Set Symmetry

Introduction

In many instances, a modeler can take advantage of symmetry present in a problem to reduce the computational complexity of a subsequent analysis. EnSight can impart visual realism to such models by mirroring parts around any or all axes of the part's reference frame or performing rotational symmetry about any of the axes. Although the mirrored or rotated portions appear identical to the source part (except for the reflection or rotation), they are only visual (client-based) and cannot be used for calculation. For example, you cannot start a particle trace in one half and expect the trace to cross the plane of symmetry into the other half (although you can make the particle trace part symmetric as well).

EnSight also provides "true" or "computational" symmetry operations (mirror, rotational, translational) as an attribute of the part's reference frame. With computational symmetry, you can trace particles across a periodic boundary.

Both types of symmetry (visual or computational) are based on the part's reference frame. Although you can use simple visual or computational symmetry without having to manipulate the frame, more advanced usage of symmetry could require a working knowledge of frames. See **How To Create and Manipulate Frames** for more information.

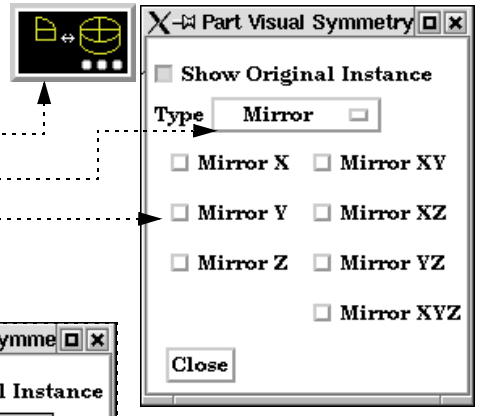
Basic Operation

Visual Symmetry

Visual symmetry is an attribute of parts. You can enable display of a mirrored copy of a part into one or more of the seven octants (opposite of +,+,+) of the part's reference frame. You can also enable display of a number of rotational instances about the x,y, or z axes of the part's reference frame. To display visual symmetry:

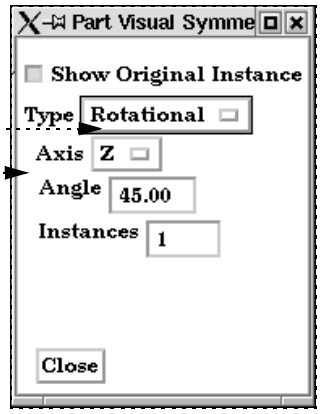
Visual Mirror Symmetry:

1. **Select the desired part(s) in the Main Parts list.**
2. **Click Part in the Mode Selection area to enter Part mode.**
3. **Click the Visual Symmetry icon**
4. **Select Mirror from the Type pulldown menu.**
5. **Select the desired octant(s) from the menu.**



Visual Rotational Symmetry:

1. **Select the desired part(s) in the Main Parts list.**
2. **Click Part in the Mode Selection area to enter Part mode.**
3. **Click the Visual Symmetry icon**
4. **Select Rotational from the Type pulldown menu.**
5. **Select rotational axis, instance angle, and number of instances.**



Recall that symmetry is performed with respect to the reference frame of the part. The frame's axes define the partitioning of space into the octants that attached parts are mirrored into, or the rotational axis. If the symmetry operation did not produce the desired effect, it is probably due to the fact that the part's frame is not aligned with the plane of symmetry, or the rotational symmetry axis, as designed for the model. The solution is to create a new frame, assign the part(s) to the new frame, and position the frame such that two of its axes lie in the plane of symmetry, or one of its axes align with the rotational axis. There operations are discussed in **How To Create and Manipulate Frames**.

Computational Symmetry

Computational symmetry can be used for unstructured and structured *model* parts with periodic boundary conditions. *(Note, it does not work for created parts.)* Computational symmetry can handle rotational, translational, and mirror symmetry. Unlike visual symmetry, computational symmetry actually produces the symmetric geometry and variables on the server - allowing for more than just visual symmetry.

You enable computational symmetry by selecting the frame, specifying the type (Mirror, Translational, Rotational), and setting type specific attributes (such as the rotation angle and the number of instances to create). Each part assigned to the frame will be updated on the server to reflect the specified symmetry.

Note that each new instance of a part created through computational symmetry creates a new part on the server.

To use computational symmetry, you will need to enable Frame Mode if it isn't already enabled. (Edit > Preferences... General User Interface - Frame Mode Allowed). Then:

1. **Click Frame in the Mode Selection area to enter Frame mode.**

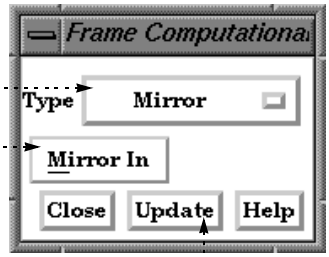
2. **If the default frame (frame 0) is not correctly positioned for the desired symmetry operation, create a new frame, position the frame in the proper location and orientation, and assign the part(s) to the new frame. (See How To Create and Manipulate Frames for details.)**

3. **Select the desired frame.**

4. **Click the Computational Symmetry Attributes Icon.**

The remaining steps depend on the type of symmetry desired.

Mirror Symmetry is similar to graphical symmetry as described above.

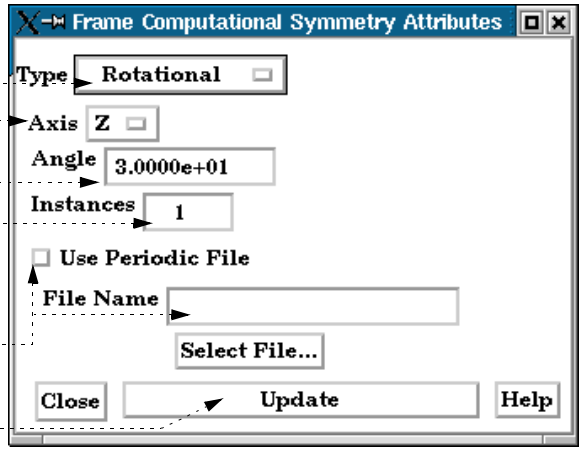


5. **Select Mirror from the Type pulldown.**

6. **Select the desired octant(s) from the Mirror In pulldown.**

7. **Click Update.**

Rotational Symmetry creates instances by rotating, around the selected axis of the frame, the specified number of degrees. The selected frame's axis must be aligned with the desired symmetry axis.

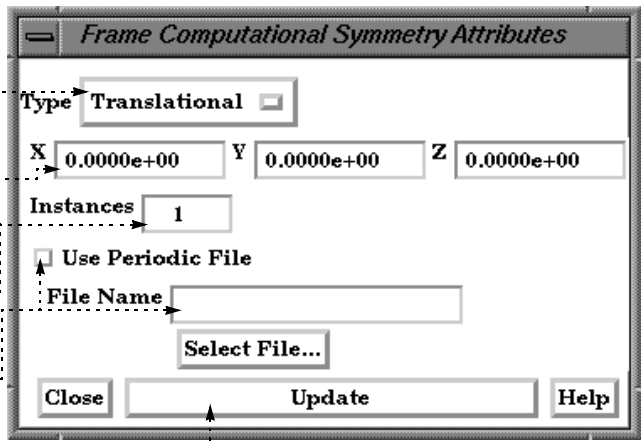


5. **Select Rotational from the Type pulldown.**
6. **Select the frame rotational axis.**
7. **Set the desired rotation angle (in degrees) in the Angle field.**
8. **Set the desired number of instances in the Instances field (number 1 is the original, set Instances to 2 to yield one copy).**
9. **If a periodic match file is available, toggle Use Periodic File and enter the file name.**

Periodic match files are discussed below.

10. **Click Update.**

Translational Symmetry creates instances in the direction of the specified translation vector. The translation vector is first rotated by the frame's rotation, but is independent of the frame's origin location.



5. Select Translational from the Type pulldown.

6. Enter the desired translation vector in the XYZ fields and press return.

7. Set the desired number of instances in the Instances field (number 1 is the original, set Instances to 2 to yield one copy).

8. If a periodic match file is available, toggle Use Periodic File and enter the file name.

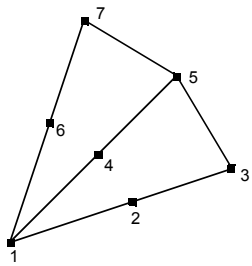
Periodic match files are discussed below.

9. Click Update.

Periodic Matching for Computational Symmetry

When a model is created with periodic boundary conditions, there is typically a built-in correspondence or "match" between certain nodes and elements. For example:

The elements defined by nodes 1,2,3 and nodes 1,6,7 should match when rotated about an axis passing through node 1 (perpendicular to the screen). When another instance is created, node 2 matches with 6 and node 3 matches with 7.



When instances are added to a part, it is desirable to eliminate these duplicate nodes. Without a match file, EnSight will attempt to find and remove them using a hashing scheme. This method works quite well, but may not find all duplicates. (Remaining duplicates are usually noticed when the part is in feature angle representation since EnSight treats elements with duplicate nodes as separate – even if they are coincident.)

Note that if you have a periodic match file you do not need to specify the rotation axis and angle in the Frame Computational Symmetry Attributes dialog – the value is provided in the file.

A user-supplied matching file can be used to quickly find and remove all duplicates. The match file is a simple ASCII text file. The file for the example above would be (the text in italics is not part of the file):

rotate_z	*specifies rotational symmetry and the applicable axis*
52.34	*the angle of rotation (in degrees)*
3	*the number of node pairs to follow*
1 1	*first node pair*
2 6	*second node pair ...*
3 7	

See **Periodic Match File** for more information on periodic match files.

See Also

How To Create and Manipulate Frames