



physics on screen

Automatic Recognition of Fasteners

ANSA
PRE PROCESSOR

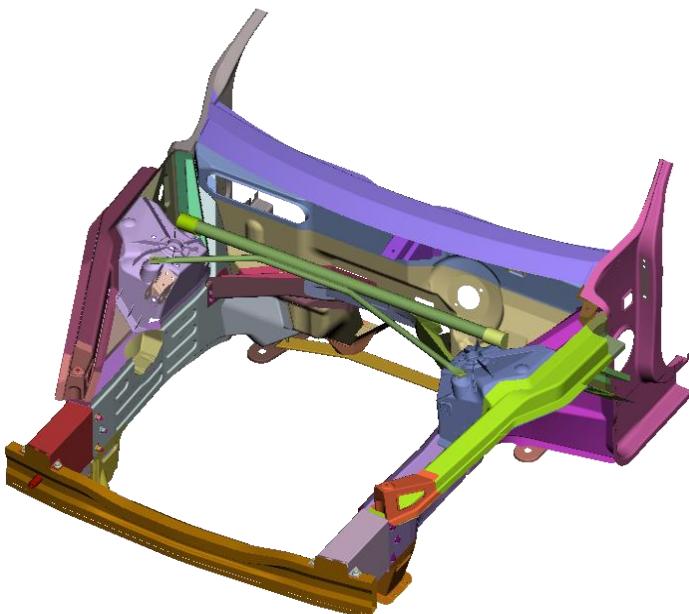


The Challenge

It is very common to include standard parts (bolts, rivets, clips, screws, nuts) as complete geometries in the CAD-data package that is delivered from the PDM. The CAE engineer is called to identify and replace these parts with the appropriate FE entities needed for each analysis types.

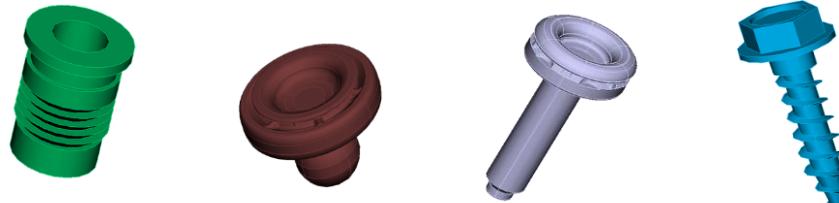
The main challenges that he faces are:

- Recognition of these entities
- Classification of type
- Automatic calculation of the nominal geometric characteristics (i.e. head diameter/ body diameter & length)
- Replacement of standard parts with the needed FE representation



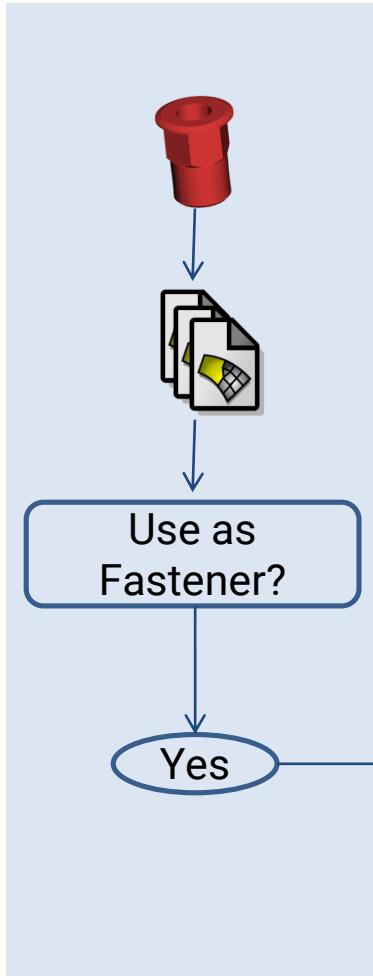
In this document it will be explained how to:

1. Create a fasteners library from scratch using ANSA DM.
2. Identify Fasteners using an already existing Fasteners library
3. Work with the identified fasteners to build the necessary FE representation

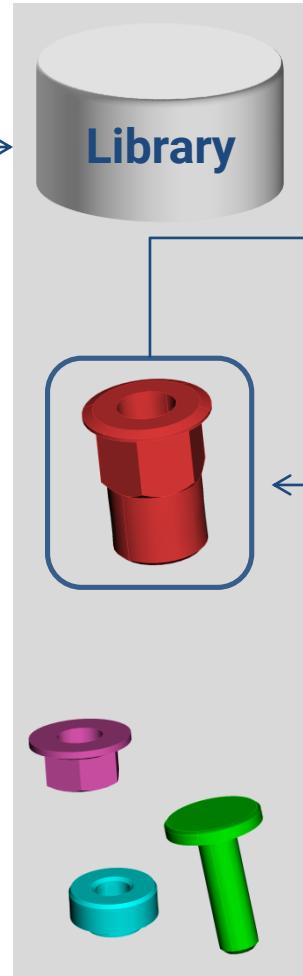


The concept

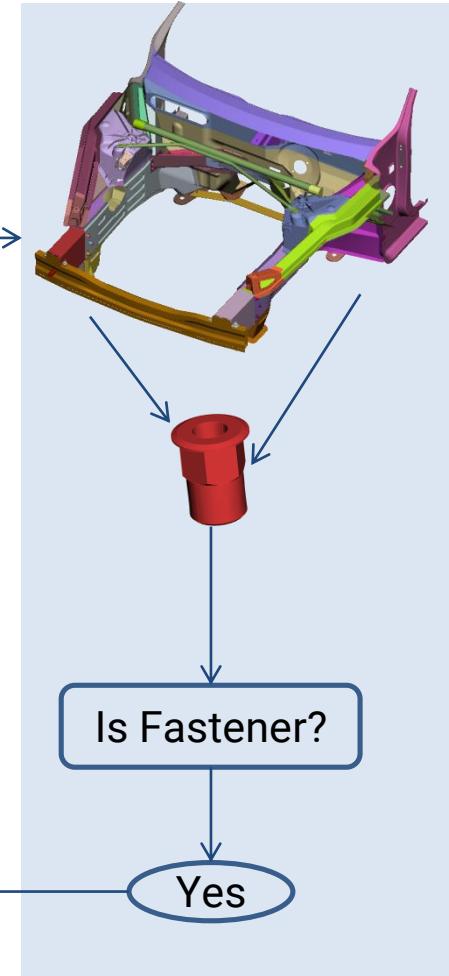
Add in library



ANSA DM



Identify in model



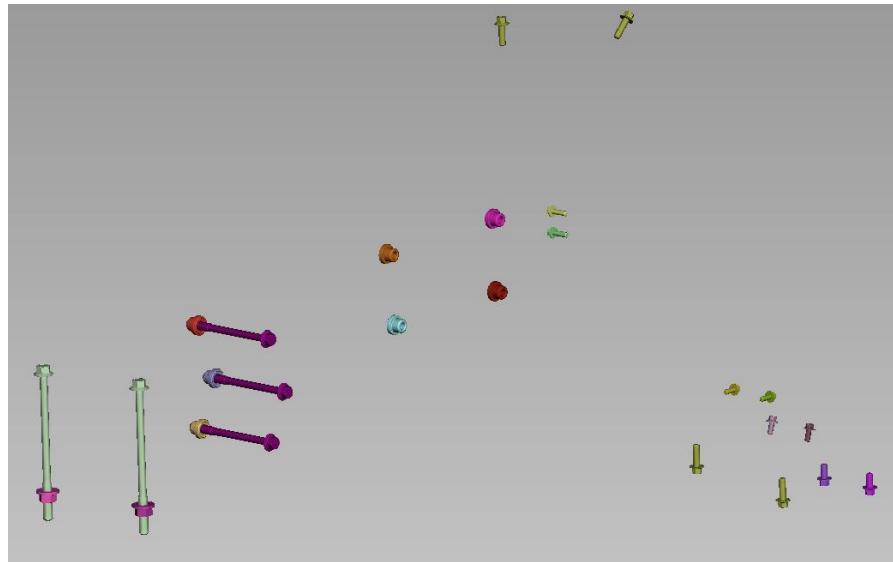
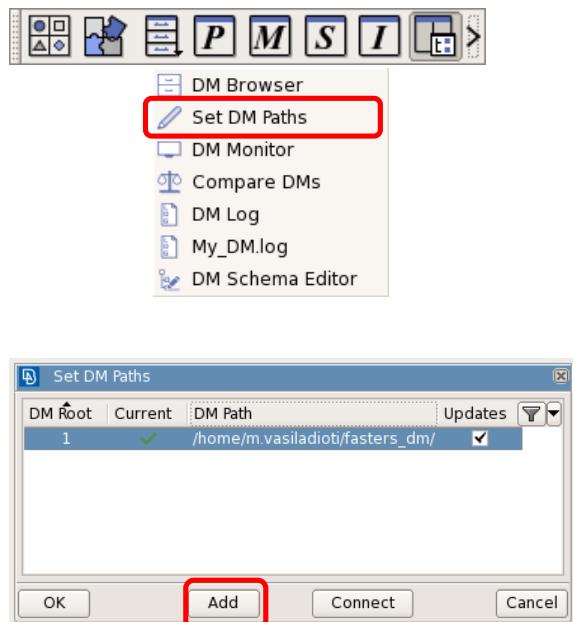
Populate Fastener Library



Populate Fastener Library

Gather the fasteners and set a the path for the library

1. Isolate the faces that constitute the fasteners on the screen.

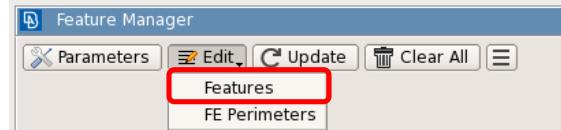


2. In order to create a fasteners library from scratch the DM path where the fasteners will be stored has to be specified.
3. From the Lists toolbar select Set the DM path
4. Press Add in the Set DM Paths window and select the directory. The selected directory is marked as current. Press OK to close the window.

Note!: At this point the, the user can go to **Plugins>Build Fasteners Library** in order to populate a DM with Fasteners with the assistance of a wizard which automates the procedure described in the next slides.

Edit features

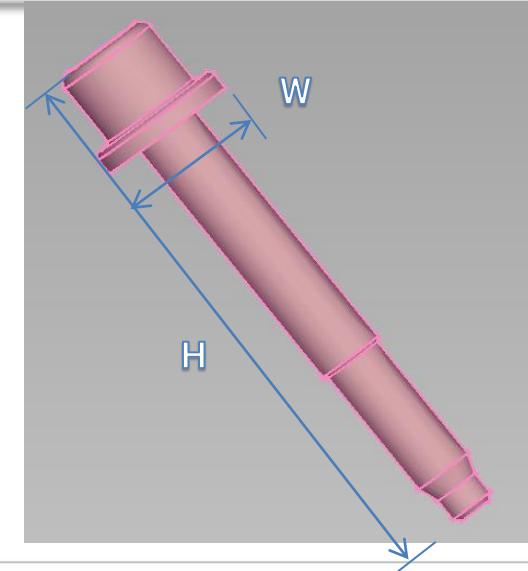
Load isolated Fasteners in Feature Manager



The screenshot shows the 'Features Editor' window on the left with a sidebar containing categories like Flanges 2D, Ribs 2D, Logos, Flanges 3D, Holes 3D, and Fasteners. The 'Fastener Areas' option is selected. To its right is the 'Feature Manager' window showing a table of 'Fasteners' with 11 rows. The fifth row, which corresponds to the selected item in the Features Editor, is highlighted with a red border. The table columns include Id, Width, Height, Axisymmetric, Embedded, Module Id, Type, and Status.

Id	Width	Height	Axisymmetric	Embedded	Module Id	Type	Status
1	26.16	13.	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
2	22.87	180.67	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
3	16.97	33.5	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
4	13.6	26.9	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
5	16.94	24.5	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
6	25.2	19.	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
7	22.78	16.	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
8	18.	13.	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
9	16.	10.	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
10	22.78	16.	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>
11	20.76	129.7	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Bolt	<input type="checkbox"/>

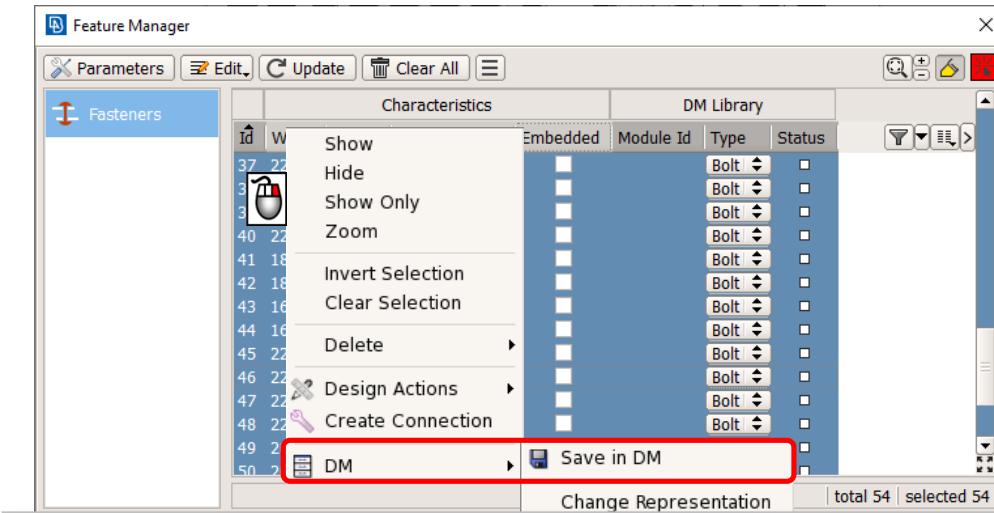
1. Activate the Feature Manager from the Tools toolbar and select Edit>Features.
2. In the Features Editor window, select the fasteners and with Ctrl+A select all the visible faces from the screen. The faces that constitute the fasteners are marked in pink.
3. Press OK. A Fastener feature entity is created per connectivity group. Several characteristics such as Width and Height are automatically filled in.



Note!: The Width, Height, Axisymmetric and Embedded characteristics are automatically filed in based on the fastener's geometry and they are **not** editable. Moreover, if any of the selected Fasteners already exist in the DM, their DM Library Characteristics (Module Id, Version etc.) will be updated too.

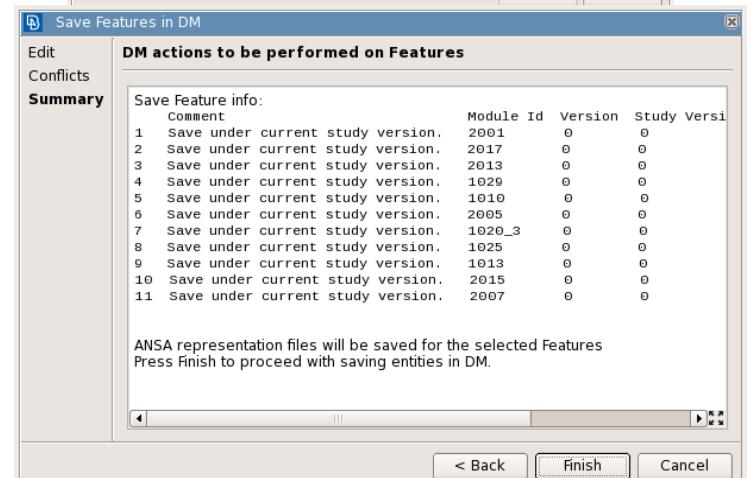
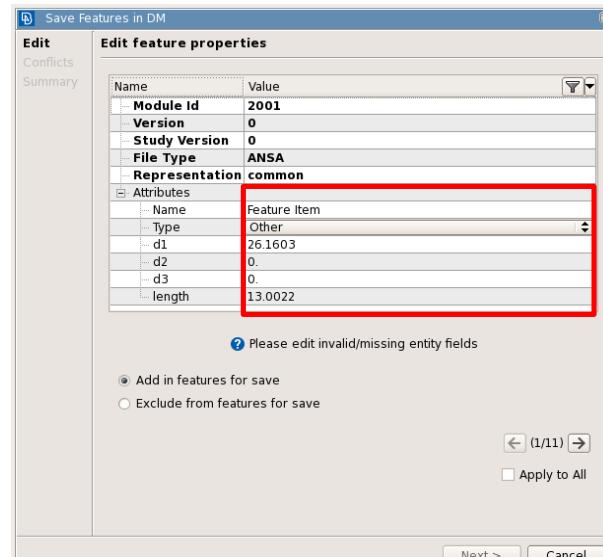
Populate Fastener Library

Save existing Fasteners in DM



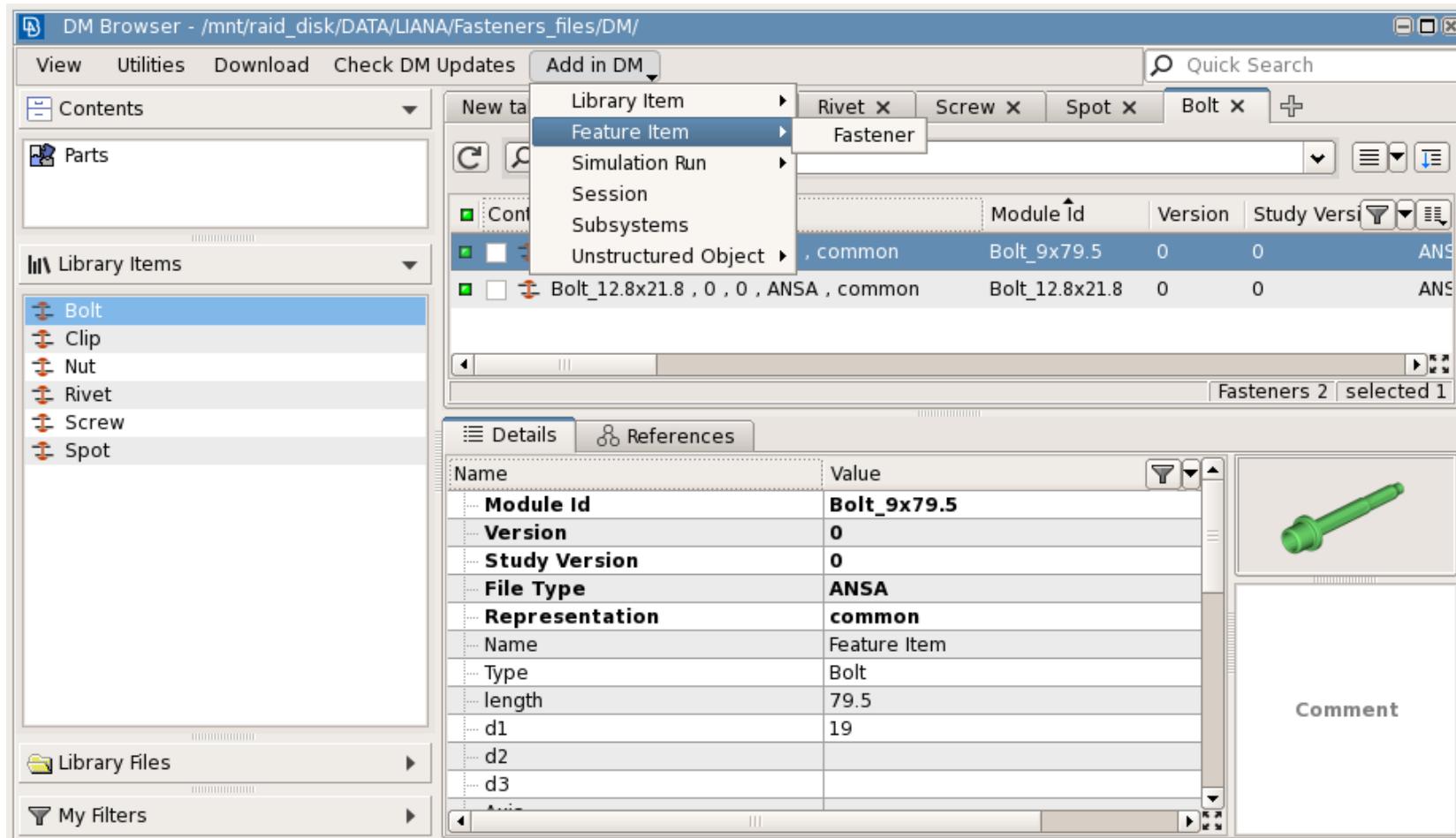
1. Select a fastener listed in Feature Manager and from the context menu select **DM>Save in DM**.
2. In the **Edit** page of the **Save Feature in DM** wizard, the *Module Id*, *Version*, *Study Version* and *Representation* have to be specified.
3. Additionally any of the *attributes* can be edited.
4. Once finished, the fasteners are Saved in DM with the given information.

Note!: When saving DM a new Fastener, ANSA will first identify similar Fasteners and then search in the existing DM library for Fasteners with similar Geometry. If a match is found, the Fastener's characteristics values are updated according to the information found in DM. In this way, duplicated Fasteners are avoided.



Populate Fastener Library

Add Fastener via DM Browser

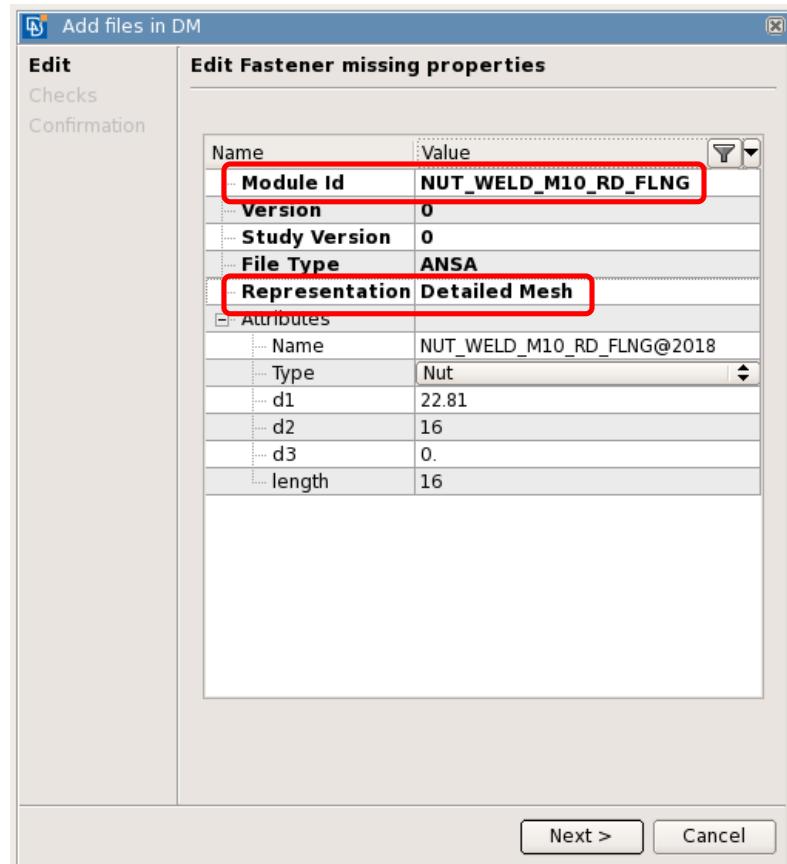
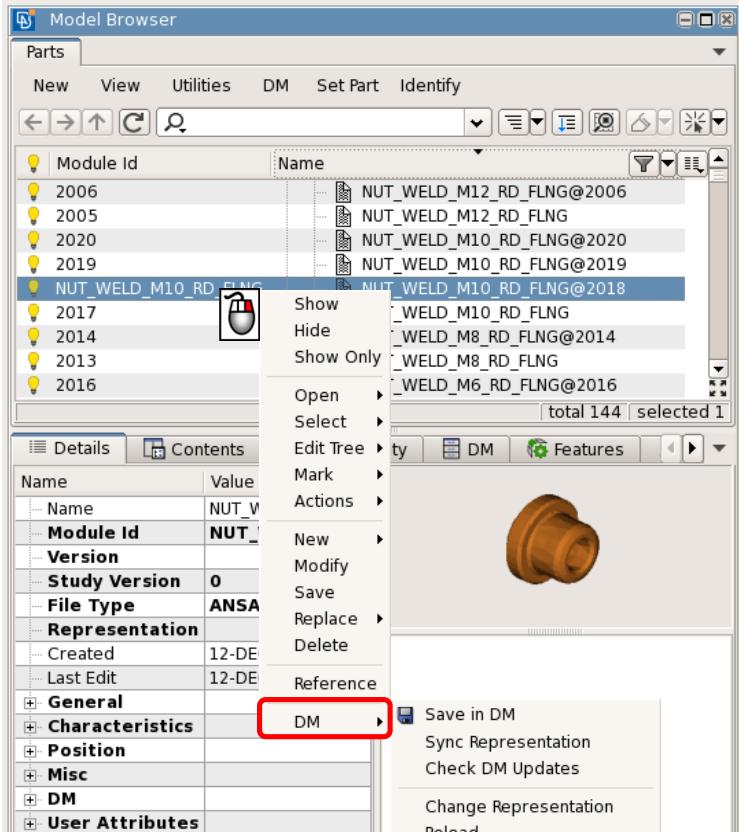


An ANSA files containing a Fasteners can be added in the Library using
Add in DM>Feature Item>Fastener.

Populate Fastener Library

Adding a new Fastener or Representation

Alternatively a new Fastener can be added from Model Browser.



To create a **new representation** for an already existing fastener in DM, a new fastener has to be added with the **same Module Id** as the existing Fastener.

Populate Fastener Library

Review Fasteners in DM

Stored Fasteners and their metadata can be viewed in DM Browser.

The screenshot shows the DM Browser window with the following interface elements:

- Toolbar:** Includes icons for various functions like Set DM Paths, DM Monitor, Compare DMs, DM Log, My_DM.log, and DM Schema Editor. The "DM Browser" icon is highlighted with a red box.
- Menu Bar:** View, Utilities, Download, Check DM Updates, Add in DM, Quick Search.
- Contents Tab:** Shows a list of fasteners:
 - Bolt M10x110 , 0 , 0 , ANSA , common
 - Bolt_M11x170 , 0 , 0 , ANSA , common
 - M06x1.00x20.0_HEX_FLNG_HD , 0 , 0 , ANSA , common
 - M08x1.25x16.0_HEX_FLNG_HD , 0 , 0 , ANSA , common
- Library Items:** A tree view showing Bolt, Nut, and Screw categories. The Screw category is selected, indicated by a blue selection bar.
- Details Tab:** Displays detailed information for the selected fastener (Bolt M10x110).

Name	Value
Module Id	Bolt_M10x110
Version	0
Study Version	0
File Type	ANSA
Representation	common
Name	Feature Item
Type	Bolt
length	129.7
d1	20.7644
d2	
- References Tab:** Shows a list of references associated with the selected fastener.
- Image View:** A preview area showing a 3D model of a bolt and a comment section below it.

Populate Fastener Library

Stored Fasteners and their metadata can be viewed in DM Browser

The screenshot shows the SolidWorks Feature Manager and DM Browser interface. In the Feature Manager, a table of fasteners is listed under the 'Fasteners' category. A context menu is open over the first row, with the 'Show in DM' option highlighted. The DM Browser window is open, showing the selected fastener's details. The 'Show in DM' option is also highlighted in the DM Browser's context menu.

1. Select a fastener listed in feature manager and from the context menu select **DM>Show in DM**.

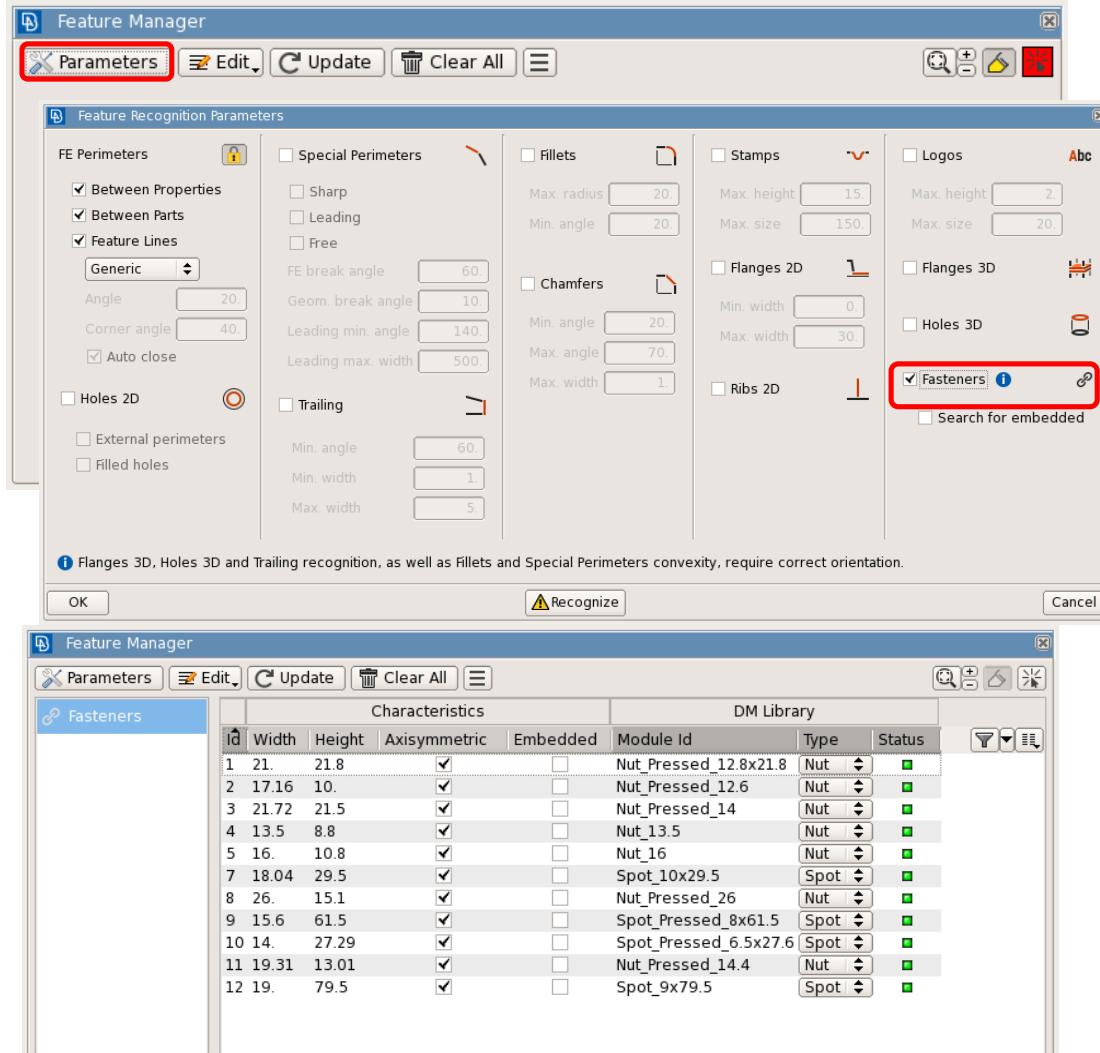
2. The DM Browser pops up having the specific item loaded, where all the features attributes and details can be inspected.

Recognize Fasteners from Library



Recognize Fasteners from existing library

Set DM path and Recognize Fasteners from Feature Manager

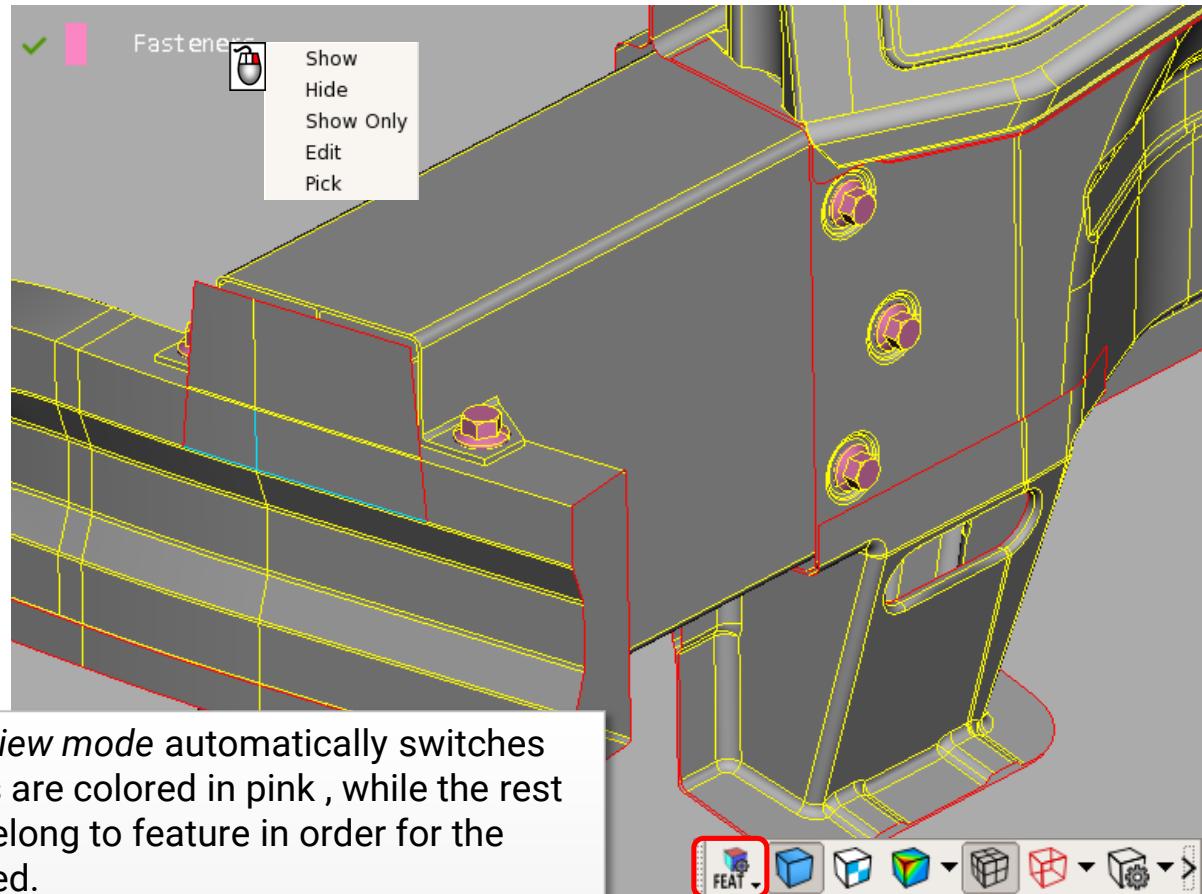


1. Use **DM>Set the DM** path and select the DM with the stored fasteners. Press **OK** to close the window.
2. From the Tools toolbar invoke Feature Manager.
3. Press the Parameters button and activate the Fasteners detection.
4. Press Recognize and **OK**. ANSA will try to recognize / match fasteners from the DM to geometries that exist in the model.
5. Identified fasteners are listed along with their characteristics i.e. width, height etc.

Note!: Pressing **Recognize** overwrites the already listed Fastener Features from the Feature Manager.

Recognize Fasteners from existing library

Identified fasteners in feature draw mode



- After the fasteners detection, *view mode* automatically switches to *feature draw mode*. Features are colored in pink , while the rest of the model which does not belong to feature in order for the fasteners be easily distinguished.
- Isolation of them is possible from the context menu of the fasteners label on the top left corner of the screen.
- Recognition of Fasteners as features does not alter the hierarchy of the model.

Recognize Fasteners from existing library

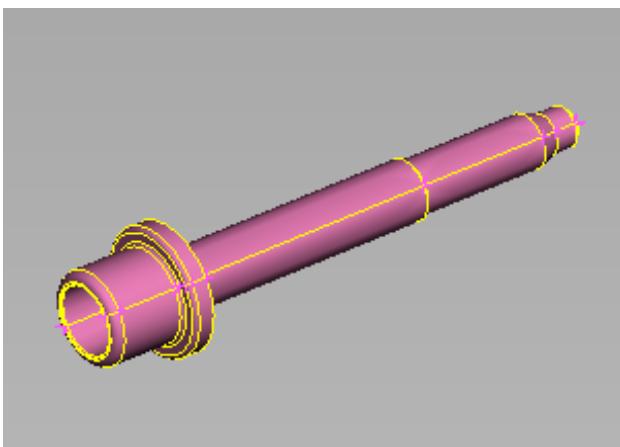
Fasteners status and characteristics in Feature Manager

Characteristics					DM Library		
ID	Width	Height	Axisymmetric	Embedded	Module Id	Type	Status
1	16.94	24.5	✓	□	M08x1.25x16.0_HEX_FLNG_HD	Nut	Green
2	16.94	24.5	✓	□	M08x1.25x16.0_HEX_FLNG_HD	Bolt	Green
3	16.94	24.5	✓	□	M08x1.25x16.0_HEX_FLNG_HD	Nut	Green
4	16.94	24.5	✓	□	M08x1.25x16.0_HEX_FLNG_HD	Clip	Green
5	25.2	19.	✓	□	NUT_WELD_M12_RD_FLNG	Spot	Green
6	25.2	19.	✓	□	NUT_WELD_M12_RD_FLNG	Rivet	Green
7	13.6	26.9	✓	□	M06x1.00x20.0_HEX_FLNG_HD	Screw	Green
8	13.6	26.9	✓	□	M06x1.00x20.0_HEX_FLNG_HD	Other	Green
9	13.6	26.9	✓	□	M06x1.00x20.0_HEX_FLNG_HD	Bolt	Green
10	13.6	26.9	✓	□	M06x1.00x20.0_HEX_FLNG_HD	Bolt	Green
11	16.97	33.5	✓	□	Flange_screw_M8	Screw	Green
12	16.97	33.5	✓	□	Flange_screw_M8	Screw	Green
13	16.97	33.5	✓	□	Flange_screw_M8	Screw	Green
14	16.97	33.5	✓	□	Flange_screw_M8	Screw	Green
15	16.97	33.5	✓	□	Flange_screw_M8	Screw	Green

total 40 selected

DM Update Status

- Green : Mesh representation applied
- Orange : Mesh representation automatically modified
- Purple : Mesh representation user modified
- Grey : No mesh representation applied
- Yellow : No mesh representation found
- Blue : Not detected

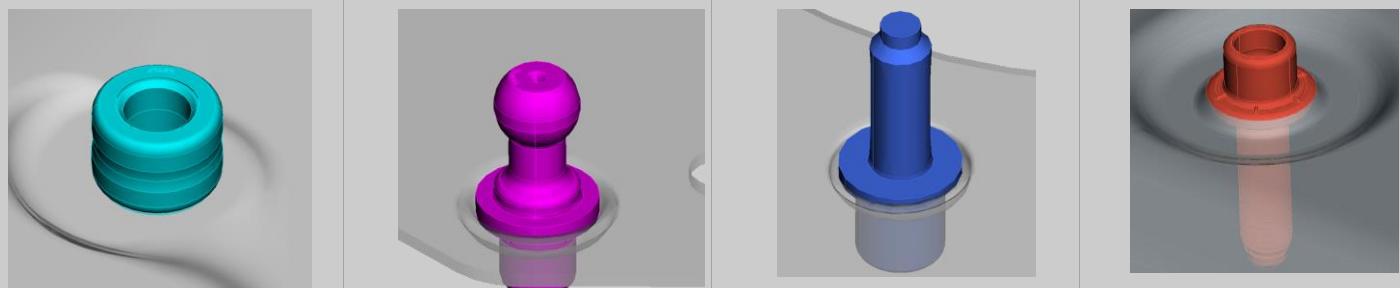


1. The Module Id, Type etc. are listed as retrieved from the fasteners library (ANSA DM), but they can be manually altered by the user.
2. Columns with additional information like Version or Representation regarding the fasteners can also be added in the list.
3. In the Status column color coded information regarding the DM Update Status is provided.

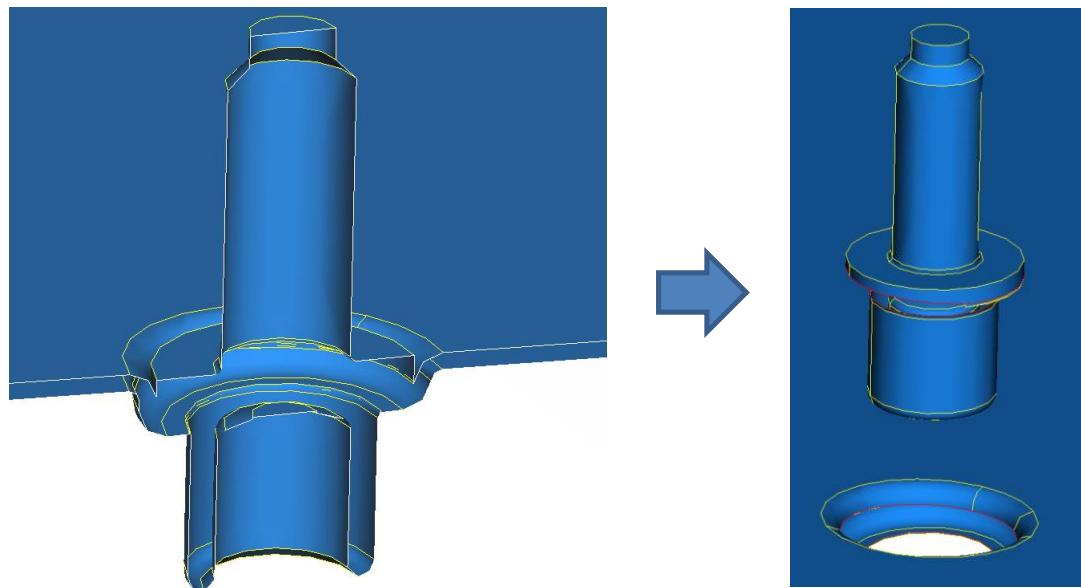
Recognize Embedded Fasteners

Embedded Fasteners are identified and isolated

Embedded
Axis-symmetric
Fasteners

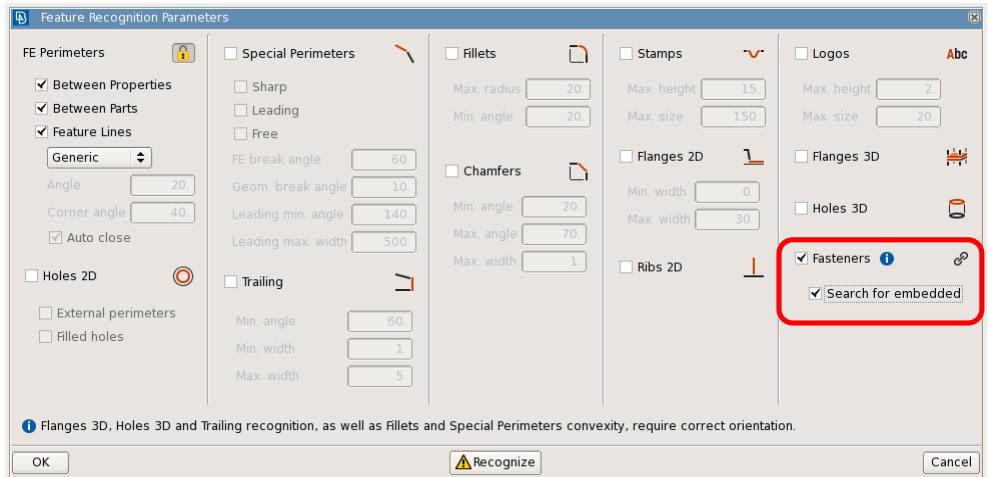


Embedded Fasteners are those that have been incorporated in the body of a part.



Recognize Embedded Fasteners

Embedded Fasteners are identified and isolated



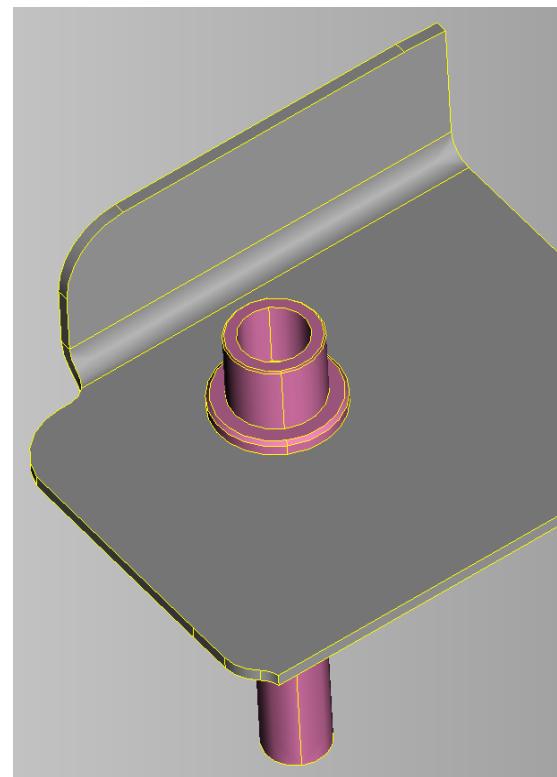
1. To identify Fasteners embedded on parts activate the **Search for embedded** sub-option.

2. The identified as embedded features get the embedded check box activated.

Id	Width	Height	Axisymmetric	Embedded	DM Library		
					Module Id	Type	Status
11	15.6	61.5	✓	✓	Spot_Pressed_8x61.5	Spot	■
7	18.	29.5	✓	✓	Spot_10x29.5	Spot	■
8	18.	29.5	✓	✓	Spot_10x29.5	Spot	■
9	26.	15.1	✓	✓	Nut_Pressed_26	Nut	■
10	26.	15.1	✓	✓	Nut_Pressed_26	Nut	■
12	19.31	13.01	✓	✓	Nut_Pressed_14.4	Nut	■
3	21.72	21.5	✓	✓	Nut_Pressed_14	Nut	■
4	21.72	21.5	✓	✓	Nut_Pressed_14	Nut	■
1	21.	21.8	✓	✓	Nut_Pressed_12.8x21.8	Nut	■
2	17.16	10.	✓	✓	Nut_Pressed_12.6	Nut	■
6	16.35	10.8	✓	✓	Nut_16	Nut	■
5	13.5	8.8	✓	✓	Nut_13.5	Nut	■

Note!: Only axisymmetric fasteners can be identified when they are one part with the rest of the geometry.

Identification of embedded fasteners require considerable more time.

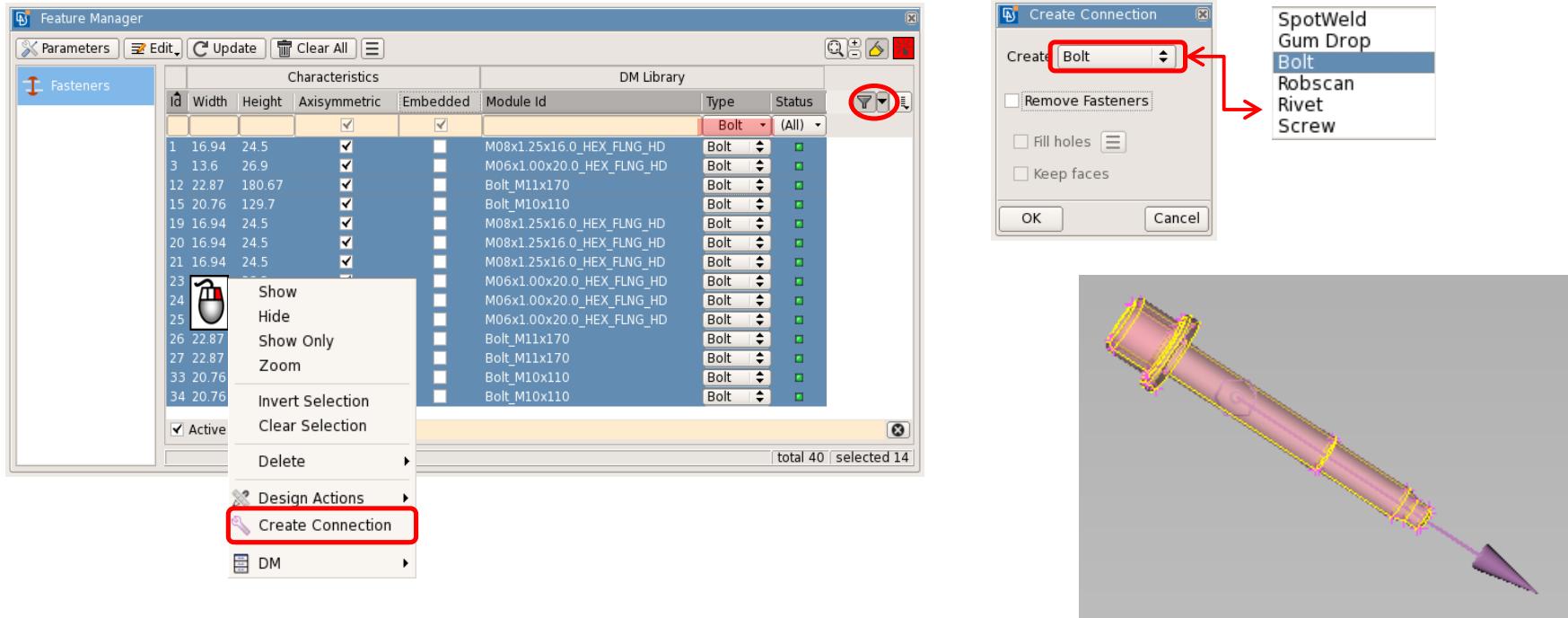


Working with Fasteners



Working with Fasteners

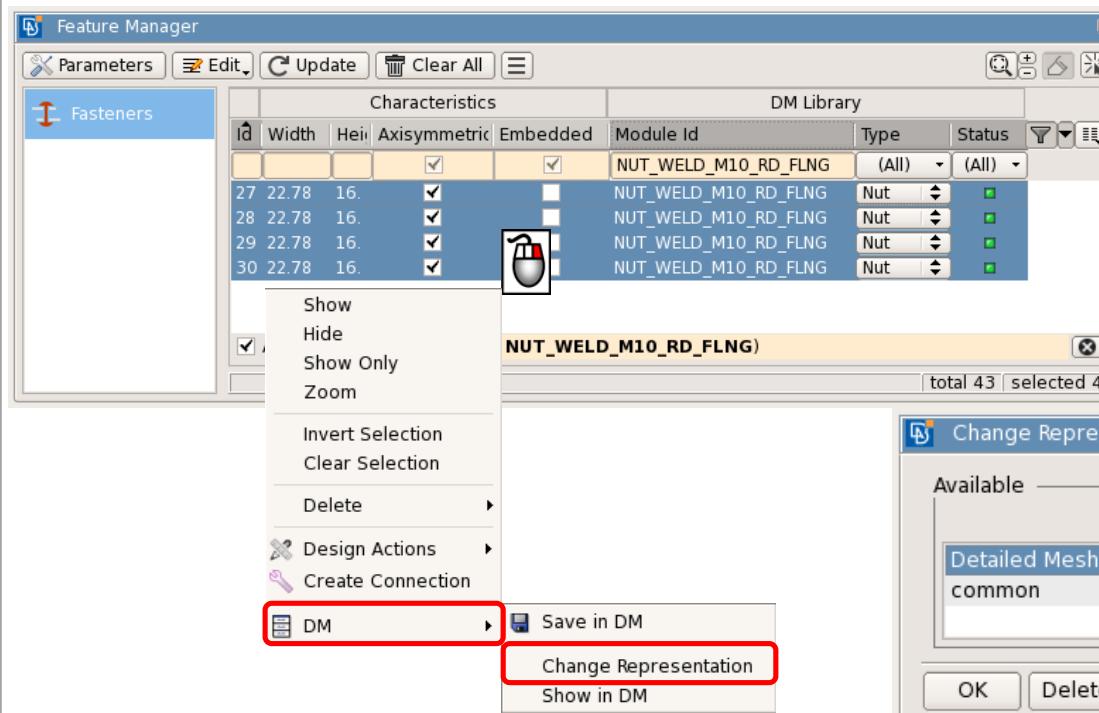
Connection creation



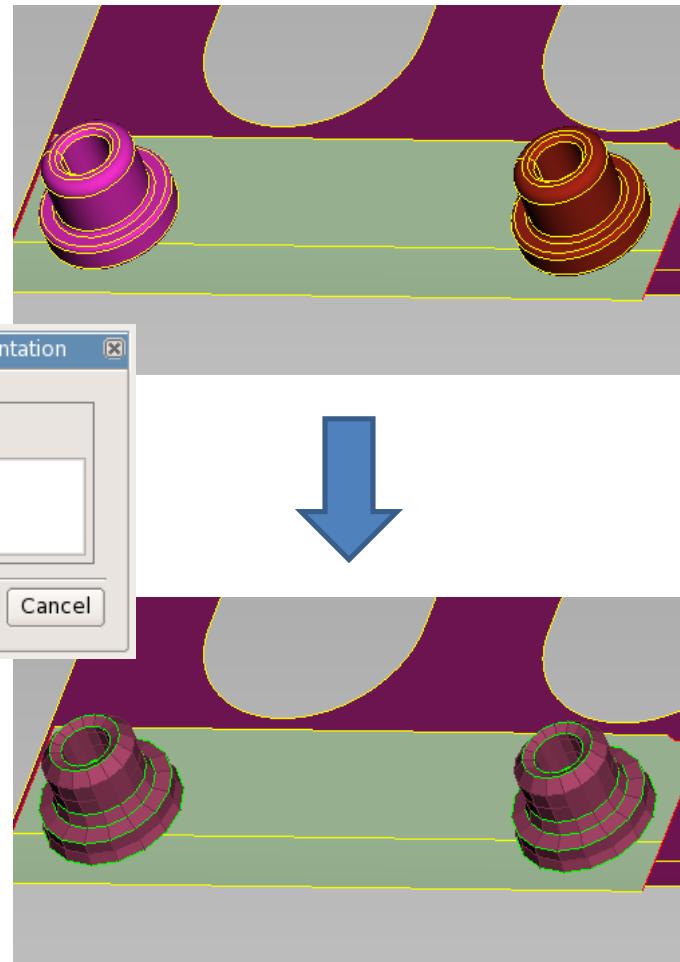
1. Activate the filter in Feature Manager and select all fasteners of Type "Bolt".
2. From the context menu select **Create Connection**.
3. In the **Create Connection** window which pops up, the user can change of type of the connection to be created, as well as make options regarding the removal of the fastener.
4. Upon **OK** the connection manager pops up with the created connection loaded. The connection has adopted the characteristics (Washer, Length) from the identified fastener. The user has to manually add the correct connectivity and select the desired FE Representation.

Working with Fasteners

Change fastener's representation

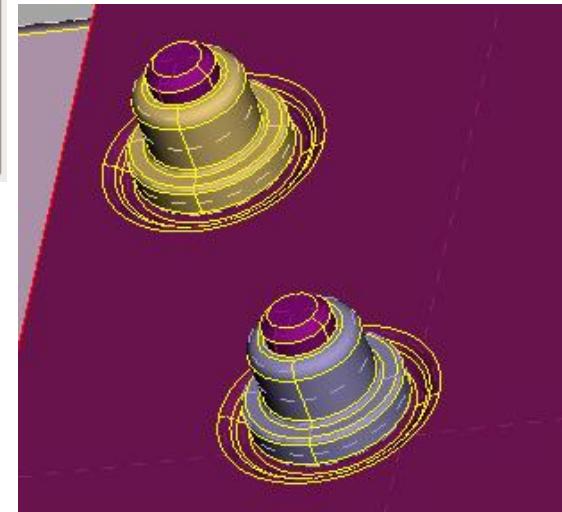
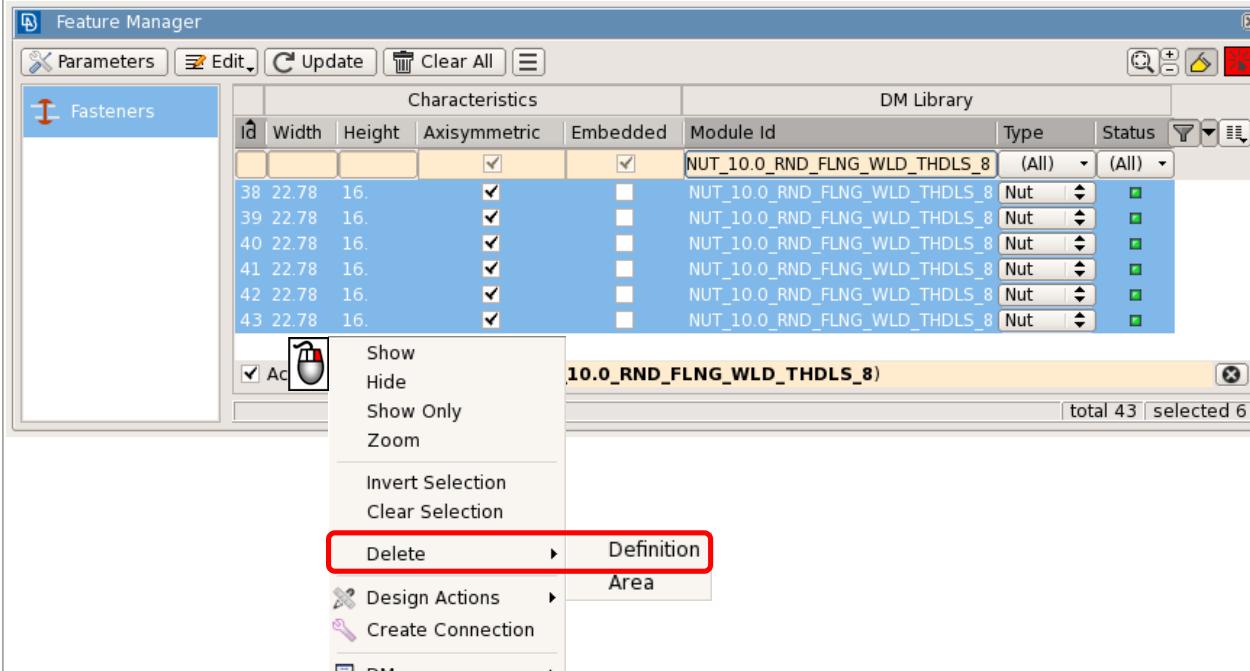


1. Activate the filter in the **Feature Manager** and select all Fasteners with Module Id “**NUT_WELD_M10_RD_FLNG**”.
2. From the context menu select **DM>Change Representation** and select the “*Detailed Mesh*” among the available representations.



Working with Fasteners

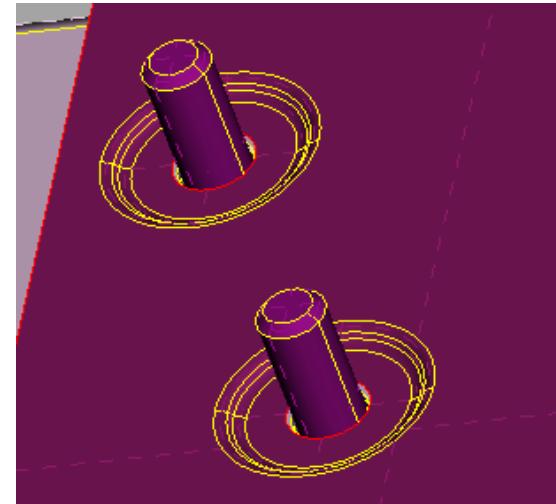
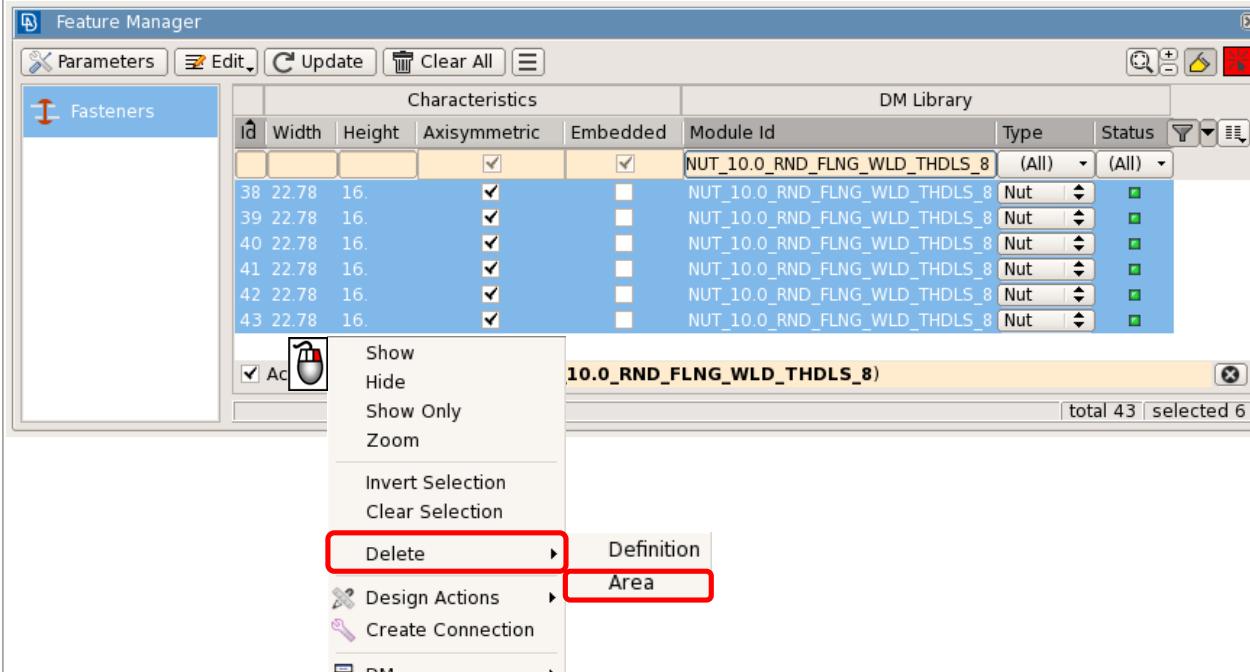
Fastener deletion > Definition



1. Select a Fastener in the **Feature Manager** and from the context menu select **Design Actions>Delete> Definition**.
2. The fastener is deleted from the fastener list in the feature manager. Faces that were defining the fastener are maintained

Working with Fasteners

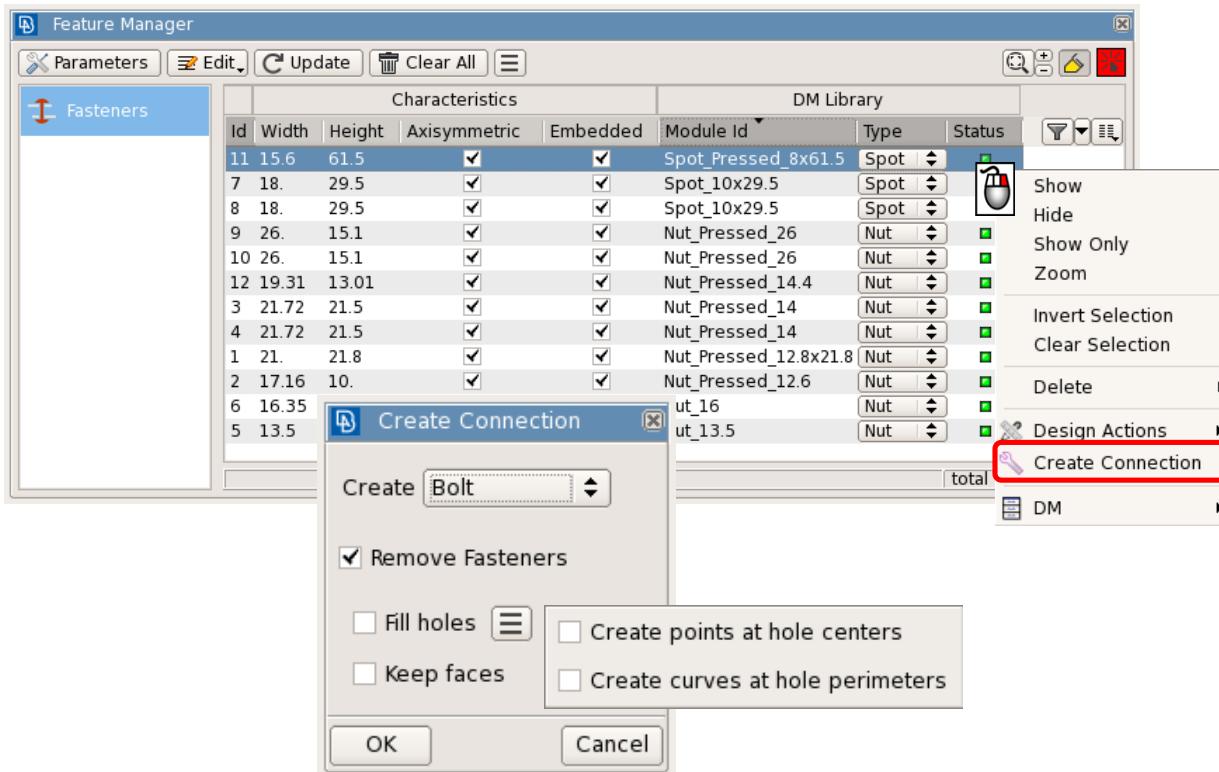
Fastener deletion > Area



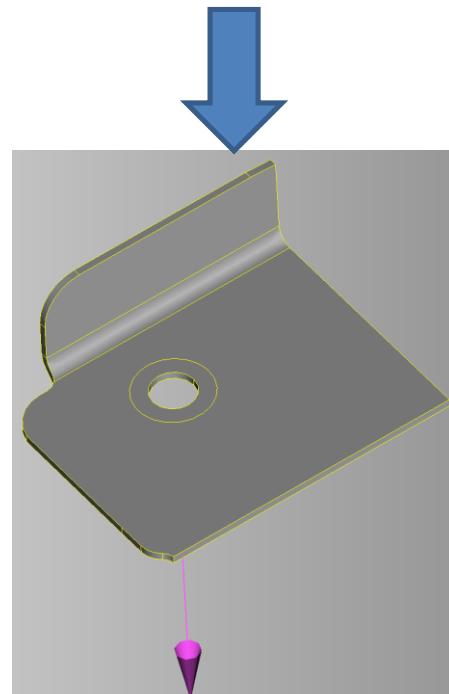
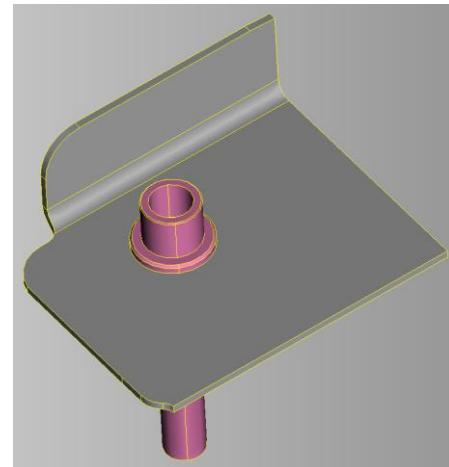
1. Select a Fastener in the **Feature Manager** and from the context menu select **Design Actions>Delete>Area**.
2. Upon **OK** in the confirmation window, both fastener entry and the faces that constitute the Fasteners are deleted.

Working with Fasteners - Embedded

Connection creation

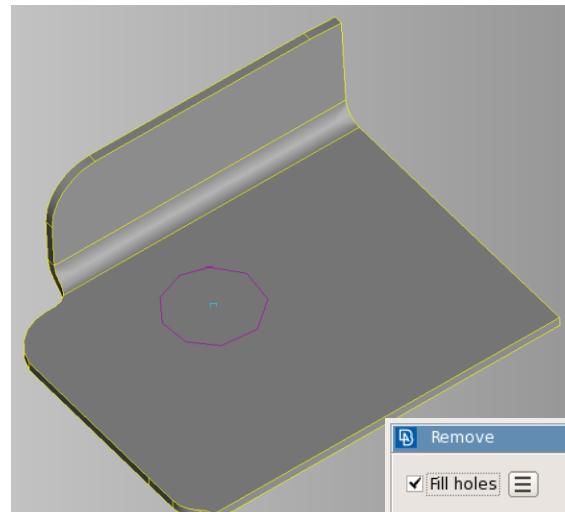
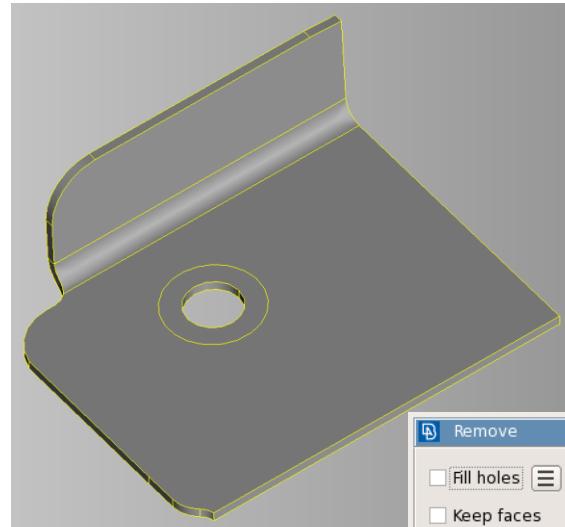
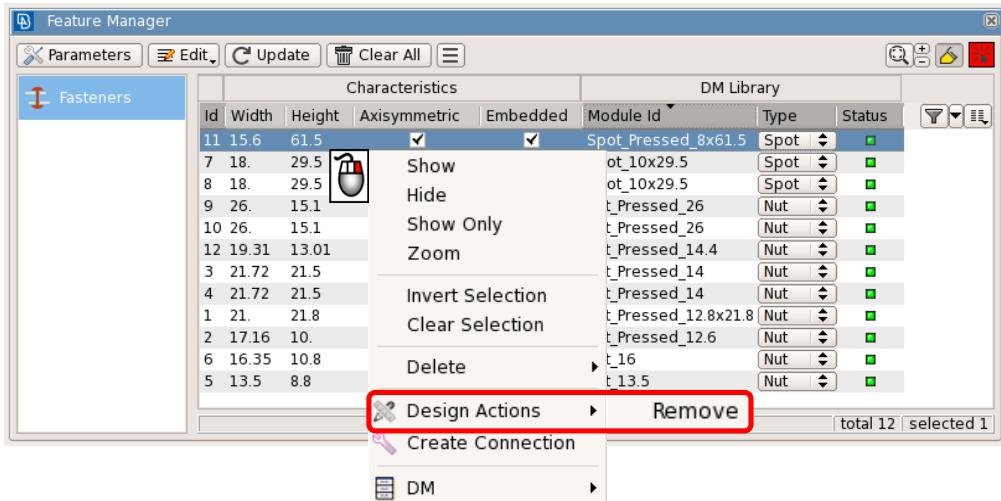


1. Select **Create connection** from the context menu.
2. In the **Create Connection** window select the fasteners to be removed. The Fastener has been replaced with the created bolt connection, while the gap left to the part has been filled up
3. Upon **OK** the connection manager pops up with the created connection loaded.



Working with Fasteners - Embedded

Removal of Fasteners



1. Select a fastener in the Feature Manager and from the context menu select **Design Actions>Remove**.
2. In the **Remove** window the user has the options to **Fill holes** and /or to keep the faces. As well as to create curves and 3D points in the holes.

Note!: **Keep faces** will prevent deletion of the faces that constitute the Fastener. If the Fastener is embedded it will be detached.

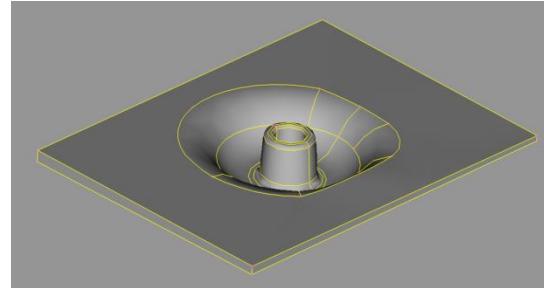
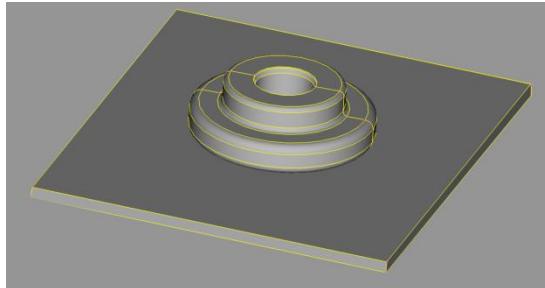
Populating Library with Embedded Fasteners



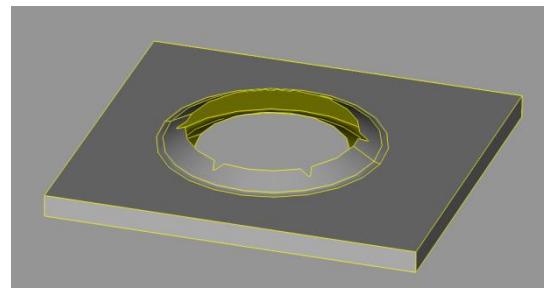
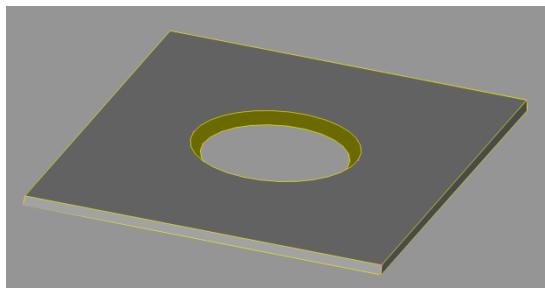
Populate Fasteners Library - Embedded

Embedded Fasteners categorization.

1. Fasteners **with/ without** stamping area around them.



2. Fasteners with **regular/ irregular** bounds.

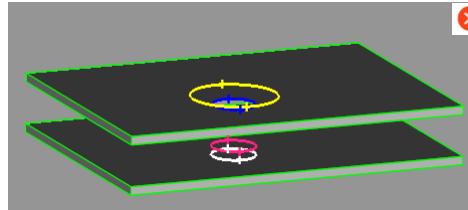
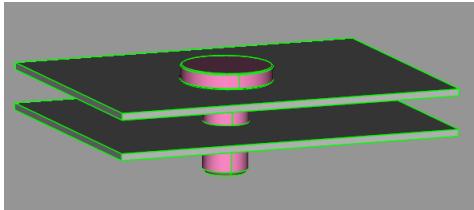


The first step when populating the Fasteners Library with embedded Fasteners, is to isolate the Faces that constitute the Fastener. This is a procedure that is case dependent .
In the next slides, you will find the proposed workflow for each featured case.

Function requirements

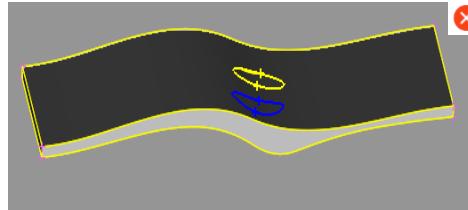
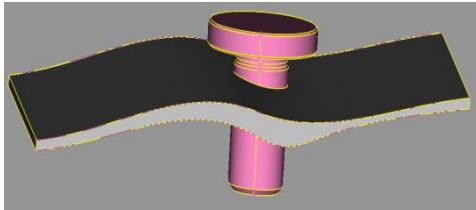
Before heading in each different case, there are some common function requirements so that the bounds of the Embedded Fasteners can be released successfully:

- Fasteners must be connected to the main Part via one or two bound lines (no more than two).



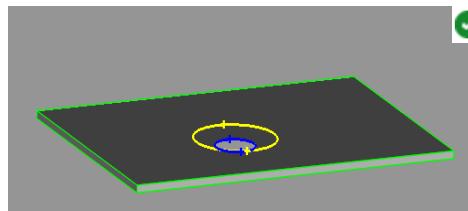
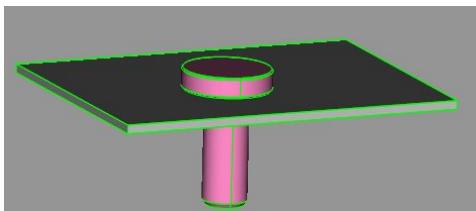
Fastener has 4 bound lines with the main part. This will cause issues during recognition and removal of Fastener.

- At least one bound line must be regular and flat.



Fastener bounds are both not flat. This will cause issues during recognition and removal of Fastener.

- The bound lines must be closed and concentric to the Fastener. (Round bounds are preferred/prioritized by the algorithm.)

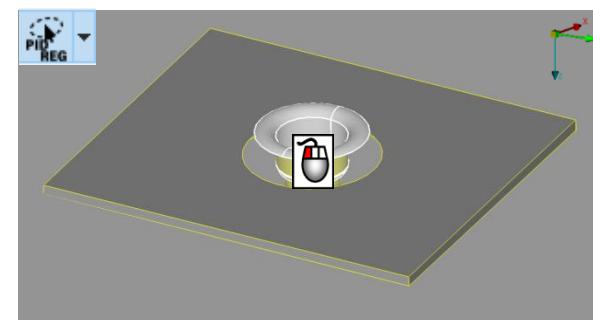
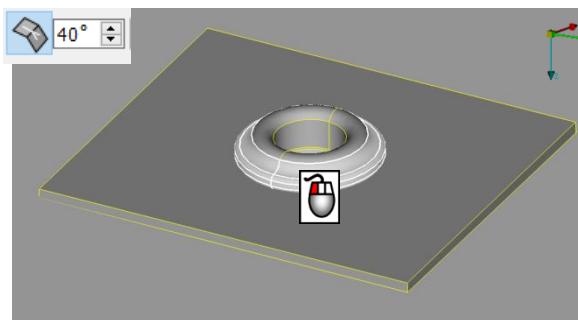
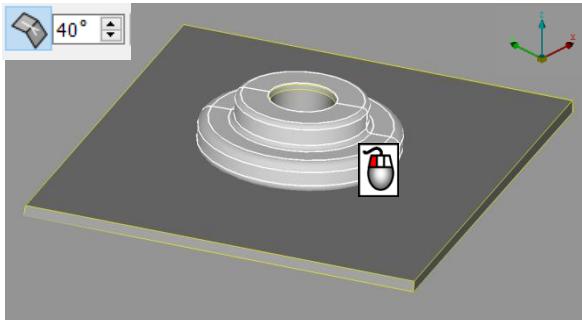


Fastener bounds are satisfy all function requirements.

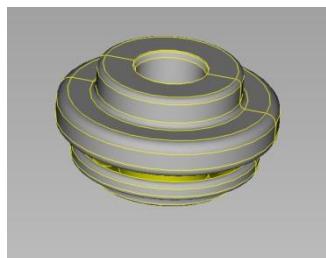
Isolating Embedded Fasteners

Case 1: with Feature Area selection (e.g. Fasteners without stamping area)

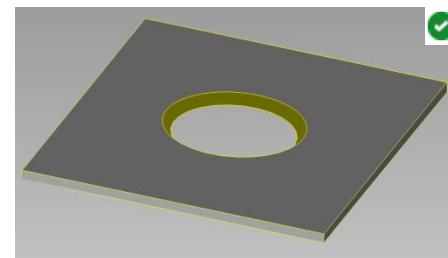
1. Isolate the Part where the embedded Fastener exists.
2. Use the **!Not** command from the Focus toolbar to isolate the Faces that constitute the Fastener.



Visible Entities:



Hidden Entities:

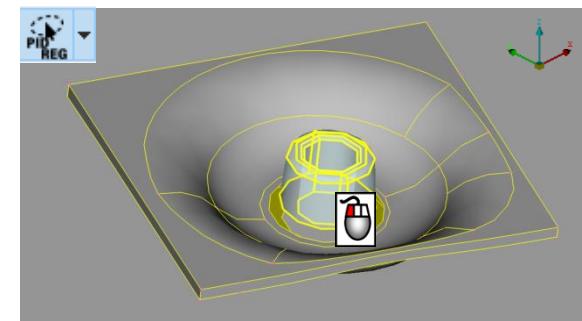
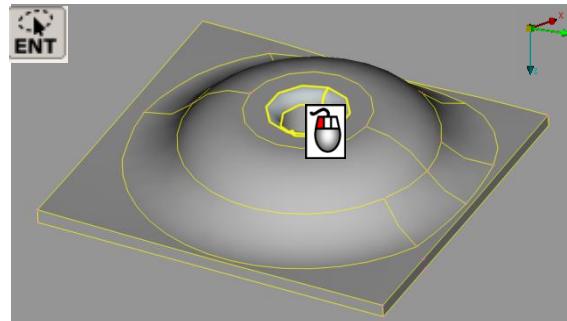
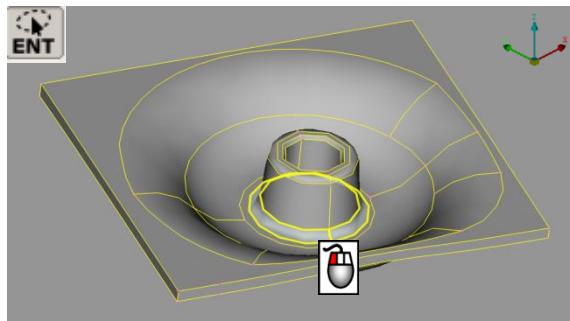


Note! :This case is the most common and should be considered as the default one. In cases where, the **Feature Area** selection tool does not give the desired result, the alternative workflows should be followed.

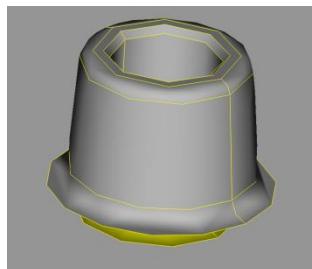
Isolating Embedded Fasteners

Case 2: without Feature Area selection (e.g. Weldnuts on stamping area)

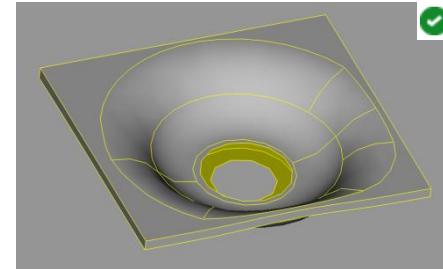
1. Isolate the Part where the Embedded Fastener exists.
2. Use the **!Not** command from the Focus toolbar to isolate the Faces that constitute the Fastener.



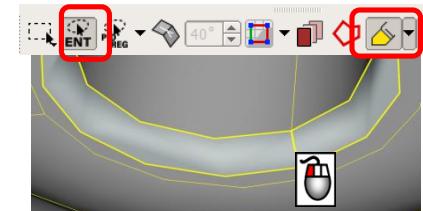
Visible Entities:



Hidden Entities:



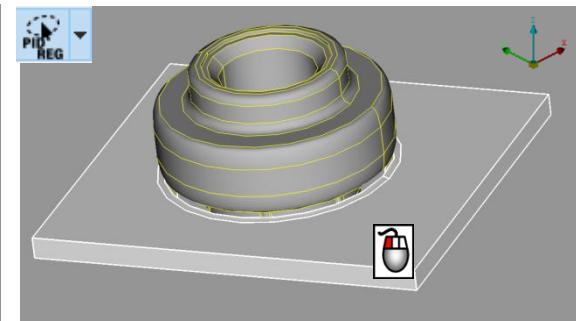
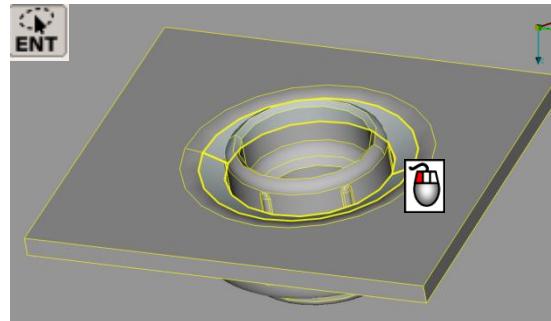
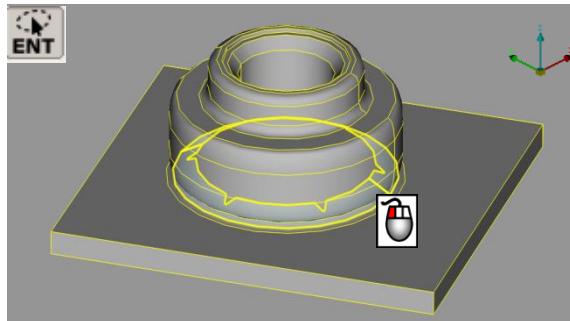
Note!: In such cases, the tricky part is to select the boundary Faces of the Fastener. A useful tip is to enable the **Highlight** option and hover over the boundary CONS. The Faces to be selected are highlighted.



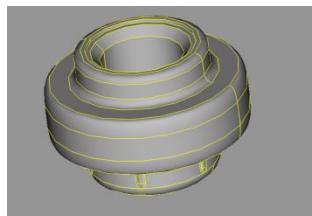
Isolating Embedded Fasteners

Case 3: Stamping area - irregular bounds

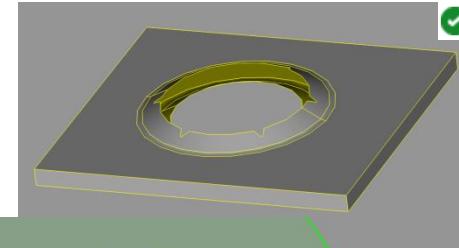
1. Isolate the Part where the Embedded Fastener exists.
2. Use the **Not** command from the Focus toolbar to hide the surrounding Entities.



Visible Entities:

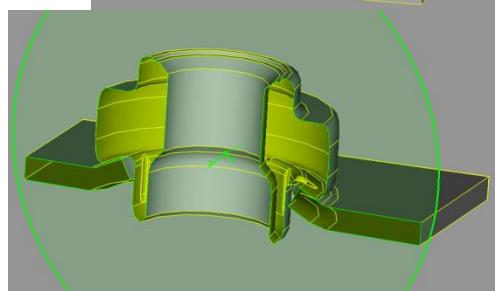


Hidden Entities:



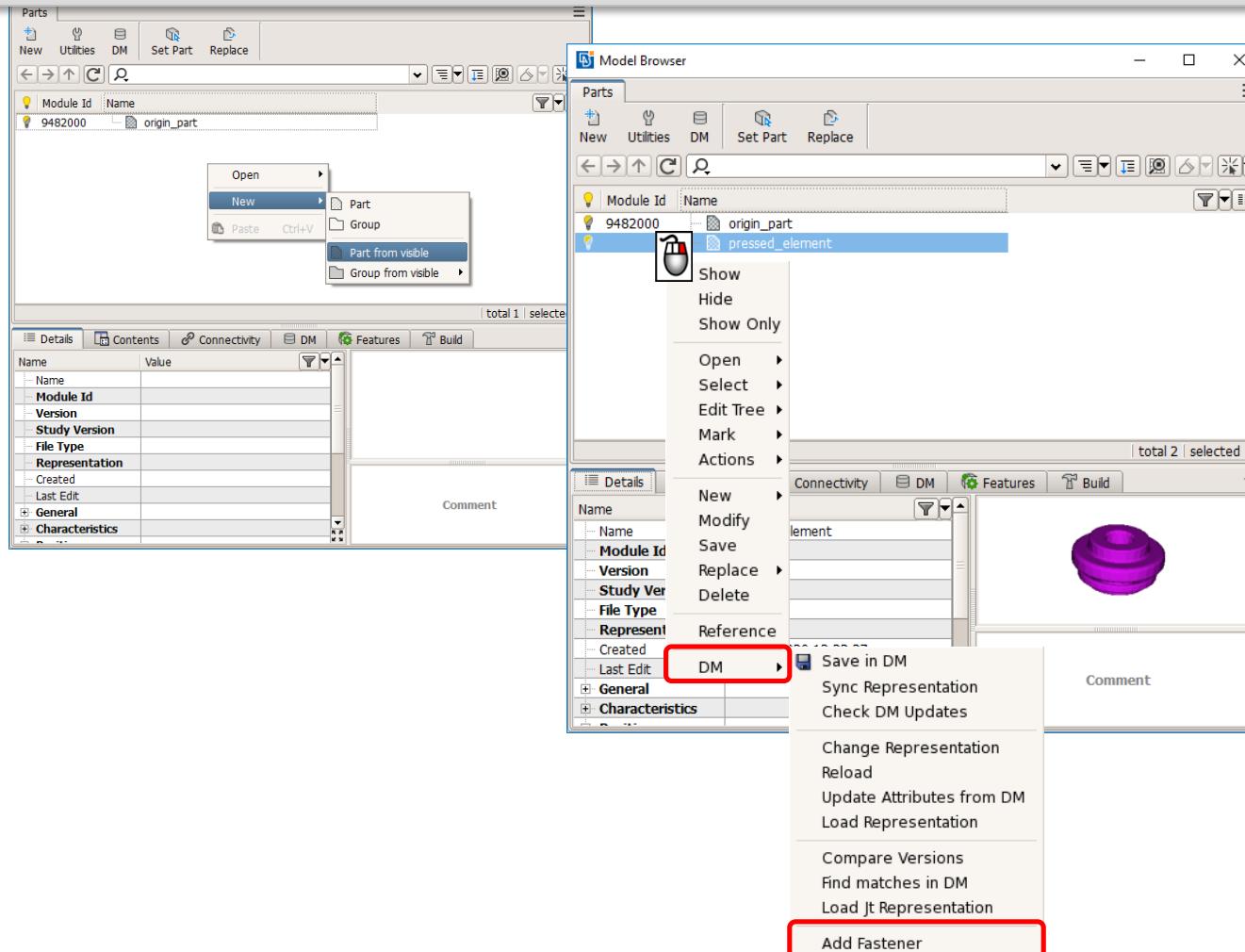
In such cases, the user can use a Model Cut to better visualize the bounds of the Fastener.

Note! the Feature Area selection tool provides good results for irregular bounds too. Thus, this workflow should be considered as an alternative to Case 1.



Add new Fastener in DM

- Once the Fastener's Faces has been isolated, open the Model Browser and create a new Part from the visible Entities.
- Select the newly created Part and add it to DM as a Fastener.



Review Fasteners in DM



Stored Fasteners and their metadata can be viewed in DM Browser.

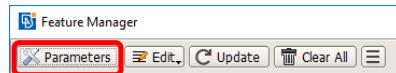
A screenshot of the DM Browser interface. The main window title is 'DM Browser'. A tab titled 'Bolt' is active. The left sidebar shows 'Library Items' with a single item named 'Bolt'. The central pane displays a table of metadata for the selected item. The table includes columns for Name, Value, and Type. The selected row is 'pressed_element'. The table rows are as follows:

Name	Value
Module Id	pressed_element
Version	0
Study Version	0
File Type	ANSA
Representation	common
File	DM:/Fastener/pressed_element/0/0/ANS
Name	pressed_element
Type	Bolt
length	17.594
d1	32
d2	10.38

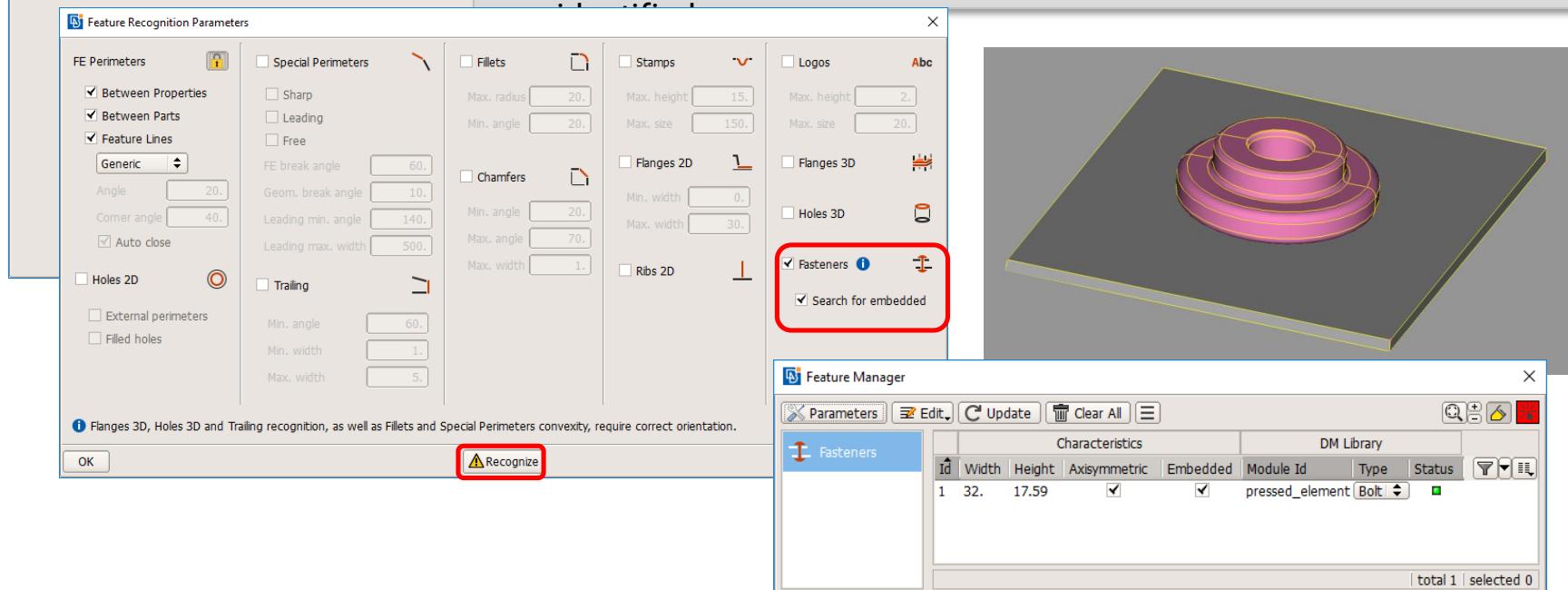
On the right side of the interface, there is a 3D view of a purple cylindrical bolt component.

Check Results

Recognize Fasteners



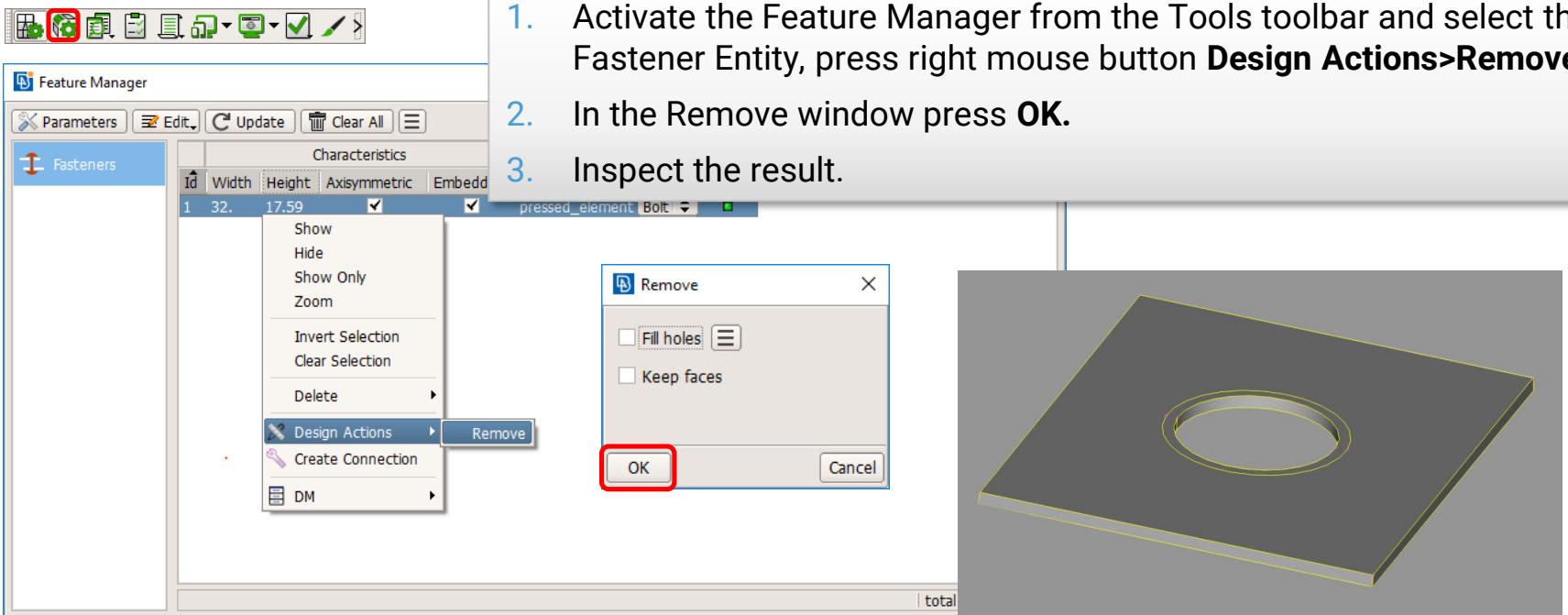
1. Activate the Feature Manager from the Tools toolbar and select **Parameters**.
2. In the Feature Recognition Parameters window, select the Fasteners check box. Moreover, enable the **Search for embedded** check box.
3. Press **Recognize**. A Fastener feature entity should have been created.



Note!: Width, Height, Axisymmetric and Embedded characteristics are automatically filed in based on the fastener's characteristics saved in DM and they are **not** editable.

Check Results

Remove Fastener



When Removing fasteners, the Feature Manager will always create a Hole 3D whose diameter is equal with the smallest diameter of the removed Fastener.

Note!: In case, the Recognition or the Removal of the Embedded Fastener fails the user should:

1. Make sure that the bounds satisfy the function requirements.
2. If there is a stamping area, expand one zone the Fastener faces, either the top, bottom or both bounds.