

TGrid allows you to create a good quality boundary mesh using a bad quality surface mesh as input. This can be done using the wrapper utility in TGrid.

The following sections discuss the procedure to use the wrapper and the parameters associated with it.

- Section 8.1: The Boundary Wrapper
- Section 8.2: The Wrapping Process
- Section 8.3: Examining and Repairing the Input Geometry
- Section 8.4: Initializing the Cartesian Grid
- Section 8.5: Examining the Cartesian Grid for Leakages
- Section 8.6: Extracting the Wrapper Surface
- Section 8.7: Checking the Quality of the Wrapper Surface
- Section 8.8: Post Wrapping Improvement Operations
- Section 8.9: The Boundary Wrapper Panel
- Section 8.10: Text Commands for the Wrapper

8.1 The Boundary Wrapper

Geometries migrated from various CAD packages often contain gaps and overlaps between the surfaces due to algorithm and tolerance differences of the CAD packages. Repairing such geometries manually is a tedious and time consuming process. The wrapper provides the ability to create reliable meshes for such geometries without extensive manual clean up and reduces the time required for preprocessing.

The wrapper can take account of gaps and overlaps at the expense of certain degree of geometry details of the model. It can handle unclean geometries and does not require a water-tight representation of the geometry.

8.1.1 Applications of Wrapper

The wrapper is useful in the following industrial applications:

- Automotive
 - Underhood thermal management (engine only, front car, full car)
 - Cabin HVAC
 - External aerodynamics
 - Brake cooling and engine cooling
- Aerospace
 - Engine core compartment
 - Cockpit HVAC, cabin HVAC
 - Landing gear
- Drill bit applications
- Smoke and fire spread
- Bio-medical applications
- Other applications with bad input geometries

8.2 The Wrapping Process

The wrapping process is based on the Cartesian grid (or overlay grid) approach. The general procedure for creating a wrapper surface is as follows:

1. A coarse Cartesian grid is overlaid on the input geometry (including gaps and overlaps). This Cartesian grid is used to automatically clean the input geometry and to create the water-tight representation.
2. The intersection between the Cartesian grid and the input geometry is calculated and TGrid identifies and marks the intersecting cells.
3. A watertight faceted representation is created along the boundary of the intersecting cells.
4. The nodes on this faceted representation are projected on to the faces and feature edges of the input geometry which then results in a wrapper surface closely representing the input geometry.
5. The wrapper surface quality is improved by post-wrapping operations such as smoothing, swapping, etc.

Figure 8.2.1 shows schematic representation of wrapping procedure.

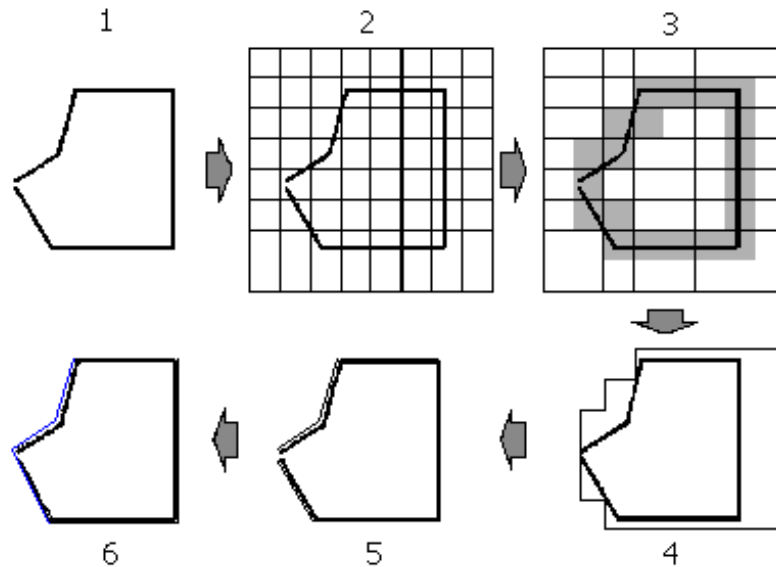


Figure 8.2.1: Schematic Representation of Wrapping Process

Note: *The dimensions of the distortion (e.g., hole, gap, etc.) in the input geometry should be smaller than that of the size of the Cartesian cells created by the wrapper. If there is significant distortion in the input geometry, repair it to the extent that the distortion becomes smaller in size. Large holes, if present in the initial geometry, should be filled. Otherwise such holes will be ignored in the wrapping process.*

The Boundary Wrapper panel allows you to perform wrapping operation. In addition to the Boundary Wrapper panel, you will also use the Display Grid panel (see Section 14.1.3: The Display Grid Panel) during the wrapping process. See Section 8.9: The Boundary Wrapper Panel for details about the use of the parameters available in the Boundary Wrapper panel.

The wrapping process consists of the following tasks:

- Examining and repairing the input geometry (Section 8.3: Examining and Repairing the Input Geometry)
- Initializing the Cartesian grid (Section 8.4: Initializing the Cartesian Grid)
- Creating the wrapper surface
- Recovering Boundary zones and features (Section 8.7: Checking the Quality of the Wrapper Surface)

- Using the post wrapping improve operations (Section 8.8: [Post Wrapping Improvement Operations](#))

8.3 Examining and Repairing the Input Geometry

Before performing the wrapping operation, you need to examine the input geometry and repair it to some extent so that the final wrapper surface is of good quality. The geometry repair operations include the following operations:

- Checking for duplicate nodes.
- Converting quad zones into tri zones.
- Detecting and filling the holes in the geometry.

Checking and Removing Duplicate Nodes

1. Read the geometry in TGrid and check for free or duplicate nodes.
2. If the mesh contains free (duplicate) nodes, delete (merge) them using the **Merge Boundary Nodes** panel before proceeding to the wrapping operation.

Free nodes may cause trouble during the wrapping process, because the wrapper assumes each edge to be a special feature of the geometry. Also, curvature calculations cannot be performed on disconnected edges.

3. Analyze the geometry and remove unnecessary details, if any.
4. Display the geometry using the **Display Grid** panel.

Triangulate Quad Zones

Triangulate the quad zones present in the input geometry using the **Triangulate Zones** panel (see Section 7.9.1: [The Triangulate Zones Panel](#)). You can also use the command `boundary/remesh/triangulate` to triangulate the quad zones.



The boundary wrapper does not support quad zones.

Detecting and Filling the Holes Manually

Examine the geometry and fill any unwanted holes using the **Modify Boundary** panel. You will mainly try to locate and fix the major holes in the geometry. If you miss smaller holes, you can fix them later using the automatic hole detection feature.

There are several ways in which you can fix the holes in the geometry.

- Fixing holes by selecting edges (Figure 8.3.1).
 1. Select the edge filter (hot-key <Ctrl> + E).
 2. Select any edge on the hole boundary.
 3. Press F5 to create the surface that closes the hole.

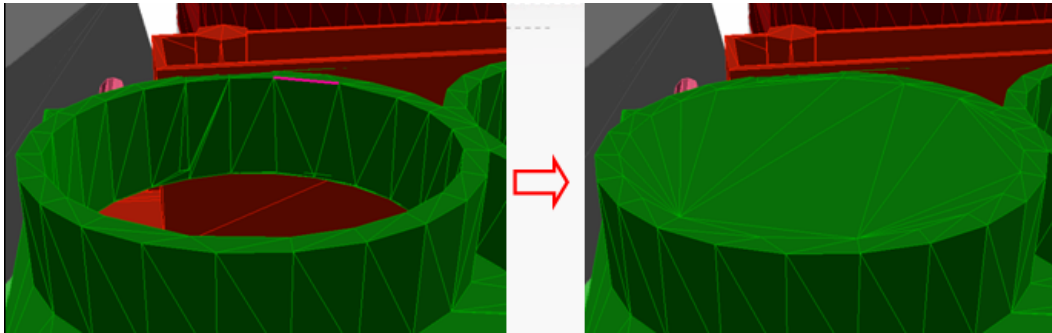


Figure 8.3.1: Hole Filling Using Edge

- Fixing holes by selecting nodes (Figure 8.3.2).
 1. Select the node filter (hot-key <Ctrl> + N).
 2. Select the nodes around the hole.
 3. Press F5 to create the surface that closes the hole.

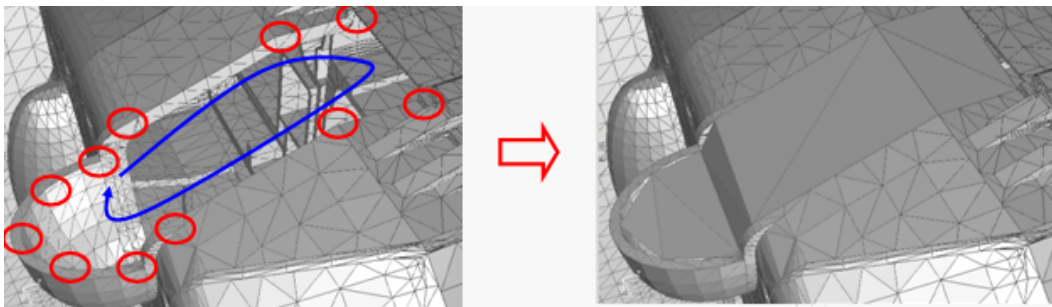


Figure 8.3.2: Hole Filling Using Nodes

- Fixing holes by selecting positions (Figure 8.3.3).
 1. Select the position filter (hot-key <Ctrl> + X).
 2. Select the positions around the hole.
 3. Press F5 to create the surface that closes the hole.

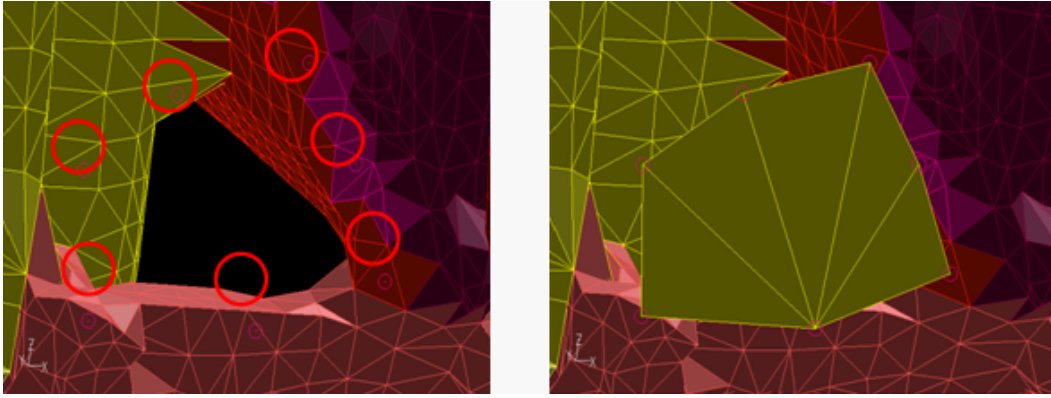


Figure 8.3.3: Hole Filling Using Positions

- Fixing multiple holes near each other by creating a planar surface.
 1. Open the Plane Surface panel.
 2. Select three positions.
 3. Specify appropriate mesh size and click Create. See Section 7.14.2: [Creating a Planar Surface Mesh](#) for details.

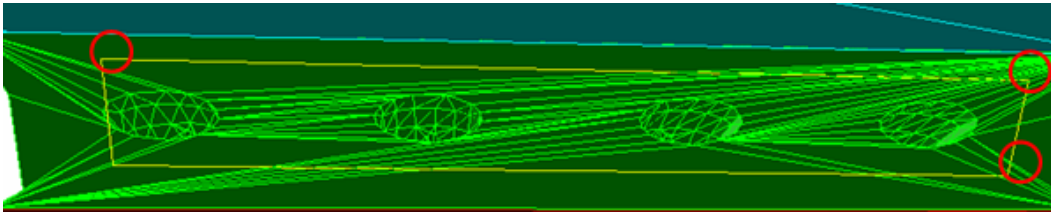


Figure 8.3.4: Hole Filling Using a Plane Surface

The TUI command `boundary/check-duplicate-geom` can be used to identify duplicate surfaces. The duplicate surfaces and the maximum and average distance between them will be printed in the TGrid console.

8.4 Initializing the Cartesian Grid

The first step in the wrapping procedure is to overlay a Cartesian grid onto the input geometry. The accuracy of the wrapping depends on the cell size distribution of the Cartesian grid. TGrid allows you to specify the cell size of the Cartesian grid according to your requirement. Finer cells give better results, but require longer computational time. Therefore, it is very important to use a Cartesian grid of optimum cell size distribution.

Before specifying these parameters, you need to identify the zones that require smaller cell sizes.

You can specify the parameters required to initialize the Cartesian grid in the **Face Size** tab of the **Boundary Wrapper** panel. The process of specifying the parameters required to initialize the Cartesian grid is as follows:

1. Open the **Boundary Wrapper** panel.

Boundary → Wrap...

*The existing face zones in the geometry will be listed in the **Tri Boundary Zones** list. The zones listed in the **Tri Boundary Zones** list may be face zones in the input geometry (before wrapping) or the wrapper surface (after wrapping).*

2. Specify an appropriate value for **Default Length**.

The **Default Length** is the largest allowable cell length in the Cartesian grid. Depending on the shape and size of the input geometry, TGrid automatically computes an appropriate value for the **Default Length**. However, you can also specify the value manually.

3. Specify the **Global Size Function**.

- (a) Enable **Proximity** and/or **Curvature**.

The **Proximity** and **Curvature** size functions calculate the required cell length on each facet of the input geometry within the upper (**Max Length**) and lower (**Min Length**) limit of the refinement. The Cartesian grid will be refined based on these sizes. The curvature size function is applied whenever there is a change in angle between the two faces. The proximity size function is applied to all the faces within the zone as well as between two zones.

Enabling these options allows you to create a Cartesian grid adapted to the gaps and curvatures of the input geometry. The size functions are established while initializing the Cartesian grid.

i If you initialize the Cartesian grid without enabling **Proximity** or **Curvature**, a grid of uniform size (the default size) will be created throughout the domain.

You can control the sensitivity of the size functions using the following TUI commands:

- `boundary/wrapper/set/curvature-factor`
- `boundary/wrapper/set/proximity-factor`

The default values of the curvature factor and the proximity factor are set to 0.5 and 0.25, respectively. If you reduce these values, the wrapper will generate a finer mesh in the affected regions.



The size functions can produce strange results if the input mesh contains cells with skewness greater than 0.99.

- (b) Set **Min Length** and **Max Length** by changing the **Level** as appropriate.

The **Min Length** is the minimum allowable cell length in the Cartesian grid. A smaller size captures details more accurately and also reduces the crossover configurations, although it increases the number of holes in the geometry. Hence, it is recommended to specify a **Min Length** value less than half the required mesh size.

Panning the regions also helps in deciding the **Min Length** value. It is recommended to specify a value 3-4 times smaller than the size of an important narrow gap present in the geometry. See Section 8.9.2: [The Pan Regions Panel](#) for details. By default, the **Max Length** is the same as the **Default Length**. If the resulting Cartesian grid is very fine, you can coarsen it at a later stage.

Cell lengths for each **Level** are determined relative to the **Default Length**. For example, if the **Default Length** is 76.46942, then the first **Level** will have a cell length of $76.46942/2^0$, the second will have a cell length of $76.46942/2^1$, and so on.

4. Specify the Zone Specific Size.

*To have a finer (or coarser) mesh for a particular boundary zone in the domain, you can manage the cell size by using the parameters in the **Zone Specific Size** group box. This option creates a Cartesian grid of the specified length throughout the selected boundary zone.*

- (a) Select the zone(s) for which you want to specify a local cell length according to your requirement from the **Tri Boundary Zones** selection list.

*You can specify the **Zone Specific Size** in terms of **Level** only.*

- (b) Increase (or decrease) the **Level** as required.

*The cell length for each **Level** will be displayed in the **Length** box.*

- (c) Click **Apply** to apply the value of the **Length** specified in the **Zone Specific Size** group box to the selected boundary zone(s).
- (d) Click **Clear** to clear the previously saved size.
- (e) Click **List** to display the zone(s) and corresponding size(s) applied to them.
- (f) Click **Select** to select the boundary zones of the selected **Level** in the **Tri Boundary Zones** list. Click **Deselect** to deselect them.

5. Specify the Local Size Function.

The parameters in this group box allow you to enable or disable proximity and curvature size functions locally to any boundary zone you want.

- (a) Enable Proximity and/or Curvature.
- (b) Set the Level as appropriate.
- (c) Click Apply.

6. Click Draw Sizes.

This is to ensure whether or not the specified cell sizes are sufficient. TGrid highlights the cells of the specified Max Length and Min Length on the selected face zone(s) in the graphics window.

- Two different sized red boxes representing the minimum and maximum cell length will be displayed on the boundary zones for which you applied Global Size Function and Local Size Function.
- Uniform sized red boxes will be displayed on the boundary zones for which you applied Zone Specific Size.

If the highlighted cell sizes in a zone are too large, reduce the values before creating the wrapper surface. See Figure 8.4.1.

You can use the following TUI command to change the number of cells to be highlighted:

```
/boundary/wrapper/set/number-of-size-boxes
```

The default value for the number of cells to be displayed is set to 20. You can increase or decrease the value as required.

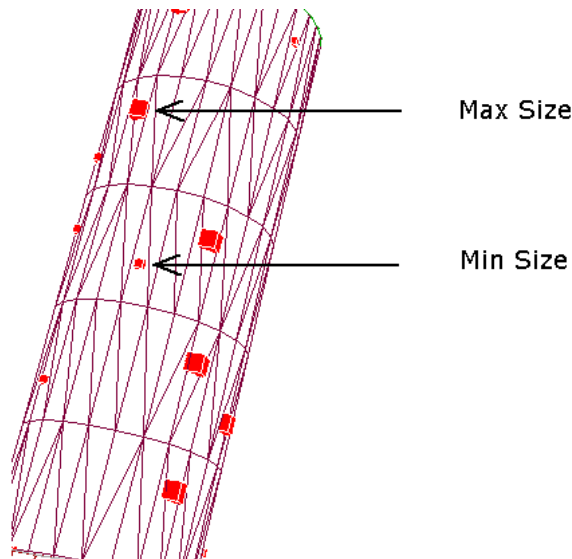


Figure 8.4.1: Display of Min and Max Cell Sizes

7. Specify advanced options, if required.

By default, TGrid considers self-proximity during the wrapping process. You can ignore self-proximity detection during wrapper initialization, if required. In order to have a smooth transition from fine to coarse cells, you can set the number of additional layers of cells to be included during refinement. When you specify the number of **Buffer Layers**, TGrid marks additional layers of cells adjacent to those marked for refinement by the size requirement.

8. Select the face zone(s) you want to wrap from the **Tri Boundary Zones** list.
 - If the input geometry does not have face zones of the **geometry** type and you do not select any zone in the **Tri Boundary Zones** list, all the available face zones will be considered for wrapping.
 - If the input geometry has face zones of the **geometry** type and you do not select any zone in the **Tri Boundary Zones** list, only the face zones of the **geometry** type will be considered for wrapping.
 - If you select specific zone(s) in the **Boundary Zones** list, irrespective of whether or not the input geometry has **geometry** type face zones, only the selected zone(s) will be considered for wrapping.
9. Click **Init** to initialize the Cartesian grid.

*After creating the Cartesian grid, the wrapper virtually partitions all the cells into several volumetric regions based on the intersecting and isolated cells. These regions are ordered according to descending order of their sizes. The surface that you want to wrap (or recover) is **region:1**.*

10. Display each region created during the Cartesian grid initialization process using the **Draw** button below the **Region** list in the **Region** tab of the **Boundary Wrapper** panel. Ensure that **region:1** is the largest region and forms a faceted watertight representation of the boundaries of the input geometry.
11. Examine **region:1** and make sure that the cell sizes are according to your requirement. If you are not satisfied with the cell size distribution of the Cartesian grid, specify appropriate values for **Zone Specific Size** and **Local Size Functions** for the individual (or required) zones to obtain an appropriate Cartesian grid in the corresponding zones.
12. Refine the Cartesian grid, if required.

Before wrapping the boundary regions, examine the configuration of the Cartesian grid around critical zones of the domain such as sharp curves and edges. If the cell size after the automated grid initialization is too large around such zones, reduce the cell sizes.

- (a) Select the zone(s) for which you want to specify local size functions from the **Tri Boundary Zones** selection list.

- (b) Specify appropriate **Zone Specific Size** parameters and **Local Size Function** parameters.

i If you specify **Zone Specific Size** as well as **Local Size Function** parameters for a particular boundary zone, the Cartesian grid will take the minimum cell size specified by both the options.

- (c) Click **Refine** to update the Cartesian grid for the new set of parameters.
- (d) Define local region(s) if required, and refine them. Currently, the only possible shape is a box, either aligned with the coordinate axes, or oriented as required. The region is defined by an x , y , and z range. You can specify the level of refinement required for each local region. You can visualize the regions defined using the **Draw** button in the **Wrapper Refinement Region** panel (see Section 8.9.1: [The Wrapper Refinement Region Panel](#)). The size of the elements in the defined region will be indicated in the graphics window.
- (e) (optional) Refine regions for better representation of the geometry. Select the region(s) to be refined in the **Regions** selection list and click the **Refine** button.

8.5 Examining the Cartesian Grid for Leakages

When the Cartesian grid you are using to create the wrapper surface contains a hole or niche of geometry whose size is greater than the size of the Cartesian cells in that zone, a leakage or hole is created in the resulting wrapper surface. Examine the region you want to wrap for mesh density, leakages, etc. before extracting the wrapper surface. You can use either the automatic leak detection feature or fix the leaks manually and update the region accordingly.

8.5.1 Automatic Leak Detection

When you refine an existing region or specify additional sizing functions for better representation of the geometry, the minimum size may be reduced to a size smaller than some existing leakages. These leakages can be detected automatically using the automatic hole detection tool in TGrid. The refinement of a region may result in the joining of previously separate regions through cells newly introduced by the refinement (region collision). While refining a region, TGrid will automatically detect cells causing region collision and group them. Such groups of cells will be identified as holes in the region. The number of holes exposed by the current refinement will be reported in the TGrid console.

The following operations allow you to automatically detect holes:

- Refining a single region.
- Specifying local size function and additional zone-specific sizes after initialization.


- Refining local regions defined according to requirements.

The options for automatic detection and fixing of leaks are available in the **Region** tab of the **Boundary Wrapper** panel. The **Automatic** selection list in the **Fix Holes** group box lists the potential holes for all regions.

The generic procedure for detecting and fixing holes/leaks automatically is as follows:

1. Open all holes other than the holes for the region of interest.

The **Open** operation can be used when the identified group of cells does not represent an actual hole or is not relevant in the subsequent wrapping process. The regions associated with the hole will be merged and the hole information will be deleted.

- (a) Enter the appropriate value for **Region** (e.g., 1 for **region:1**) and click **Select** to select the potential holes for the region of interest.
- (b) Click the  button to select all the holes other than those in **region:1**.
- (c) Click **Open**.

2. Select all the holes in the **Automatic** selection list and click **Fix**.

The fix operation automatically fills the holes using triangular patches. The patches created will be added into the geometry and cell-intersections will be updated accordingly. The newly added patches will serve as part of the geometry in the subsequent wrapping process.

8.5.2 Manual Leak Detection

The manual leak detection procedure involves using the **Pan Regions** panel to examine the region, the **Trace Path** panel to detect the exact location of the hole, and the various methods described in Section 8.3: [Detecting and Filling the Holes Manually](#) to fill the hole.

Using the Pan Regions Panel

The **Pan Regions** panel allows you to observe and analyze the region (to be wrapped) created during the Cartesian grid initialization. A plane can be passed through the selected region (or all available regions) along the X, Y, or Z direction, as required. The interior of the region(s) on every position of the plane is displayed on the plane. You can view the interior of the Cartesian grid on the plane.

You can also overlay the boundary surfaces while panning, and clip the boundary surfaces on either side of the cutting plane.

To pan through all the region(s) of your choice, do the following:

1. Display the required region (using the **Draw** button below the **Regions** list).
2. Click the **Pan Regions...** button to open the **Pan Regions** panel.
3. Select the appropriate axis along which you want to pan through the selected region(s) from the **Direction** list.

*The **Start**, **End**, and **Increment** fields will be updated automatically based on the cell size distribution of the Cartesian grid. You can change these values as appropriate.*

4. Enable **Overlay Graphics** if you want to see the geometry along with the pan plane. Select **Positive** or **Negative** to clip the surfaces on the positive or negative side of the cutting plane. Figure 8.5.1 shows the geometry on the positive side of the cutting plane.

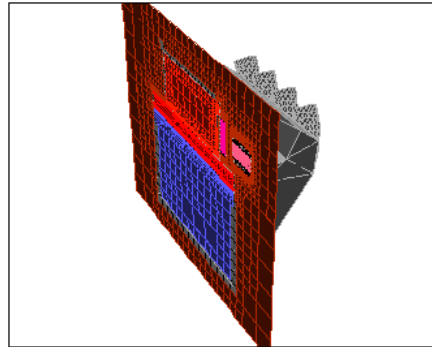


Figure 8.5.1: Overlaid Geometry Clipped with the Pan Plane

5. Enable **All** in the **Region** group box to pan through all regions. Alternatively, disable **All** and select the required region to pan.
6. Click **Pan** to start the plane movement through the selected region(s).

*The interior of the Cartesian grid is displayed on every position of the plane during its movement through the region. Increase (or decrease) the **Increment** value to increase (or decrease) the speed of movement of the plane.*



7. Use the  and  buttons to observe the interior of the region at a particular location. You can also move the plane to any position by moving the slider bar to any position using the mouse.

Figure 8.5.2 shows how the leakage can be detected using the **Pan Regions** panel. When the plane passes through the Cartesian grid the interior of the Cartesian

grid is displayed at every position on the plane. If at any position of the plane the color of the region is seen inside the geometry, there may be a leak or hole in the Cartesian grid.

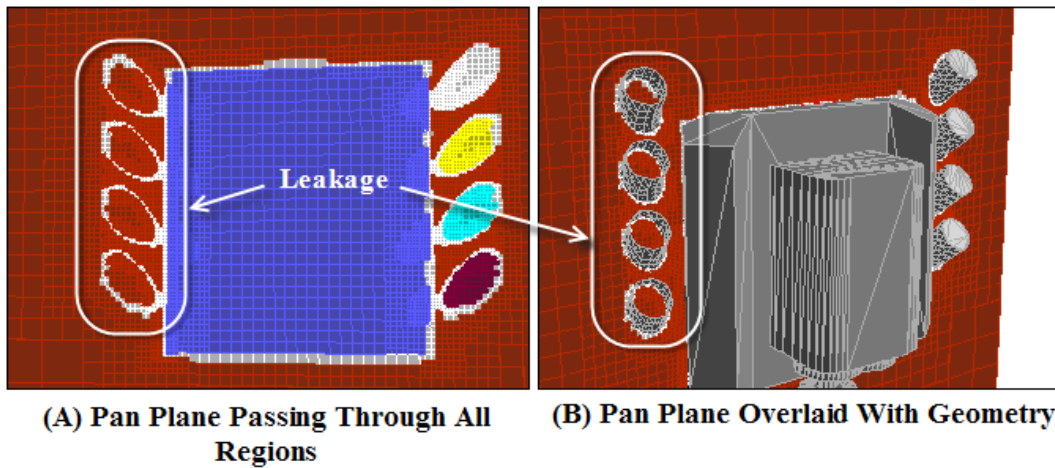


Figure 8.5.2: Leak Detection Using the Pan Regions Panel

8. Adjust the plane at the position where the leak is seen on the plane.



The Pan Regions panel only allows you to know whether or not there is a leak or hole in the geometry. If the geometry has a hole or leak, you need to find its exact location and fill it.

Using the Trace Path Panel

To locate the hole or leak using the Trace Path panel, do the following:

1. Display the pan plane at a position where there is an indication of a possible leak. You can overlay the geometry to allow easier location of the leak.
2. Click the Trace Path... button (in the Region tab of the Boundary Wrapper panel) to open the Trace Path panel.
3. Specify a pair of points, one “inside” and the other “outside” the geometry (see Figure 8.5.3). You can either enter the locations manually, or click the Select Points... button and select the points using the mouse.
4. Click Trace (Figure 8.5.3).

TGrid highlights the path connecting the cells corresponding to the points specified. This traced path will always pass through the hole/leak.

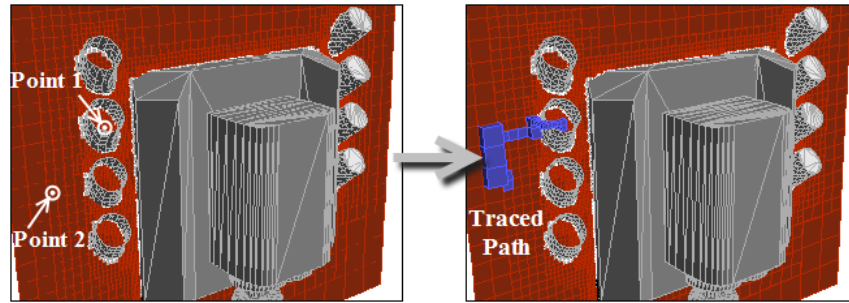


Figure 8.5.3: Trace Path

5. Display the original geometry and click the Trace button in the Trace Path panel (Figure 8.5.4).

The traced path will now be visible along with the original geometry. You can zoom in to the region where the trace path enters the geometry (Figure 8.5.4).

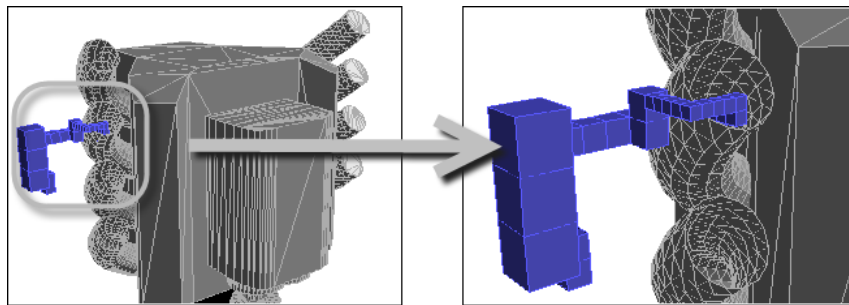


Figure 8.5.4: Display of Geometry with Highlighted Trace Path

6. Close the hole or leak using the methods described in Section 8.3: [Detecting and Filling the Holes Manually](#).
7. Select the surfaces in the Tri Boundary Zones selection list and click the Update Regions button in the Manual group box.

The regions will be updated to account for the fixed hole. You can click the Trace button in the Trace Path panel to verify that the region has been updated for the fixed hole. TGrid will report that there is no path between the two positions.
8. Examine the updated region for further leaks or holes. Fill any remaining leaks or holes before proceeding.

8.6 Extracting the Wrapper Surface

In this section you will learn how to extract the initial wrapper surface and imprint it on the feature edges of the input geometry.

1. Select the region to be wrapped and click the **Wrap** button (below the **Region** list) to extract the initial wrapper surface.

*Alternatively, you can select the region to be wrapped and click the **Extract** button to extract the interface. The extracted interface will be available in the **Interface** list.*

2. Select the appropriate interface in the **Interface** list and click **Wrap**.

You may want to clear the regions created during the initialization of the Cartesian grid before proceeding to extract the wrapper surface. Deleting the regions reduces the peak memory and improves the speed of further operations.

*When creating the wrapper surface directly from the region, TGrid will ask if you want to delete all the regions. Click **Yes** in the **Question** dialog box to clear the regions. When creating the wrapper surface from an interface, click **Clear** (below the **Region** selection list) before extracting the initial wrapper surface from the interface.*

TGrid creates a wrapper surface having a face zone type **wrapper**. The newly created wrapper surface will be listed in the **Tri Boundary Zones** selection list. It takes the name, **wrapper-surf-xx** (where, **xx** is a random number). The wrapper surface can be displayed using the either the **Display Grid** panel or the **Boundary Wrapper** panel.



You can perform the imprinting and post wrapping improvement operations only on surfaces having the type **wrapper**. If the mesh file contains the wrapper surface created in TGrid 4.0, you need to change the type of the surface from **internal** to **wrapper** before performing these operations. TGrid will report an error if you perform operations like imprinting features or post wrapping improvements on a surface having type other than **wrapper**.

It is a good practice to save the mesh at this point.

3. Modify the wrapper surface to represent the input geometry more closely.

The initial wrapper surface created will not be the exact representation of the input geometry. Some of the distinctive features such as sharp edges between the zones will be ignored. In this step, you will recover the feature edges of the input geometry and imprint the wrapper surface onto these edge loops.

- (a) Select the zones for which you want to recover the feature edges from the **Tri Boundary Zones** selection list.
- (b) Select the method to be used for feature extraction from the **Feature Methods** list. Refer to Section 7.6.1: [Creating Edge Loops](#) for details on the feature extraction methods.

- (c) Click **Extract Features**.

*The edge loops (edge zones) will be created for the selected boundary zones. These edge loops will be listed in the **Edge Zones** list. You can display each of them by selecting each one and clicking the **Draw** button.*

- (d) Modify/create feature edges using advanced options using the **Feature Modify** panel, if required. Click the **Feature Modify...** to open the **Feature Modify** panel (see Section 7.6.3: [The Feature Modify Panel](#)). Refer to Sections 7.6.1 and 7.6.2 for details about using this panel.

- (e) Project the nodes of the wrapper surface on the edge loops that you have created.

- i. Select the wrapper surface (**wrapper-surf-xx**) in the **Tri Boundary Zones** list.
- ii. Select the edge loops on which you want to project nodes of the initial wrapper surface in the **Edge Zones** selection list.

*Deselect the edges to be ignored during imprinting from the **Edge Zones** list.*

- iii. Enable **With Advanced Tracking** to allow recovery of more features, if required. Click **Imprint**.

Imprinting is carried out by tracking a node path on the wrapper surface corresponding to a feature edge in the geometry. The nodes on the wrapper surface close to the feature edge are projected onto the edge loop. See Figure 8.6.1 to see the effect of imprinting.



You may have to click **Imprint** more than once.

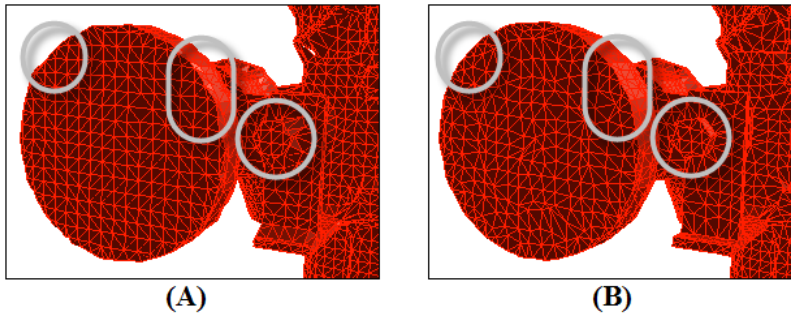


Figure 8.6.1: Wrapper Surface (A) Before and (B) After Imprinting

The nodes outside the critical range will not be projected because the projection of such nodes creates flipped or highly skewed triangles.

If the features are not extracted properly after the imprint operation, you can separate the wrapper surface zone by zone, and click **Imprint** by selecting all the separated zones at a time. This is useful when handling a large and complicated mesh.

8.7 Checking the Quality of the Wrapper Surface

The quality of the wrapper surface can be checked using the options available in the **Reports** tab. You can display the contours of **Distance**, **Normal**, or **Composite** and check the deviation of the wrapper surface from the original geometry. You can also identify problems like crossover configurations, insufficient geometry representation using the contours of quality.

1. Click the **Reports** tab and select the wrapper surface in the **Tri Boundary Zones** list.
2. Enable **Node Value** and/or **Auto Range** as appropriate in the **Contour Options** group box.
3. Select **Distance**, **Normal**, or **Composite** as appropriate in the **Contours** of drop-down list.
4. Set the **Levels** as appropriate and click **Draw Contours**.

Figure 8.7.1 shows a sample display of contours of distance of the wrapper surface from the input geometry. The red patches in the display indicate that at such locations wrapper surface does not exactly represent the input geometry. You will use the available post wrapping operations to improve the wrapper surface at such locations.

8.8 Post Wrapping Improvement Operations

The wrapper surface created after imprinting is of good quality and it represents the input geometry very well in most regions. However, you can improve it further in some regions of the geometry such as sharp corners and curves. The post wrapping improvement operations allow you to improve the wrapper surface by performing various operations such as smoothing, swapping, inflating thin regions, removing crossovers, etc.

The improvement operations are available in the **Post Improve** tab in the **Boundary Wrapper** panel. They are grouped as follows:

- Coarsening options
- Post wrapping options
- Zone options
- Expert options

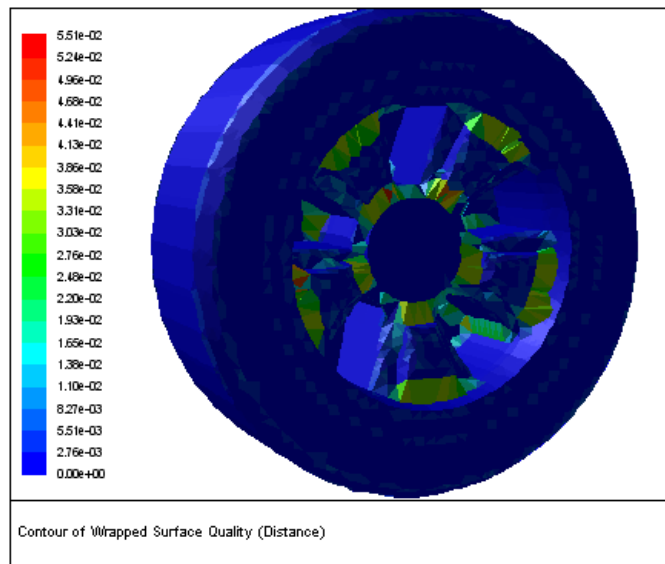


Figure 8.7.1: Contours of Distance of a Wrapper Surface

When you perform a particular post wrap operation, TGrid will indicate (in the console) the completion of the operation performed along with the zone(s) on which the operation was performed.

8.8.1 Coarsening the Wrapper Surface

The wrapper surface created may be finer than you require in some regions. You can coarsen the mesh in such regions (or globally for the entire wrapper surface). This operation also reduces the cell count of the mesh, thereby reducing the computation time.

To coarsen the wrapper surface, do the following:

1. Select the boundary zone(s) that you want to coarsen.
2. Select Coarsen in the Options drop-down list.
3. Enter an appropriate value for Edge Length Change.

The Edge Length Change value specifies the allowable change in edge length during the coarsening operation.

4. Enter an appropriate value for Max Angle Change.

The Max Angle Change value specifies the maximum allowable change in the angle between adjacent faces during the coarsening operation. This allows you to prevent the appropriate curvatures from over coarsening.

5. Specify appropriate values for Min Length and Max Length.

These values specify the minimum and maximum edge length. Only faces within this range will be considered for coarsening.

6. Enable Preserve Boundary, if required.
7. Click Apply.

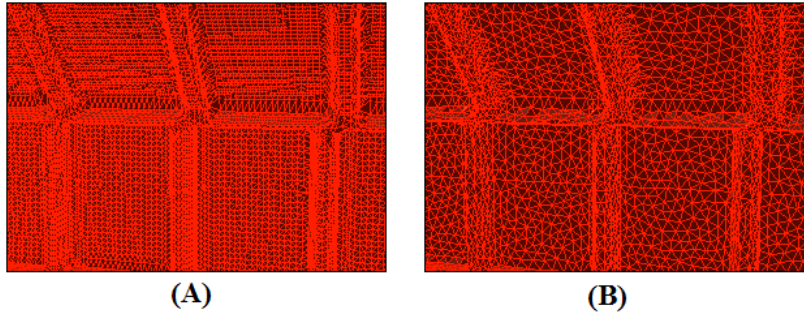


Figure 8.8.1: Wrapper Surface (A) Before and (B) After Coarsening

Figure 8.8.1 shows the coarsening of the wrapper surface.

8.8.2 Post Wrap Options

The following post wrapping operations are available in TGrid:

- Auto post wrap
- Remove duplicate nodes
- Smoothing
- Smoothing folded faces
- Inflating thin regions
- Removing self intersections
- Deleting islands
- Swapping
- Improving the quality

Auto Post Wrap

TGrid allows you to use a pre-defined sequence of post wrapping operations to improve the wrapper surface. The automatic post wrapping procedure performs the various post wrapping operations in a pre-defined sequence based on the parameters specified in the Boundary Wrapper panel. You can also use the individual post wrapping operations in the order required as described in the subsequent sections.

To use the automatic post wrapping option, do the following:

1. Select the wrapper surface in the Tri Boundary Zones list.
2. Select **Post Wrap** in the Options drop-down list and **Auto Post Wrap** in the Sub Options list, respectively.
3. Enter an appropriate value for Distance Tolerance.

The value specified for Distance Tolerance will be considered for the removal of duplicate nodes on the wrapper surface.

4. Enter an appropriate value for Relative Thickness.

The value specified for Relative Thickness will be considered for the removal of self-intersecting surfaces on the wrapper surface.

5. Enter an appropriate value for Critical Thickness.

The value specified for Critical Thickness will be considered for the inflating of thin regions on the wrapper surface.

6. Enter an appropriate value for Max Improve Angle.

7. Click **Apply**.

TGrid will report the operations performed and the quality at the end of the auto post wrapping in the console.

Removing Duplicate Nodes

The initial wrapper surface created after imprinting may contain duplicate nodes (two nodes having the same Cartesian coordinates). Multiple copies of the same node may cause problems in connectivity of the final wrapper surface. To remove the duplicate nodes, do the following:

1. Select the wrapper surface in the Tri Boundary Zones selection list.
2. Select **Post Wrap** in the Options drop-down list and **Remove Duplicate** in the Sub Options list, respectively.

3. Enter an appropriate value for **Distance Tolerance**.

The Distance Tolerance specifies the minimum distance between two distinct nodes on the wrapper surface. If the distance between two nodes is less than the value specified, the nodes will be considered to be duplicate nodes.

4. Click **Mark** to highlight the duplicate nodes on the wrapper surface. Alternatively, you can use the command `/boundary/mark-duplicate-nodes` to view the duplicate nodes.

5. Click **Apply**.

The nodes within the specified tolerance value will be removed.

Smoothing

This operation improves the skewness of the faces in the wrapper surface. Smoothing allows you to reposition the nodes to improve the cell connectivity and quality. To perform node smoothing, do the following:

1. Select the wrapper surface in the **Tri Boundary Zones** selection list.
2. Select **Post Wrap** in the **Options** drop-down list and **Smooth** in the **Sub Options** list.
3. Specify the number of smoothing attempts in the **Iteration** field.
4. Enter an appropriate value for **Relaxation**.
5. Enable **Reprojection**, if required.
6. Specify an appropriate value for **Rel Reproject Range**.

The smoothing operation repositions the nodes on the wrapper surface. The new position of the node may not be on the original geometry. This parameter specifies the maximum allowable distance between the new location of the node and the original geometry. The local mesh size (say D) is computed by averaging edge lengths at the node. If the new node position is within the **Rel Reproject Range** $\times D$, the node will be projected back on the original geometry. Others are left at their locations.

7. Enable **Preserve Boundary**, if required.

If you perform the smoothing operation after separating the zones of the wrapper surface, the nodes on the boundaries of the separated zones will not be moved or repositioned during smoothing.

Smoothing Folded Faces

The presence of folded faces on the wrapper surface may cause problems in calculating the CFD solution. TGrid allows you to resolve folded faces by performing node smoothing and reprojection of nodes on the original geometry. To smooth the folded faces, do the following:

1. Select the wrapper surface in the Tri Boundary Zones selection list.
2. Select Post Wrap in the Options drop-down list and Smooth Folded in the Sub Options list.
3. Specify the number of attempts to be made to resolve the folded faces in the Iteration field.
4. Specify an appropriate value for Critical Angle.

The critical angle is the angle between adjacent faces. If the feature angle between the two faces is less than the value specified, the faces are considered as folded. The default value for this parameter is 30. You can specify an appropriate value for the critical angle, however, it is recommended that you not specify a very large value.

5. Enable Reprojection to allow projection of nodes onto the original geometry, if required.
6. Click Apply.

Inflating Thin Regions

If the geometry to be wrapped contains regions of very small thickness (e.g., zero-thickness walls), the wrapper surface around it forms a thin region configuration. Such type of configurations may cause problems in further volume meshing.

The Inflate Thin Regions option allows you to resolve such configurations by pushing apart the nodes of the faces very close to each other. To inflate thin regions, do the following:

1. Select the wrapper surface in the Tri Boundary Zones selection list.
2. Select Post Wrap in the Options drop-down list and Inflate Thin Regions in the Sub Options list.
3. Specify an appropriate value for Critical Thickness.

The critical thickness is the maximum distance the nodes can be moved away from each other.

- Specify an appropriate value for Critical Angle.

The critical angle is the angle between the faces below which the faces are considered for inflating. Increasing this value will include more faces to be inflated.

- Enable Preserve Boundary, if required.
- Click Mark to highlight the thin regions.
- Click Apply.

Figure 8.8.2 shows the inflating of thin regions on the wrapper surface.

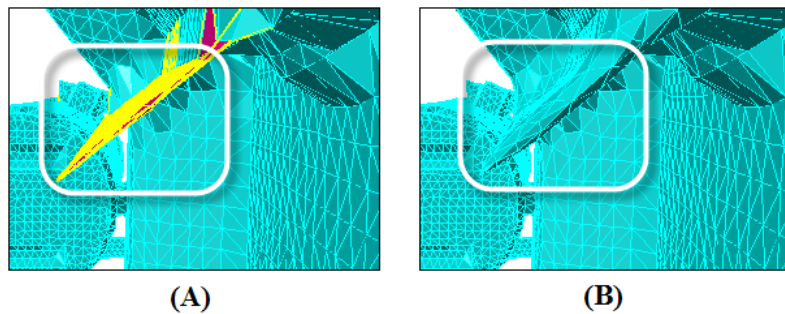


Figure 8.8.2: Wrapper Surface (A) Before and (B) After Inflating Thin Regions

In Figure 8.8.3, Face1 and Face2 are the faces of the wrapper surface on either side of a thin region. The angle between the two faces is less than the Critical Angle specified.

- When inflating the thin region, the nodes of the faces are moved away from each other and the marked region will be inflated.
- If you enable Preserve Boundary, the node on the feature edge will not be moved.
- If you disable Preserve Boundary, the node on the feature edge will also be moved.

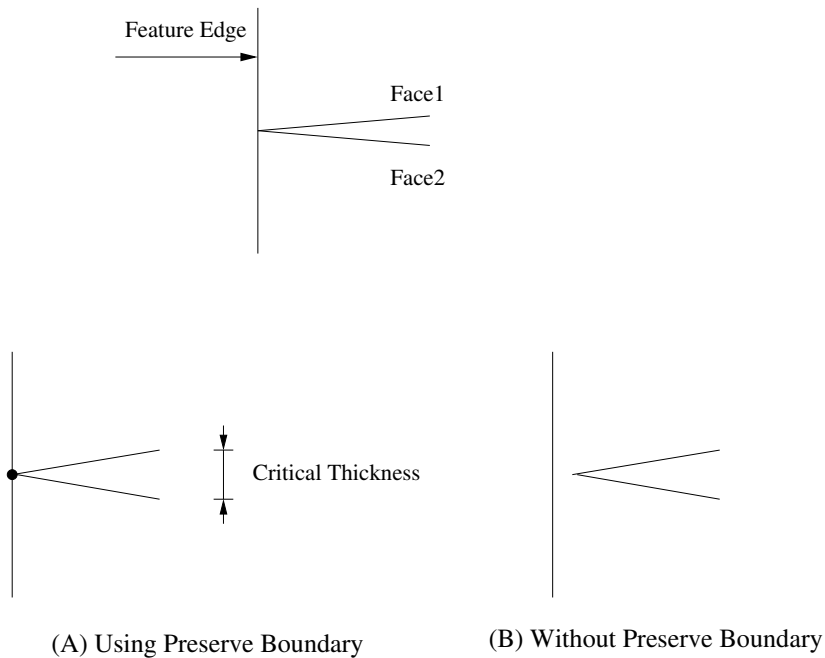


Figure 8.8.3: Preserving the Feature Edge While Inflating Thin Regions

Removing Self Intersections

TGrid removes most invalid configurations and improves the face quality when you smooth and swap the wrapper surface. However, configurations such as self-intersecting faces may remain. To remove self-intersecting faces, do the following:

1. Select the wrapper surface in the **Tri Boundary Zones** selection list.
2. Select **Post Wrap** in the **Options** drop-down list and **Remove Self Intersection** in the **Sub Options** list.
3. Specify the number of attempts for resolving self-intersecting configurations in the **Iteration** field.
4. Specify an appropriate value for **Relative Thickness**.
The relative thickness is the maximum distance by which the self-intersecting faces should be separated.
5. Click **Apply**.

TGrid will check for the presence of self-intersecting faces and report the number of such faces in the console. The self-intersecting configurations will be removed from the wrapper surface. Most self-intersecting configurations will be removed by TGrid, but there may be some faces that may not be resolved. Such faces will also be reported in the console.

Deleting Islands

The Delete Islands option allows you to delete faces in a non-contiguous region of a face zone. You can delete islands having a face count less than or equal to the specified critical face count. The critical face count is determined from the values specified for **Absolute Count** and **Relative Count**. The value for the critical face count is taken as the absolute count specified or the product of the relative count specified and the face count of the largest region, whichever is lower.

To delete island faces, do the following:

1. Select the wrapper surface in the **Tri Boundary Zones** list.
2. Select **Post Wrap** in the **Options** drop-down list and **Delete Island** in the **Sub Options** list.
3. Enter appropriate values for **Absolute Count** and **Relative Count** in the **Critical Face Count** group box.
4. Click **Apply** to delete the island faces.

Swapping

Swapping is another operation to improve the skewness of the faces in the wrapper surface. It allows you to swap the common edge of two adjacent triangles into the other diagonal directions. The swapping is carried out only when the two triangles form an angle close to planar and the swapped configuration gives better skewed cells.

To perform swapping on the wrapper surface, do the following:

1. Select the wrapper surface in the **Tri Boundary Zones** selection list.
2. Select **Post Wrap** in the **Options** drop-down list and **Swap** in the **Sub Options** list.
3. Specify an appropriate value for **Max Angle**.

The maximum angle specifies the maximum angle between two adjacent face normals. This restriction prevents the loss of sharp edges in the geometry while swapping wrapper surface.

4. Specify an appropriate value for Max Skew.

All the faces having a skewness value greater than the specified value will be swapped.

5. Click Apply.

Improving the Quality

This Improve operation allows you to further improve the quality of the wrapper surface.

To improve the wrapper surface, do the following:

1. Select the wrapper surface in the Tri Boundary Zones selection list.
2. Select Post Wrap in the Options drop-down list and Improve in the Sub Options list.
3. Select the appropriate option from the Quality Measure drop-down list.
4. Specify the number of attempts to improve the wrapper surface quality in the Iteration field.
5. Specify an appropriate value for Max Angle.

The maximum angle is the maximum allowable angle between two adjacent face normals. This restriction prevents the loss of sharp edges in the geometry while improving the wrapper surface.

6. Specify an appropriate value for Quality Limit.

The quality limit is the limit above which the wrapper surface will be improved.

7. Click Apply.

8.8.3 Zone Options

The wrapper surface created by TGrid comprises only a single boundary zone. It is a good practice to separate the wrapper surface into several zones based on the zones of the original geometry. This is particularly useful when boundary conditions are to be applied for certain zones during the fluid simulation. You will then rezone the separated wrapper zones for better recovery of the zones in the geometry. You can also rename the zones as required.

Recovering Zones

The wrapper surface will be separated into boundary zones based on the zones in the original geometry. When you separate the wrapper surface into different zones, the boundary zones associated with the original geometry will be retained and the newly created boundary zones will be prefixed by “wrap”. For example, for the boundary zone `rear-wing`, the corresponding zone created from the wrapper surface will be `wrap-rear-wing:xx` (where, `xx` is a random number). The original wrapper surface will be deleted.

To separate the zones of the wrapper surface, do the following:

1. Select **Zone** in the **Options** drop-down list and **Recover Zone** in the **Sub Options** list.
2. Click **Apply**.

*This operation separates the wrapper surface into several zones based on the input geometry. The newly created zones will be listed in the **Tri Boundary Zones** selection list, prefixed by “wrap”. The boundaries of the separated zones are not smooth, you need to smooth them using the **Rezone** option.*

Rezoning Faces

The zones separated from the single wrapper surface can be smoothed by adjusting the node positions on the zone boundaries. Very small zones (islands) will be merged to bigger adjacent zones. To rezone the faces on the separated wrapper zones, do the following:

1. Select the boundary zone(s) to be rezoned in the **Tri Boundary Zones** selection list.
2. Retain the selection of **Zone** in the **Options** drop-down list and select **Rezone** in the **Sub Options** list.

*The **Rezone** option allows you to smooth the boundaries of the separated zones and removes the island zones (Figure 8.8.4).*

3. Enable **Reprojection**, if required. This is useful in recovering the distinctive zone boundary in the original geometry.
4. Click **Apply**.

Multiple rezone operations may be required for better recovery of the boundaries of the wrapper zones. You may also need to rezone each wrapper zone separately.

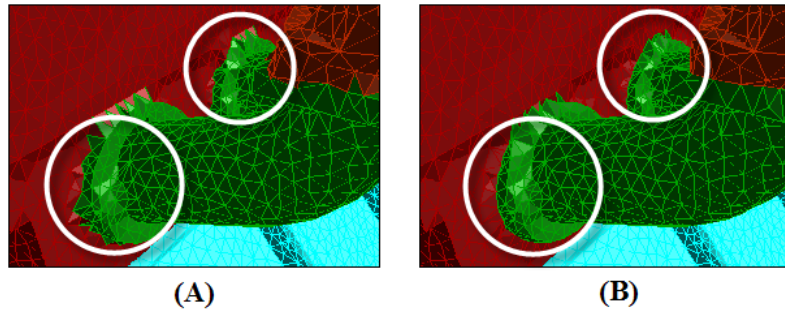


Figure 8.8.4: Wrapper Surface (A) Before and (B) After Rezoning

Renaming Zones

By default, the separated wrapper zones are prefixed by “wrap-” to distinguish them from the original geometry. To rename the wrapper surfaces, do the following:

1. Select the surfaces to be renamed in the Tri Boundary Zones list.
2. Retain the selection of Zone in the Options drop-down list and select Rename in the Sub Options list.
3. Specify the prefix as appropriate in the From and To fields in the Change Prefix group box.
4. Click Apply.

8.8.4 Expert Options

The Expert options contain advanced post wrapping improvement options available in TGrid.

- Auto post improvement
- Recovering a single surface
- Removing crossovers

Auto Post Improvement

TGrid allows you to use a pre-defined sequence of improvement operations to improve the wrapper surface after recovering and rezoning the wrapper surface based on the original geometry. The improvement operations include the splitting and merging of nodes to remove small areas, improving the boundary surface quality, collapsing skewed faces, and removing duplicate and intersecting faces. The automatic improvement procedure performs these improvement operations in a pre-defined sequence based on the parameters specified in the **Boundary Wrapper** panel.

To use the automatic post improvement procedure, do the following:

1. Select **Expert** in the **Options** drop-down list and **Auto Post Improve** in the **Sub Options** list, respectively.
2. Enter an appropriate value for **Min Triangle Area**.
3. Enter appropriate values for **Max Aspect Ratio**, **Max Skewness**, and **Max Size Change**.
4. Click **Apply**.

TGrid will report the improvement operations performed and the quality at the end of the auto improvement in the console.

Recovering a Single Surface

Certain geometries may have sheet metal components which have a small thickness and which are connected to other components. The post wrapping improvement options include the recovery of such thin sheets as a single surface after wrapping. You can either use the **Automatic** option to mark the thin parts or manually select the faces on opposite sides of the thin part. The marked faces will then be merged to obtain a single surface. You can also remove unmerged island regions after recovering the surfaces. To recover a single surface for thin parts, do the following:

1. Select **Expert** in the **Options** drop-down list and **Recover Single Surface** in the **Sub Options** list, respectively.
2. Select **Single Surface** in the **Recover Options** list.
3. Enable **Automatic** and click **Mark** to mark the faces to be merged in thin parts. Alternatively, disable **Automatic** and click the **Select** button in the **Parameters** group box. Select the seed faces as appropriate and click **Mark** to mark the faces to be merged.
4. Specify appropriate values for **Critical Thickness** and **Critical Angle**.

5. Click **Merge** to merge the thin surfaces into a single surface.

Figure 8.8.5 shows the recovered surface for a thin part. Enable the display of multiply-connected faces in the **Display Grid** panel (see Section 14.1.3: [The Display Grid Panel](#)) to see the remaining unmerged regions.

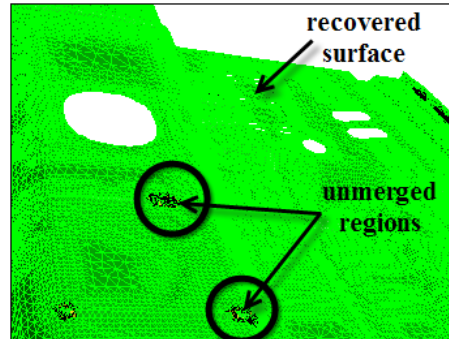


Figure 8.8.5: Recovering a Single Surface

The unmerged regions can be removed using the **Post Single Surface** option.

6. Select **Post Single Surface** in the **Recover Options** list.
7. Enter an appropriate value for **Max Face Count** and click the **Auto** button in the **Parameters** group box to automatically remove the remaining unmerged regions.

Most unmerged faces will be deleted when the automatic option is used. Any remaining unmerged faces can be deleted manually. Select the seed face as appropriate and click the **Mark** button in the **Parameters** group box. TGrid will mark the regions and report the number of faces to be deleted. Click **Delete** to delete the marked faces.

Removing Crossovers

If the geometry has small gaps between two separate faces, the wrapper can create crossover configurations. The crossovers are unwanted faces that connect parts of the wrapper surface separated by a small gap. The crossover faces have one vertex on one side of the gap and the other two nodes on the other side of the gap. You need to remove the crossovers to make the wrapper surface represent the original geometry precisely.

TGrid allows you to remove crossover faces either automatically or manually. To remove crossover configurations, do the following:

1. Select the wrapper surface in the **Tri Boundary Zones** selection list.
2. Select **Expert** in the **Options** drop-down list and **Remove Crossover** in the **Sub Options** list.

3. Enable **Automatic** and click **Apply** to automatically remove crossovers.

The automatic crossover removal resolves the crossover faces throughout the domain. You may need to manually resolve some configurations that could not be resolved during the automatic crossover removal.

4. Disable **Automatic** and specify the following crossover removal parameters.
 - (a) Specify the number of crossover removal attempts in the **Iteration** field.
 - (b) Select the seed face as appropriate.
 - (c) Enter appropriate values for **Max Faces** and **Relaxation**.
 - (d) Click **Apply**.

Figure 8.8.6 shows crossovers connecting separate parts of the wrapper surface. These faces will be deleted during the crossover removal.

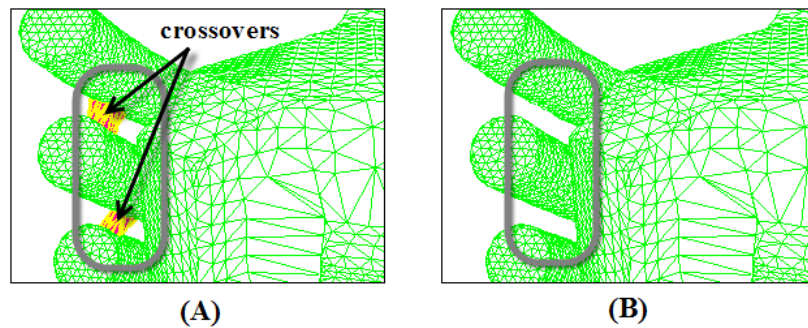
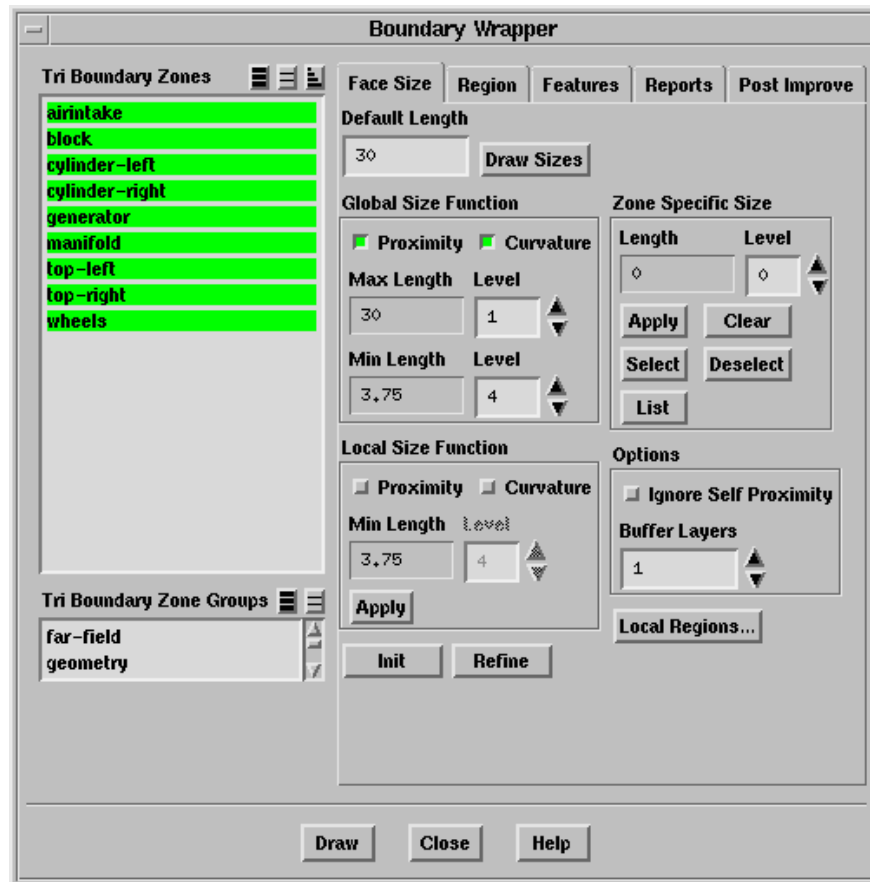


Figure 8.8.6: Wrapper Surface (A) Before and (B) After Crossover Removal

8.9 The Boundary Wrapper Panel

The Boundary Wrapper panel allows you to preprocess geometries that contains gaps and overlaps. See Section 8.2: [The Wrapping Process](#) for more details about using the Boundary Wrapper panel.

Boundary → Wrap...



Tri Boundary Zones contains a list of existing tri face zones. The zones may be face zones in the input geometry or the wrapper surface (generated after wrapping).

Face Size contains parameters for creating and controlling the initial Cartesian grid.

Default Length specifies the size of the largest cells in the Cartesian grid.

Draw Sizes displays red boxes of the specified default size over the selected boundary zone.

Global Size Function allows you to specify the Cartesian grid initialization size function parameters to be applied globally.

Proximity allows you to automatically refine the Cartesian cells based on the proximity of the zone to other faces in the current domain.

Curvature allows you to automatically refine the Cartesian cells based on the curvature of the zone in the current domain.

Max Length, **Min Length** specify the maximum and minimum size of the cells in the Cartesian grid, respectively. These are only informative boxes and you cannot make any change to the values displayed here.

Level allows you to select the level of refinement. The cell size for each level is determined relative to the **Default Length**.

Zone Specific Size contains the parameters for modifying the Cartesian grid cell configuration for each zone.

Length specifies the size of the cells in the Cartesian grid that you want to create for the zone(s) selected in the **Tri Boundary Zones** list. The value in the **Length** can only be modified by changing the **Level**.

Level allows you to specify the cell length for the zones selected in the **Tri Boundary Zones** list.

Apply applies the specified level of refinement to the selected boundary zone.

Clear clears the specified level of refinement to the selected boundary zone.

Select selects the geometry zones on which specified zone sizes are defined.

Deselect deselects the geometry zones on which specified zone sizes are defined.

List reports the name, level and cell size of the zone(s) selected in the **Tri Boundary Zones** list.

Local Size Function allows you to define local size functions and to refine local cells based on the size functions.

Proximity allows you to automatically refine the local cells based on the proximity of the zone to other faces in the domain.

Curvature allows you to automatically refine the local cells based on the curvature of the zone in the domain.

Min Length specifies the minimum allowable size of the cells in the Cartesian grid.

Level allows you to specify the minimum cell length for local refinement.

Apply computes required sizes based on the input geometry zones as well as parameters and updates size functions.

Options contains additional options for wrapping.

Ignore Self Proximity allows you to ignore self-proximity during wrapping. By default, this option is disabled.

Buffer Layers specifies the number of additional layers to be added in order to have a smooth transition from fine to coarse cells.

Local Regions... opens the Wrapper Refinement Region panel (see Section 8.9.1: The Wrapper Refinement Region Panel)

Init allows you to initialize the Cartesian grid.

Refine refines the Cartesian grid according to the specified Zone Specific Size and/or Local Size Function parameters.

Region contains the parameters to examine the region of interest among the several regions created during the wrapper initialization process.



Region contains a list of the regions generated during the wrapping process.

Overlay Graphics displays the Cartesian grid overlaid with the current display.

Wrap wraps the selected region(s).

Extract extracts the interface(s) from the selected region(s).

Draw displays the selected region(s).

Refine refines the selected region(s).

Clear clears all the regions.

Deleting the regions reduces the peak memory and improves the speed of further operations. You can not recover the regions after they have been deleted.

Interface contains a list of the interface surfaces extracted from the regions.

The Interface list is available only after you have extracted an interface from any region.

Wrap creates the wrapper surface from the selected interface(s).

Draw displays the selected interface(s).

List lists the face count for all extracted interface(s) in the console.

Delete deletes the selected interface(s).

Fix Holes contains options for fixing holes in the Cartesian grid.

Automatic lists the holes detected for all regions.

Draw draws the hole(s) selected in the **Automatic** selection list.

List lists the ID, location, and the region for the hole(s) selected in the **Automatic** selection list.

Fix closes the holes selected in the **Automatic** selection list.

Open allows you to ignore holes in regions other than the region of interest.

Region specifies the region to be considered for automatic hole fixing.

Select selects the holes detected for the region specified in the **Region** field.

Manual contains options for manual hole fixing.

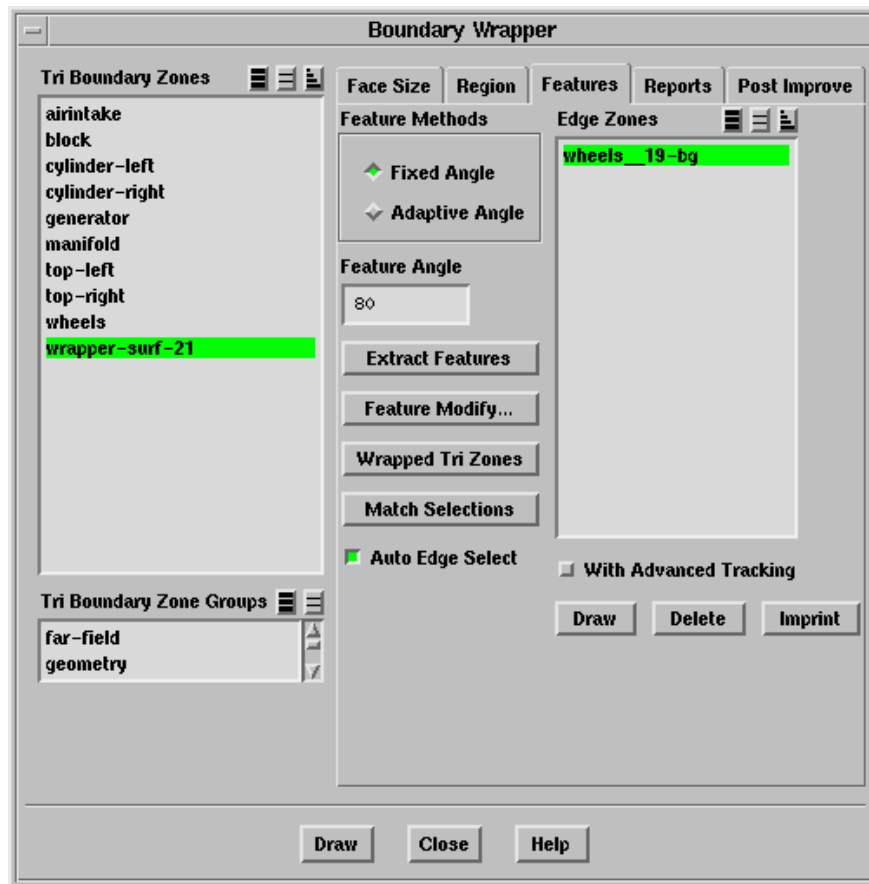
Pan Regions... opens the **Pan Regions** panel, using which you can examine the Cartesian grid.

Trace Path... opens the **Trace Path** panel, using which you can trace the leaks or holes in the existing geometry.

Update Regions updates the selected region for the modifications made to the zones selected in the **Tri Boundary Zones** list.

See Section [8.5.2: Manual Leak Detection](#) for details on the manual hole fixing procedure.

Features contains the parameters to recover the distinctive feature lines in the geometry.



Feature Methods specifies the methods available to create edge loops.

Fixed Angle specifies the feature edge should be preserved only if the angle between adjacent triangular faces is greater than the specified value.

Feature Angle specifies the minimum feature angle that should be prevented while remeshing operation.

Adaptive Angle specifies the feature edge should be preserved using adaptive angle criteria.

Extract Features extracts the edge loops for the zones selected in the **Tri Boundary Zones** selection list and lists them in the **Edge Zones** list.

Feature Modify... opens the **Feature Modify** panel, using which you can modify/remesh edge loops.

Wrapped Tri Zones selects the wrapped zones in the **Tri Boundary Zones** selection list.

Match Selections selects the edge loop(s) associated with the selected zone(s) in **Tri Boundary Zones** list. This feature can be used only if the **Auto Edge Select** option is disabled.

Auto Edge Select automatically selects edge loop(s) associated with the zones selected in the **Tri Boundary Zones** selection list.

Edge Zones contains a list of edge loops that have been created for one or more face zones.

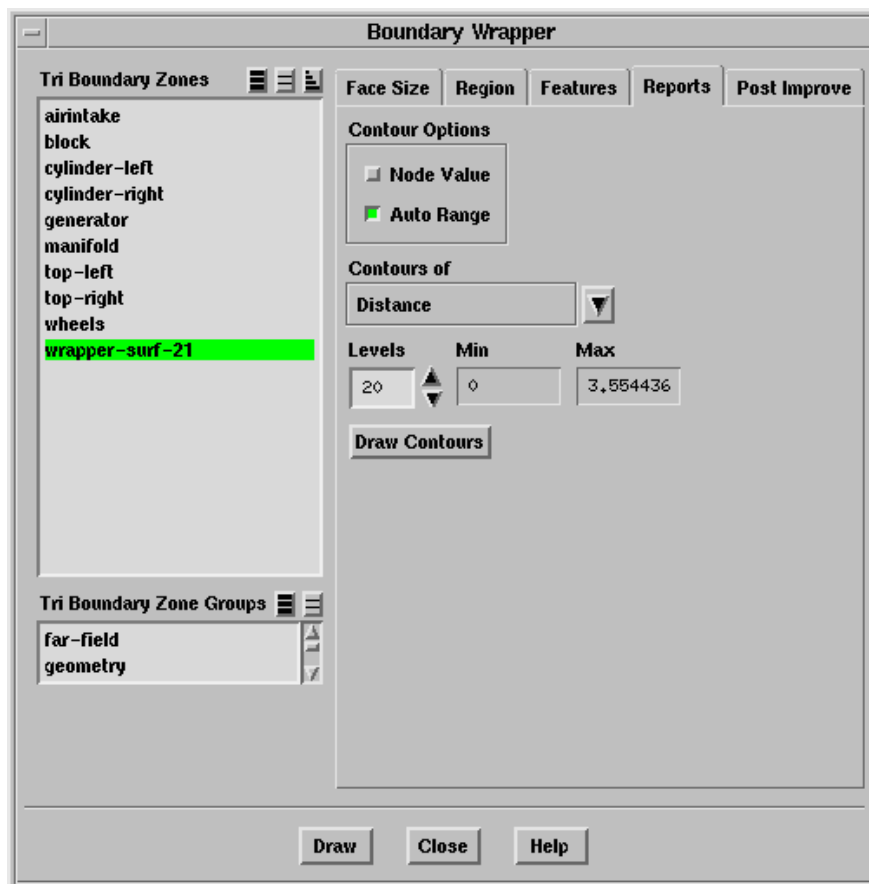
With Advanced Tracking enables advanced tracking of the node path corresponding to a feature edge on the wrapper surface during imprinting of features.

Draw displays the edge loops selected in the **Edge Zones** list.

Delete deletes the edge loops selected in the **Edge Zones** list.

Imprint projects the nodes of the wrapper surface onto the selected **Edge Zones**.

Reports contains the parameters to check the quality of the wrapper surface.



Contour Options contains the various contour display options.

Node Values toggles between using scalar field values at nodes and at face centers for computing the contours.

Auto Range toggles between automatic and manual setting of the contour range.

Contours of contains a list from which you can select the parameters to be contoured.

Distance specifies the distance of face center to the original geometry.

Normal specifies the direction of the face with respect to the original geometry.

Composite specifies the value calculated by linearly combining above two values.

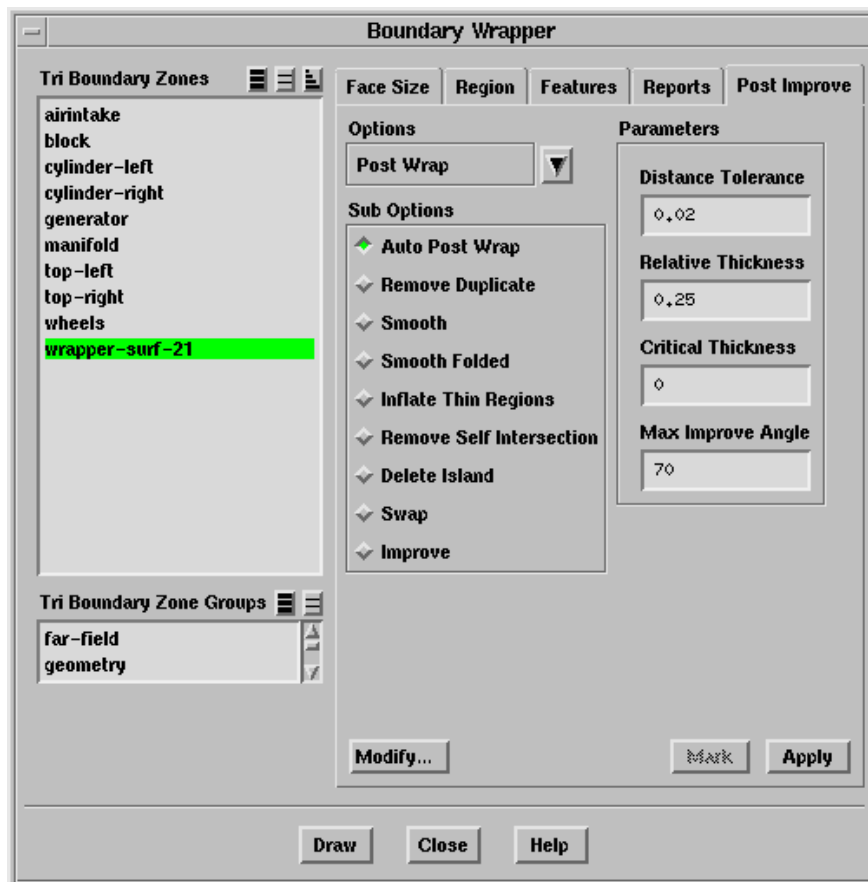
Levels sets the number of contour levels that are displayed.

Min shows the minimum value of the scalar field.

Max shows the maximum value of the scalar field.

Draw Contours displays the contours in the active graphics window.

Post Improve contains the parameters to improve the quality of the wrapper surface.



Options contains various options that are available to improve the quality of the wrapper surface.

Coarsen allows you to coarsen the wrapper surface. This option can also be used for wrapper boundary zones after zone recovery.

Total Face Count reports the face count for the zone selected in the Tri Boundary Zones list. The value in this field is informational only.

Edge Length Change specifies the maximum allowable edge length change.

Max Angle Change specifies the maximum allowable angle change.

Min Length, Max Length specify the minimum and maximum values (range) for the average length of faces to be considered for coarsening.

Preserve Boundary allows you to preserve the original locations of the zone boundary nodes.

Post Wrap contains options for the post wrapping operations available in TGrid.

Auto Post Wrap allows you to perform a pre-defined sequence of post wrapping operations on the wrapper surface.

Distance Tolerance specifies the tolerance value for removing duplicate nodes.

Relative Thickness specifies the distance for the separation of self-intersecting faces.

Critical Thickness specifies the critical thickness for inflating thin regions.

Max Improve Angle specifies the maximum angle considered for improving the wrapper surface.

Remove Duplicate deletes the duplicate nodes within the proximity of the tolerance value.

Distance Tolerance specifies the tolerance value to be considered while removing duplicate nodes.

Smooth allows you to smooth the wrapper surface.

Iteration specifies the number of smoothing attempts.

Relaxation specifies the node smoothing relaxation factor.

Reprojection enables the projection of nodes onto the geometry after smoothing.

Rel Reproject Range specifies the maximum relative distance of the nodes from geometry within which the nodes are projected onto the geometry.

Preserve Boundary allows you to preserve the original locations of the zone boundary nodes.

Smooth Folded allows you to fix the folded faces on the wrapper surface.

Iteration specifies the number of node smoothing attempts for resolving folded configurations.

Critical Angle specifies an angle between the pair of adjacent faces. If the feature angle between the two faces is smaller than the specified value, the faces are assumed to be folded.

Relaxation specifies the relaxation factor for node smoothing.

Reprojection enables the projection of the adjusted nodes back on the geometry edges after smoothing.

Inflate Thin Regions improves the wrapper surface by pushing apart the overlapping faces to a certain thickness.

Critical Thickness specifies the critical distance within which the faces are assumed to be overlapped.

Critical Angle specifies the critical angle between the faces below which the faces are assumed to be overlapped.

Preserve Boundary allows you to preserve the original locations of the zone boundary nodes.

Remove Self Intersection moves apart the intersecting faces in the wrapper surface.

Iteration specifies number of attempts to remove self intersecting faces.

Relative Thickness specifies the distance upto which the separation of self-intersecting faces takes place.

Delete Island deletes island faces having a face count less than or equal to the specified critical face count.

Critical Face Count specifies the critical face count for deleting the island faces.

Absolute Count specifies the absolute face count below which the non-contiguous region can be treated as an island configuration.

Relative Count specifies the face count relative to the largest region below which the non-contiguous region can be treated as an island configuration.

Swap allows you to perform node swapping on the wrapper surface.

Max Angle specifies the maximum angle between two adjacent faces allowed for performing swapping.

Max Skew specifies the maximum allowable skewness value after swapping.

Improve allows you to improve the wrapper surface based on the **Quality Measure** selected.

Quality Measure contains the available options for improving the quality of the wrapper surface.

Skewness allows you to improve the wrapper surface quality based on the skewness.

Size Change allows you to improve the wrapper surface quality based on size change.

Aspect Ratio allows you to improve the wrapper surface quality based on the aspect ratio.

Iteration specifies the number of improving attempts.

Max Angle specifies the maximum allowable angle between two adjacent face normals.

Quality Limit specifies the quality limit for the improvement operation. All elements above the specified quality limit will be improved.

Preserve Boundary allows you to preserve the original locations of the zone boundary nodes.

Zone contains options for the recovery of zones from the wrapper surface.

Recover Zone separates the wrapper surface into zones based on the original geometry.

Rezone smoothes the separated zones by adjusting the node position on the zone boundaries.

Reprojection enables the projection of nodes onto the geometry after smoothing.

Rename allows you to rename the boundary zones.

From specifies the prefix of the existing zone names that you want to rename.

To specifies the prefix of the new zone names.

Expert contains advanced improvement options

Auto Post Improve performs a pre-defined sequence of improvement operations like splitting and merging of nodes to remove small areas, improving the boundary surface quality, collapsing skewed faces, and removing duplicate and intersecting faces.

Min Triangle Area specifies the minimum face area to be considered while removing small areas.

Max Aspect Ratio specifies the maximum allowable aspect ratio.

Max Skewness specifies the maximum allowable skewness.

Max Size Change specifies the maximum allowable size change.

Recover Single Surface contains options for recovering thin surfaces and removing any remaining overlapping regions.

Single Surface allows you to recover a single thin surface.

Automatic enables the automatic marking and merging of thin regions for recovering the single surface.

First Seed Face, Second Seed Face specify the seed faces to be used for marking the thin regions.

Critical Thickness specifies the critical thickness of the surface to be recovered.

Critical Angle specifies the maximum angle between a pair of opposing faces while checking for overlapping faces. Any pair of faces whose normal vectors form an angle greater than the specified value will be regarded as non-overlapping.

Select allows you to select the seed faces when the **Automatic** option is disabled.

Mark marks the faces to be merged.

Merge merges the thin surfaces into a single surface.

Post Single Surface allows you to remove unmerged island regions after recovering the thin surface.

Start Seed Face specifies the seed face to be used for marking the unmerged regions. You need to specify the seed face while marking the unmerged regions manually.

Max Face Count specifies the maximum allowable face count for the removal of the unmerged regions.

Mark marks the unmerged regions to be removed.

Delete deletes the marked faces.

Reset clears the previously selected seed face.

Auto automatically marks and deletes the unmerged regions.

Remove Crossover allows you to remove the crossover configurations the wrapper surface.

Automatic automatically removes the crossover configurations.

Seed Face specifies the seed face for determining the crossover configuration.

Max Faces specifies the maximum number of faces to be collected and deleted after performing this operation.

Iteration specifies the number of attempts to remove the crossover configuration in case of failure.

Relaxation specifies the relaxation factor for node smoothing in making different number of attempts.

Modify... opens the **Modify Boundary** panel.

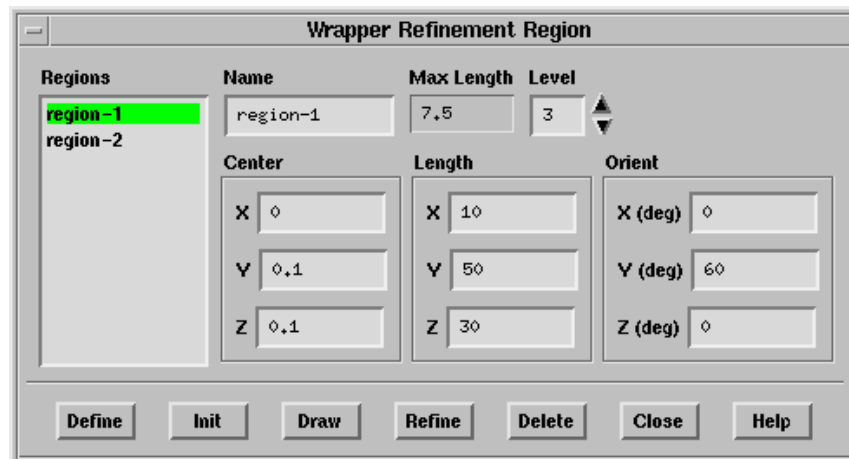
Mark marks the cells to be considered for the selected post wrapping improvement operation. The **Mark** option is available

Apply executes the operation selected in the **Options** list.

Draw displays the zones selected in the **Tri Boundary Zones** list in the graphics window.

8.9.1 The Wrapper Refinement Region Panel

The Wrapper Refinement Region panel allows you to define local regions to be refined.



Controls

Regions contains a list of the defined regions.

Name specifies the name of the region selected in the **Regions** list, or the region to be created.

Max Length specifies the maximum cell length in the region. The **Max Length** value is specified by the **Level** specified.

Level specifies the refinement level for the local region defined.

Center specifies the coordinates of center of the refinement region.

Length specifies the extent of the refinement region in the x , y , z directions.

Orient specifies the orientation of the refinement region.

Note: TGrid orients the region by rotation first about the x -axis, then the y -axis, and finally the z -axis. You need to take this into account while specifying the orientation of the region as rotation in any other order will produce different results.

Define creates a new region according to the specified parameters. It also allows you to modify the selected region according to specified parameters.

Init creates a default region encompassing the entire geometry.

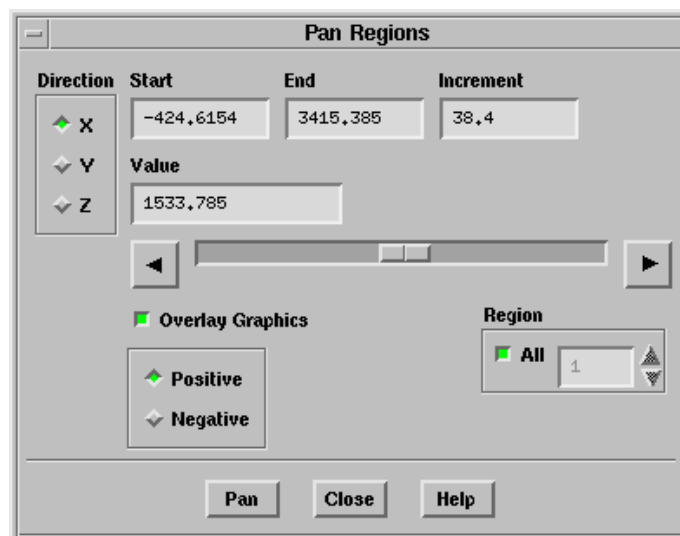
Draw displays the selected region in the graphics window.

Refine refines the selected region.

Delete deletes the selected region.

8.9.2 The Pan Regions Panel

The Pan Regions panel allows you to observe and analyze the region (you want to wrap) created during the Cartesian grid initialization.



Controls

Direction allows you to select the direction in which you want pan the selected region(s).

Start specifies the frame number from which you want to start the plane movement.

End specifies the frame number at which you want to stop the plane movement.

Increment specifies the interval of the cutting plane coordinate during panning.

Overlay Graphics allows you to display either the Cartesian grid surface or the geometry along with the pan plane while panning through the selected region(s).

Positive displays the surfaces on the positive side of the cutting plane.

Negative displays the surfaces on the negative side of the cutting plane.

Region allows you to select the regions you want to pan through.

All enables panning through all regions. When this option is disabled, you can select a particular region to pan.

Pan starts the movement of the plane from one end to the other in the specified direction through the Cartesian grid.

8.9.3 The Trace Path Panel

The Trace Path panel allows you to locate the position of the hole or leak in the Cartesian grid or input geometry by tracing the path connecting the cells corresponding to specified locations.

	X Pos	Y Pos	Z Pos
Start	1533,78	-786,4937	726,6909
End	1533,78	-1059,644	910,128

Controls

`Locations` specifies the positions (X Pos, Y Pos, Z Pos) of the `Start` and `End` points between which the path is to be traced. You can either enter the position values or select the points using the mouse.

`Select Points...` allows you to select the start and end points of the trace using the mouse.

`Trace` highlights the shortest possible path between the specified `Start` and `End` points.

8.10 Text Commands for the Wrapper

The text interface command for wrapping boundary zones is listed below:

`/boundary/wrapper/delete-all-cells?` allows you to delete the Cartesian mesh. This command is available only after initializing the Cartesian grid.

`/boundary/wrapper/imprint-edges` imprints the wrapper surface on recovered feature edges that you recover. This command is available only after creating the wrapper surface.

`/boundary/wrapper/initialize` creates a Cartesian mesh of the specified parameters.

`/boundary/wrapper/local-regions/define` allows you to define the local refinement region.

`/boundary/wrapper/local-regions/delete` deletes the specified refinement region.

`/boundary/wrapper/local-regions/init` creates a region encompassing the entire geometry.

`/boundary/wrapper/local-regions/list-all-regions` lists all the refinement regions in the TGrid console.

`/boundary/wrapper/local-regions/refine` refines the specified region according to the refinement parameters specified.

`/boundary/wrapper/pre-smooth?` allows you to enable or disable smoothing of nodes during wrapping. This command is available only after initializing the Cartesian grid.

`/boundary/wrapper/region/draw-holes` draws the holes detected by TGrid. See Section 8.5.1: [Automatic Leak Detection](#) for details.

`/boundary/wrapper/region/extract-enclosing-region` extracts the interface for the region enclosing the specified point.

`/boundary/wrapper/region/extract-interface` extracts the interfaces for the specified regions.

`/boundary/wrapper/region/fix-holes` fixes the specified hole(s). See Section 8.5.1: [Automatic Leak Detection](#) for details.

`/boundary/wrapper/region/list-holes` lists the existing holes.

`/boundary/wrapper/region/list-regions` lists the region created when the Cartesian grid is initialized.

`/boundary/wrapper/region/modify-region-holes` allows you to fix or open holes related to the specified region.

`/boundary/wrapper/region/open-holes` opens the specified hole(s). See Section 8.5.1: [Automatic Leak Detection](#) for details.

`/boundary/wrapper/region/refine` refines the Cartesian grid based on the zone specific sizes and local size functions. This command is available only after initializing Cartesian grid.

`/boundary/wrapper/region/refine-enclosing-region` refines the region enclosing the specified point.

`/boundary/wrapper/region/refine-region` refines the specified region.

`/boundary/wrapper/region/refine-zone-cells` refines the cells associated with the specified boundary zone. This command is available only after initializing the Cartesian grid.

`/boundary/wrapper/region/update-regions` updates the regions to account for the changes made to the original geometry (during manual hole fixing).

`/boundary/wrapper/region/wrap-enclosing-region` generates the wrapper surface for the region enclosing the specified point.

`/boundary/wrapper/region/wrap-region` generates the wrapper surface for the specified region. This command is available only after initializing the Cartesian grid.

`/boundary/wrapper/region/wrapper-region-at-location` reports the region at the specified location.

`/boundary/wrapper/set/clear-size` clears all the zone specific size parameters.

`/boundary/wrapper/set/curvature?` allows you to enable or disable the curvature size function.

`/boundary/wrapper/set/curvature-factor` allows you to specify the curvature factor for initializing the wrapper.

`/boundary/wrapper/set/default-face-size` allows you to specify the default face size for the Cartesian grid.

`/boundary/wrapper/set/feature-threshold` allows you to specify the critical range within which the nodes of the wrapper will be projected onto the feature edges.

`/boundary/wrapper/set/ignore-feature-skewness` specifies the critical skewness to preserve feature lines during the face improvement. Only faces with skewness greater than the specified value will be modified. The default value is such that no feature lines will be modified during the face improvement.

`/boundary/wrapper/set/ignore-self-proximity?` allows you to enable or disable the self-proximity calculation during the refinement.

`/boundary/wrapper/set/list-size` lists the current zone specific sizes of the domain.

`/boundary/wrapper/set/local-size-function` allows you to set local size functions for refining the Cartesian grid.

`/boundary/wrapper/set/max-refine-level` specifies the maximum allowable refinement level.

`/boundary/wrapper/set/maximum-size-level` specifies the largest cell size in the Cartesian grid.

`/boundary/wrapper/set/minimum-proximity-gap` specifies the minimum gap within which the proximity will be ignored.

`/boundary/wrapper/set/number-of-size-boxes` specifies the number of boxes to be displayed when using the Draw Sizes button in the Face Size tab.

`/boundary/wrapper/set/proximity?` allows you to enable or disable the proximity size function.

`/boundary/wrapper/set/proximity-factor` allows you to specify the proximity factor for initializing the wrapper.

`/boundary/wrapper/set/read-local-sizes` reads the zone-specific sizes written to a file.

`/boundary/wrapper/set/refinement-buffer-layers` allows you to specify the specific number of additional cell layers that you want to refine.

`/boundary/wrapper/set/relative-island-count` allows you to specify a critical cell count for island regions generated during wrapping.

`/boundary/wrapper/set/write-local-sizes` writes the zone-specific sizes to a file.

`/boundary/wrapper/set/zone-specific-size` allows you to specify zone specific sizes.

`/boundary/wrapper/post-improve/auto-post-improve` improves the wrapper surface using a pre-defined sequence of operations.

`/boundary/wrapper/post-improve/auto-post-wrap` performs a pre-defined sequence of post-wrapping operations on the wrapper surface.

`/boundary/wrapper/post-improve/coarsen-wrapper-surf` allows you to coarsen the wrapper surface.

`/boundary/wrapper/post-improve/imprint-geom-surf` allows you to imprint the geometry on the wrapper surfaces (manual zone recovery).

`/boundary/wrapper/post-improve/improve` allows you to improve the wrapper surface quality based on skewness, size change, or aspect ratio.

`/boundary/wrapper/post-improve/inflate-thin-regions` allows you to push apart the overlapping faces in thin regions.

`/boundary/wrapper/post-improve/post-single-surface` allows you to clean up unmerged island regions after recovering the single surface.

`/boundary/wrapper/post-improve/recover-feature` projects nodes from the wrapper surface on to the extracted features.

- Use the `mark` option to mark the nodes to be projected.
- Use the `project` option to project the nodes to the extracted features.



You need to use the `mark` option and examine the tracked line before using the `project` option. If you attempt to project the nodes without marking them first, TGrid will display a warning about missing feature path information, indicating that the nodes were not marked for projection.

`/boundary/wrapper/post-improve/recover-single-surface` allows you to recover thin surfaces as a single surface after wrapping.

`/boundary/wrapper/post-improve/recover-zone` separates the wrapper surface into zones based on the original geometry.

`/boundary/wrapper/post-improve/remove-crossover-config` allows you to remove crossover configurations.

`/boundary/wrapper/post-improve/remove-duplicated-nodes` removes the duplicate nodes on the wrapper surface.

`/boundary/wrapper/post-improve/rename-wrapper-zones` allows you to rename the wrapper zones by specifying an appropriate prefix instead of the default prefix (`wrap-`).

`/boundary/wrapper/post-improve/resolve-nonmanifoldness` allows you to resolve non-manifold configurations on the wrapper surface.

`/boundary/wrapper/post-improve/resolve-self-intersection` removes the self intersecting faces.

`/boundary/wrapper/post-improve/rezone` smoothes the zones separated from the wrapper surface for better representation of the geometry.

`/boundary/wrapper/post-improve/smooth-folded-faces` smoothes the folded faces on the wrapper surface.

`/boundary/wrapper/post-improve/smooth-wrapper-surf` smoothes the wrapper surface.

`/boundary/wrapper/post-improve/swap-wrapper-surf` swaps the nodes of the wrapper surface to improve its quality.

