drive” • Option “E003 Gear Drive”
Feature “EF003 EBike Controller” <ul style="list-style-type: none"> • Option “E004 Controller”
Feature “EF004 EBike Throttle” <ul style="list-style-type: none"> • Option “E005 Thumb” • Option “E006 Twist Grip”
Feature “EF005 EBike Battery Pack” <ul style="list-style-type: none"> • Option “E008 36v 14Ah” • Option “E009 52v 20Ah”

Adding an EBike Conversion Feature to the Bicycle

- EBike Conversion will enable conversion of a Bicycle configuration to an EBike
- A new Feature and its Options will be added to make conversion available in Validation and Resolution selection screens



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Creating an EBike Conversion Feature for the Bicycle Configuration

Now that we have defined Features and Options for the EBike itself, we need to expand the scope of variability of the **Bicycle** structure to support **EBike** variant selections. To do this, we will create a conversion Feature to be added to the Bicycle's **Variability Item** where Rules are defined. We can then define new Rules using EBike Features and Options to allow selection of EBike Options during resolution of Bicycle variants.

Try It – EBike Conversion Feature

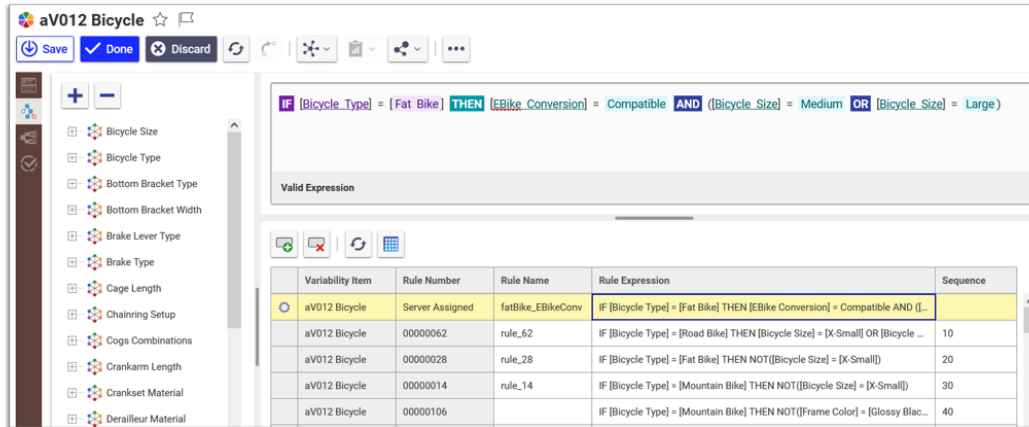
Create a new Feature and its Options to enable conversion to EBike variant:

1. Create a new Feature **EF001 EBike Conversion** and add the Options to the relationship tab **“Options”** as shown in the table below:

- | |
|---|
| <p>Feature “EF001 EBike Conversion”</p> <ul style="list-style-type: none"> • Option “E011 Compatible” • Option “E012 Not Compatible” |
|---|

2. Click 'Done' to save the Feature.
3. Next, navigate to Variant Management/Variability Items and open the **aV012 Bicycle Variability** Item for editing. Add the newly created EF001 EBike Conversion Feature to the Relevant Features tab. Save, and keep the aV012 Bicycle Variability Item open for the next exercise.

Add New Rules to the Bicycle Variability Item



Add New Rules to the Bicycle Variability Item

Because EF001 EBike Conversion Feature is now 'Relevant' to Bicycles, we can now define Rules to constrain Option compatibility. In this example, we will set 'Fat Bike' Bicycle Type to be convertible to EBike variants. We will also set Road Bike, and Mountain Bike as 'not compatible' until engineering and design has been completed for those types to support EBike conversions.

Try It – Creating Rules

Create new Rules in the Bicycle Variability Item to constrain EBike variant selection:

- In the **aV012 Bicycle** Variability Item: open the **Rule Editor** sidebar window. Use the 'New Rule' button from the Rule Grid toolbar to add a new Rule. Add the column values from the table below. *(Copy/paste works, but clear leading/trailing white space after pasting)*

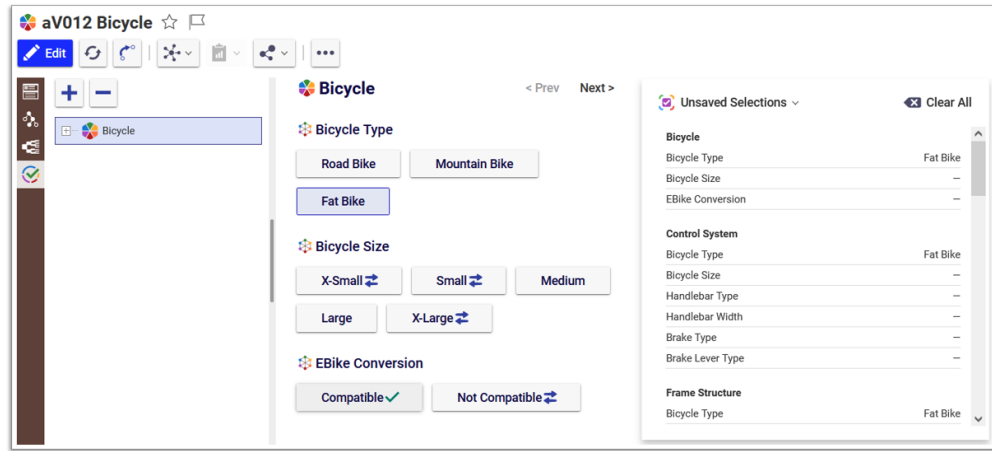
Rule Name	Fat EBike Only (or your choice of names)
Rule Expression	IF [Bicycle Type] = [Road Bike] OR [Bicycle Type] = [Mountain Bike] THEN [EBike Conversion] = [Not Compatible]
Sequence	50

- Again, use the 'New Rule' button in the Rule Grid toolbar to add another new Rule in the Rule Grid pane. Populate with the following column values:

Rule Name	EBike Size (or your choice of names)
Rule Expression	IF [Bicycle Type] = [Fat Bike] AND [EBike Conversion] = Compatible THEN ([Bicycle Size] = Medium OR [Bicycle Size] = Large)
Sequence	60

- Save the Variability Item and keep it open for the next exercise.

Testing EBike Conversion on Bicycle Variability



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Check Exclusive EBike Compatibility for Fat Bike Bicycle Types

Based on the Rules configured in the Rule Editor sidebar window of the **aV012 Bicycle** Variability Item, only Bicycle Type 'Fat Bike' allows selection of an EBike variant. Selection of other types will set EBike Conversion to 'Not Compatible' on click.

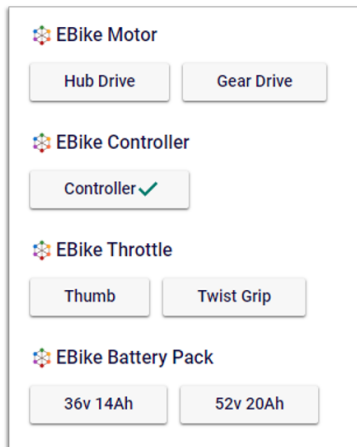
Furthermore, Bicycle Size must be either Medium or Large to be 'Compatible' for EBike conversion, where they allow other sizes in pedal-drive models.

Try It – Validate EBike Compatibility

Test the selection of EBike Conversion against all bicycle types to validate Rules:

1. Open the **Validation** sidebar window from the Bicycle Variability Item (checkmark icon). From the Feature/Options selection pane (middle), click to select 'Fat Bike'. Note that EBike conversion becomes available.
2. Select either 'Road Bike' or 'Mountain Bike'. Note that these types are not compatible with EBike conversions, perhaps until these designs are released by the engineering department.
3. Now from the EBike Conversion Feature selections, choose 'Compatible'. Click to choose 'Proceed' from the pop-up menu and note that Fat Bike becomes checked with a green checkmark to indicate that it is the only valid selection.
4. Lastly, select EBike Conversion Option 'Not Compatible', which allows Fat Bikes to be configured for pedal-drive in other sizes that are not valid for EBike models.
5. Remain in the **aV012 Bicycle** Variability Item for the next exercise.

Configure Variability for E-Bike Options



- Variability within the EBike itself:
 - Motor
 - Controller (common to all variants)
 - Throttle
 - Battery
- Rules on EBike Variability Item work in tandem with Rules on (parent) Bicycle Variability Item



Variability within the EBike Structure Itself

To implement variability within the EBike Structure, we will add a new Variability Item, reference relevant Features, and define Rules to constrain Option combinations.

Try It – EBike Variability

Create the EBike Structure Variability Item and add the previously created EBike Features (and Options):

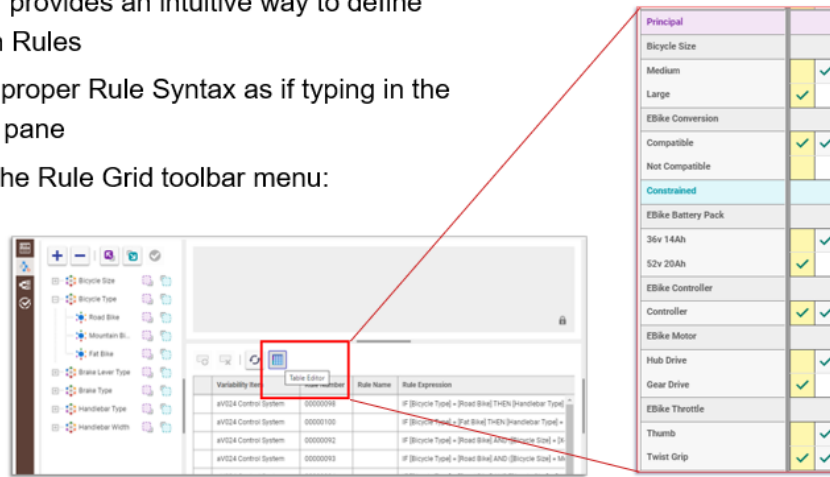
1. Navigate to Variant Management/Variability Items and create a new instance with the following:
 - a. Number: 'eV001'
 - b. Name: EBike Structure
2. Under the 'Relevant Features' tab, add references to these existing Features:

Number	Name	Sequence
F001	Bicycle Size	10
EF001	EBike Conversion	20
EF002	EBike Motor	30
EF003	EBike Controller	40
EF004	EBike Throttle	50
EF005	EBike Battery Pack	60

3. Save the **EBike Structure** Variability Item and leave it open for the next exercise.

Configure E-Bike Rules Using the Table Rule Editor

- The Table Editor provides an intuitive way to define Option Selection Rules
- It generates the proper Rule Syntax as if typing in the Text Rule Editor pane
- Accessed from the Rule Grid toolbar menu:



Using the Table Rule Editor

Although we have established Rules for EBike conversion at the *Bicycle* level, we still need to define variability within the EBike structure itself. For example, not all EBike variants support the high-capacity battery pack. Also, the thumb throttle might not be robust enough to be used with the more powerful motor option.

To enforce these constraints, we need to define Rules on the EBike Structure Variability Item. We had typed Rules in the Text Rule Editor earlier, but this time we will use the **Table Rule Editor** – a mouse-click driven alternative to typing Rules syntax manually.

The Table Editor describes Rules in terms of ‘Principal’ and ‘Constrained’ Options, which correspond to the left side vs. right side of the ‘THEN’ operator in a Rule expression.

For example:

Principal		Constrained
<i>IF [Bicycle Type] = [Fat Bike]</i>	<i>THEN</i>	<i>[Bicycle Size] = Medium OR [Bicycle Size] = Large</i>
<i>IF [Bicycle Type] = [Road Bike] OR [Bicycle Type] = [Mountain Bike]</i>	<i>THEN</i>	<i>[EBike Conversion] = [Not Compatible]</i>

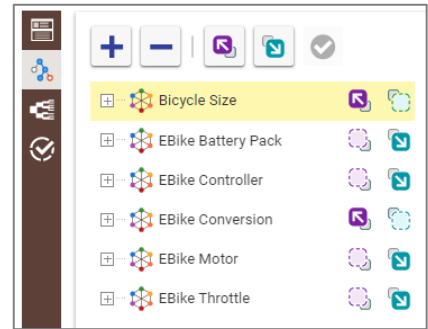
Features and their Options are selected as either Principal or Constrained in the Feature Option Tree, then all rules using those are displayed in a new pane with a matrix of clickable cells.

Try It – Table Rule Editor

Use the Table Rule Editor to define EBike selection behavior:

1. Click to Edit the **ev001 EBike Structure** Variability Item. Use the ‘Rule Editor’ button on sidebar to display the Rule Editor window.

- From the Rule Grid toolbar, locate and click on the Table Editor button. This adds a new pane at right with 'Principal' and 'Constrained'.
- In the Feature/Options Tree (left pane), select Features 'Bicycle Size' and 'EBike Conversion' to *Principal*, and the other Features to *Constrained*. Click the 'Apply' checkbox.
- Click Apply to display any existing Rules using these settings. The Table Editor will display the Principal and Constrained Features and Options.
- Create a new Rule, assign name (optional). Rule Number will be system assigned. The Table Editor will display a highlighted column with a 'Server Assigned' Number heading.
- Use mouse clicks to add checkmarks in the following arrangement:

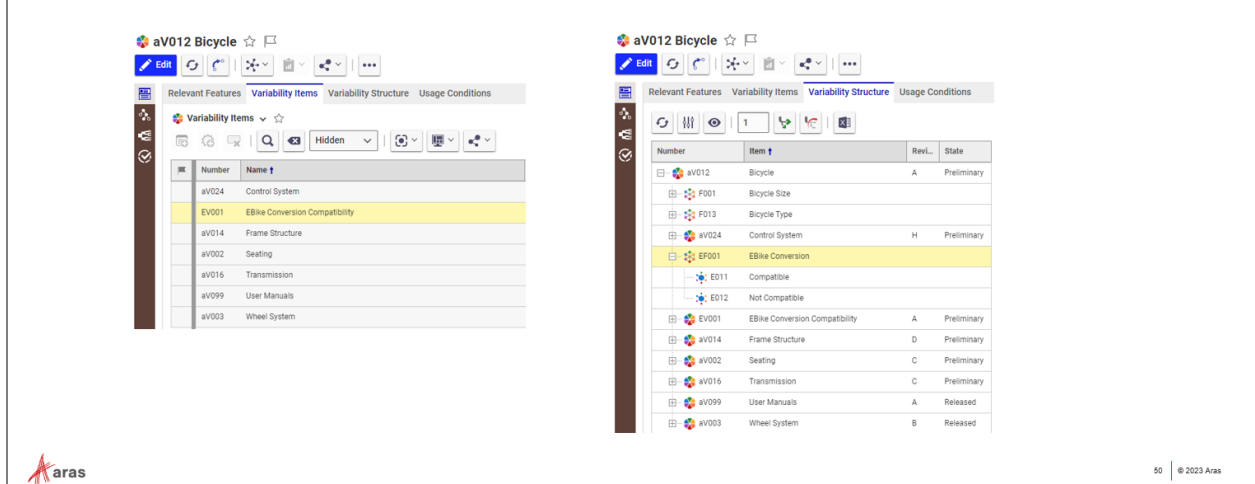


Principal		
Bicycle Size		
Medium		✓
Large	✓	
EBike Conversion		
Compatible	✓	✓
Not Compatible		
Constrained		
EBike Battery Pack		
36v 14Ah		✓
52v 20Ah	✓	
EBike Controller		
Controller	✓	✓
EBike Motor		
Hub Drive		✓
Gear Drive	✓	
EBike Throttle		
Thumb		✓
Twist Grip	✓	✓

- Save the Variability Item. Use the Validate Sidebar window to check your Rules.
- Click Done and close the Variability Item if desired.

Enable EBike Conversion on Bicycle Variability Item

With EBike Variability validated, we incorporate it into the top-level Bicycle Variability Item



Enable EBike Conversions

The Variability Item 'EBike Structure' can now be applied to the top-level Bicycle structure. This is done by simply referencing it from the Bicycle Variability Item under its 'Variability Items' tab. This is analogous to the Part-Part BOM-Part relationship.

Once added, EBike variability becomes incorporated into Bicycle variability, thus Option selection will be driven by the combination of EBike and the overall Bicycle variability during validation and resolution.

Try It – Update Bicycle Structure

Add the EBike variability to the Bicycle structure:

1. With "aV012 Bicycle" Variability Item in edit mode, add "eV001 EBike Structure" to its Variability Items tab. Save aV012 Bicycle Variability Item.
2. Examine the Rules. You should see that the Rules and Feature scope from eV001 EBike Structure Item have been incorporated in aV012 Bicycle.
3. Open the Validation window from the "aV012 Bicycle" Variability Item sidebar menu and verify that EBike Rule logic has been incorporated in the context of the Bicycle structure.

Completing and Resolving EBike Variants

Goal

Configure Breakdown Items, Variable Components and Assets to support resolution of discreet Bicycle BOMs including EBike variants.

Scenario

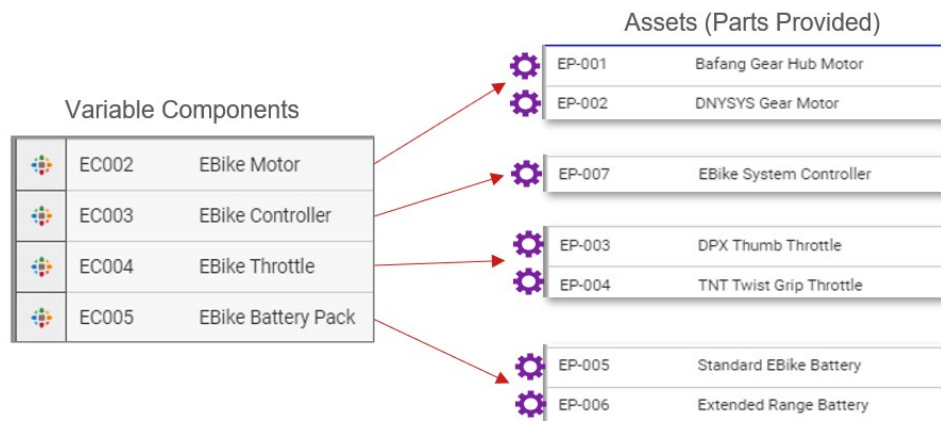
We have defined the Variability Items to enforce Option selection using Rules and relationships. We need to generate discreet Part BOM output from resolution for each variant.

To complete the Bicycle variant solution, we must now configure the EBike Breakdown Item, Variable Components and Assets to support Resolution to a 100% BOM for EBike variants from the Bicycle Breakdown Structure.

Try It – Defining the Usage Conditions that Determine which Part Assets are Used

You should be familiar with these Variant Management components and the data model from the introduction exercises. In this section we will apply Usage Conditions on each Part Asset so that Option selections will resolve to those Parts for each variant.

1. Create four new Variable Components and assign Assets (Parts):



EC002 EBike Motor	EP-001 Bafang Gear Hub Motor EP-002 DNYSYS Gear Motor
EC003 EBike Controller	EP-007 EBike System Controller
EC004 EBike Throttle	EP-003 DPX Thumb Throttle EP-004 TNT Twist Grip Throttle
EC005 EBike Battery Pack	EP-005 Standard EBike Battery EP-006 Extended Range Battery

2. For each Variable Component add the Variability Item **ev001 EBike Structure** to the Variability Items tab on the main form and Save. This sets Feature/Option scope for Usage Conditions.

- Using the sidebar menu open the Usage Condition Editor for each Variable Component and use the table view or copy/paste these conditions to configure usage according to this chart:

Part	Name	Expression
EP-001	Bafang Gear Hub Motor	[Bicycle Size] = Medium AND [EBike Motor] = [Hub Drive]
EP-002	DNYSYS Gear Motor	[EBike Motor] = [Gear Drive] AND [Bicycle Size] = Large
EP-003	DPX Thumb Throttle	[EBike Conversion] = Compatible AND [Bicycle Size] = Medium AND [EBike Throttle] = Thumb
EP-004	TNT Twist Grip Throttle	[Bicycle Size] = Large AND [EBike Conversion] = Compatible AND [EBike Throttle] = [Twist Grip]
EP-005	Standard EBike Battery	[EBike Conversion] = Compatible AND [Bicycle Size] = Medium
EP-006	Extended Range Battery	[EBike Conversion] = Compatible AND [Bicycle Size] = Large
EP-007	EBike System Controller	<i>(leave blank)</i>

Note: Be sure to try the table mode for Usage Definition. When not provided with copy/paste Usage Conditions the table approach is very convenient and visual.

The screenshot shows the Usage Condition Editor interface. On the left, a sidebar lists variability items: Bicycle Size (checked), EBike Battery P..., EBike Controller, EBike Conversi..., EBike Motor (checked), and EBike Throttle (checked). The main area displays the expression editor with the text: `[Bicycle Size] = Large AND [EBike Throttle] = [Twist Grip]`. Below the editor is a table with columns: Item, Name, and Sequ... (Sequence). The table contains two rows: EP-003 (DPX Thumb Throttle, Sequ... 10) and EP-004 (TNT Twist Grip Throt..., Sequ... 20). On the right, a table view shows the usage conditions for EP-003 and EP-004 across various categories: Bicycle Size (Medium, Large), EBike Throttle (Thumb, Twist Grip), and EBike Conversion (Compatible). Checkmarks indicate that the conditions are satisfied for EP-003 (Medium, Thumb) and EP-004 (Large, Twist Grip).

Configuring the Breakdown Item Structure

1. Create a new Breakdown Item **EB001 EBike Components**, and add all of the above Variable Components to the Content tab and Save.
2. Add EB001 EBike Components to **B012 Bicycle** Breakdown Item's Content tab and Save it.
3. Use the Usage Conditions sidebar menu on the Bicycle Breakdown Item to open the Usage Condition Editor window, and add the expression to the EBike Components row:

[Bicycle Type] = [Fat Bike] AND [EBike Conversion] = Compatible

The screenshot shows the Usage Condition Editor interface. At the top, the expression `[Bicycle Type] = [Fat Bike] AND [EBike Conversion] = Compatible` is entered. Below the input field is a "Valid Expression" status bar. Underneath are four icons: a plus sign in a blue box, a plus sign in a green box, a minus sign in a red box, and a grid icon. At the bottom is a table with the following data:

I...	Item	Name	Expression ↓
	EB001	EBike Component Structure	[Bicycle Type] = [Fat Bike] AND [EBike Conversion] = Compatible

This Usage Condition will configure the structure to show EBike components only when Bicycle Type is 'Fat Bike' and EBike Conversion is 'Compatible'.

4. Save the B012 Bicycle Breakdown Item.
5. Use the Resolution sidebar window to generate a discreet variant where no ambiguities in the Part results remain based on your selections. Pay special attention to the EBike Parts.

Summary

In this unit we added new Features and Options for the EBike variant and configured a Variability Item for EBike structures. This new definition was then added to the overall Bicycle variability by linking it under the Variability Item relationship tab. In effect, this added an EBike conversion capability to the Bicycle variable configuration and constrained EBike Options based on Bicycle Features.

You should now be familiar with:

- Creating custom Variability Items
- Using the Table Rule Editor (vs. Text Rule Editor).
- Re-use of Variability Items in a structure to extend variable configurations.

Review Questions

1. Can I edit Rules from a related Variability Item in the Rule Editor of the source item?
2. How do we determine the Principal vs. Constrained selections when using the Table Rule Editor?
3. What ItemTypes can reference Variability Items?

Review Answers

1. No. Although the Option hierarchy is displayed and the scope of Rule definition is expanded by referenced Variability Items, Rules on referenced items cannot be edited unless opened for Edit.
2. Generally, the Feature/Options on the left side of 'THEN' are principal, and those on the right are Constrained. However, if using a simple Rule like [FEATURE]=[OPTION] then the named Feature is constrained directly by the Option value.
3. Breakdown Items, Variable Components, and other Variability Items. Also, Usage Condition items use them to incorporate Feature/Option scope to use in Usage Expressions.