
Tutorial 6. Generating the Hexcore Mesh Upto Domain Boundaries

Introduction

When generating the hexcore mesh for external flow domains, it may not be necessary to have a tetrahedral mesh at the domain boundaries. For such cases, you can generate the hexcore mesh until the domain boundaries, thereby also reducing the cell count. This tutorial demonstrates the generation of the hexcore mesh upto the domain boundaries for a sedan car.

This tutorial demonstrates how to do the following:

1. Read the mesh file and display the boundary mesh.
2. Set parameters for generating the hexcore mesh.
3. Set parameters for creating prism layers and the hexcore mesh using automatic meshing.
4. Check and save the volume mesh.

Prerequisites

This tutorial assumes that you have some experience with TGrid, and that you are familiar with the graphical user interface.

Preparation

1. Download `hexcore-boundaries.zip` from the [FLUENT User Services Center](#) to your working directory. This file can be found from the Documentation link on the TGrid product page.

OR

Copy `hexcore-boundaries.zip` from the TGrid documentation CD to your working directory.

- For UNIX systems, insert the CD into your CD-ROM drive and go to the following directory:

`cdrom/tgrid5.0/help/tutfiles`

where, *cdrom* must be replaced by the name of your CD-ROM drive.

- For Windows systems, insert the CD into your CD-ROM drive and go to the following folder:

`cdrom:\tgrid5.0\help\tutfiles`

where, *cdrom* must be replaced by the name of your CD-ROM drive (e.g., E).

2. Unzip `hexcore-boundaries.zip`.

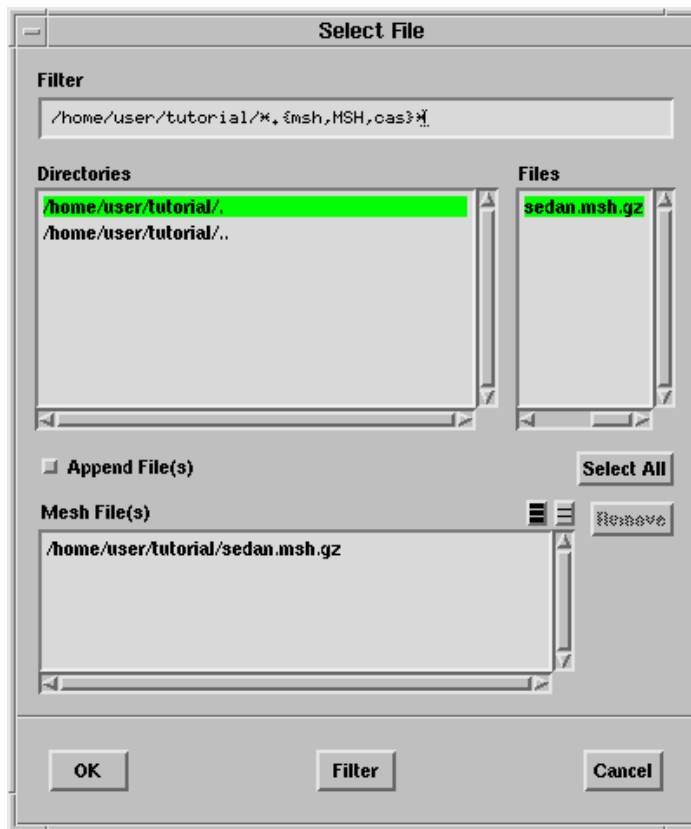
The file, sedan.msh.gz can be found in the hexcore-boundaries folder created on unzipping the file.

3. Start the 3D (3d) version of TGrid.

Step 1: Read and Display the Boundary Mesh

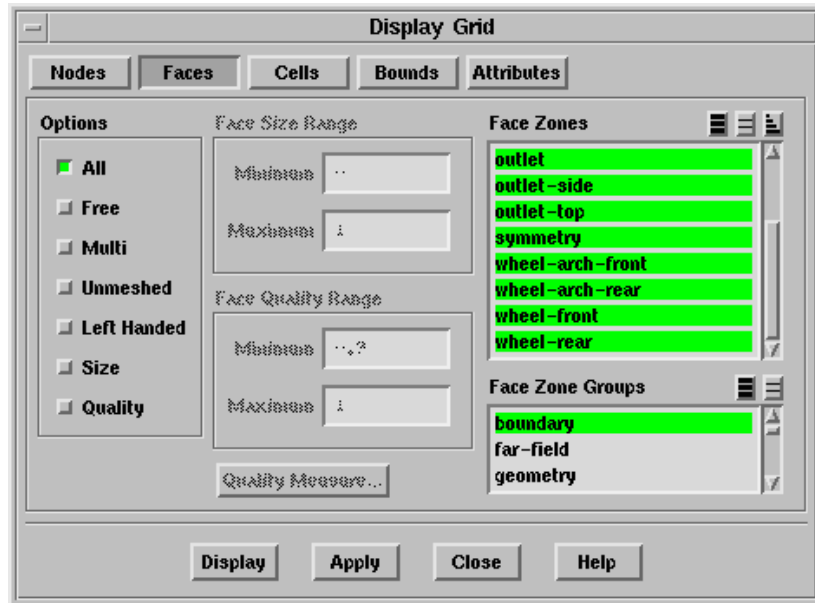
1. Read the mesh file.

File → Read → Boundary Mesh...



- (a) Select sedan.msh.gz in the Files list.
 - (b) Click OK.
2. Display the boundary mesh (Figure 6.1).

Display → Grid...



- (a) Select boundary in the Face Zone Groups selection list to select all the boundary zones in the Face Zones selection list.
- (b) Click Display.

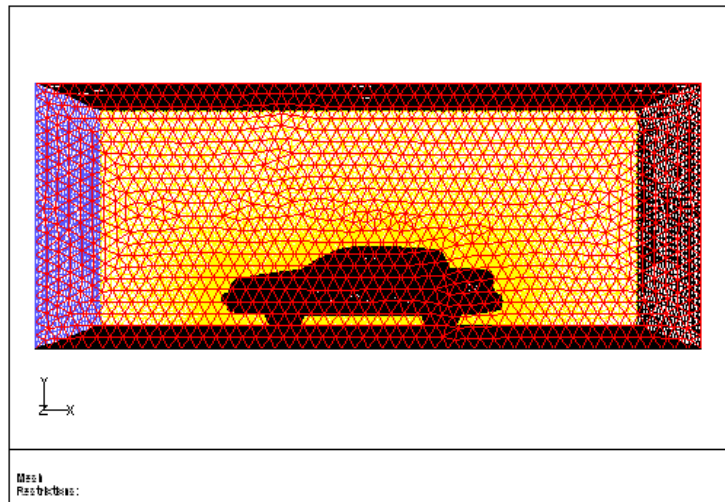


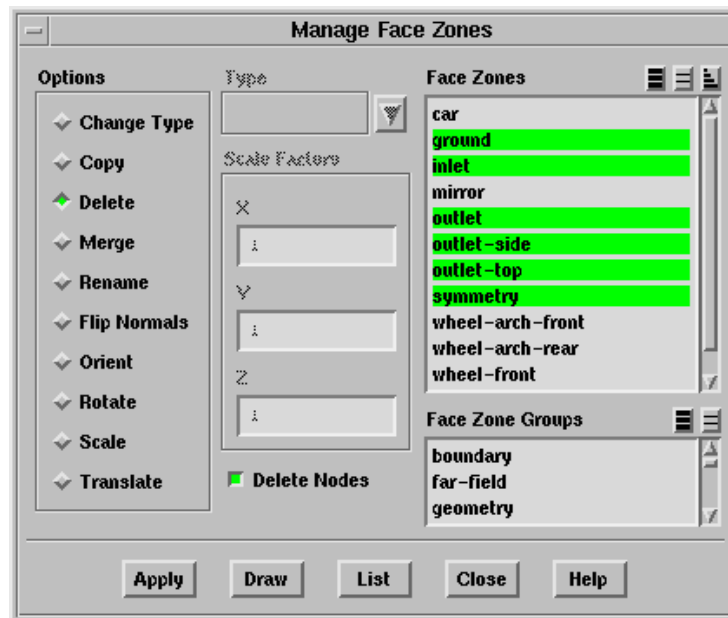
Figure 6.1: Boundary Mesh for the Sedan

The mesh contains the boundary mesh of the sedan and the outer box. You will initially generate the hexcore mesh without using the outer box boundaries to define the domain extents.

- (c) Close the Display Grid panel.

Step 2: Delete the Outer Box Boundaries

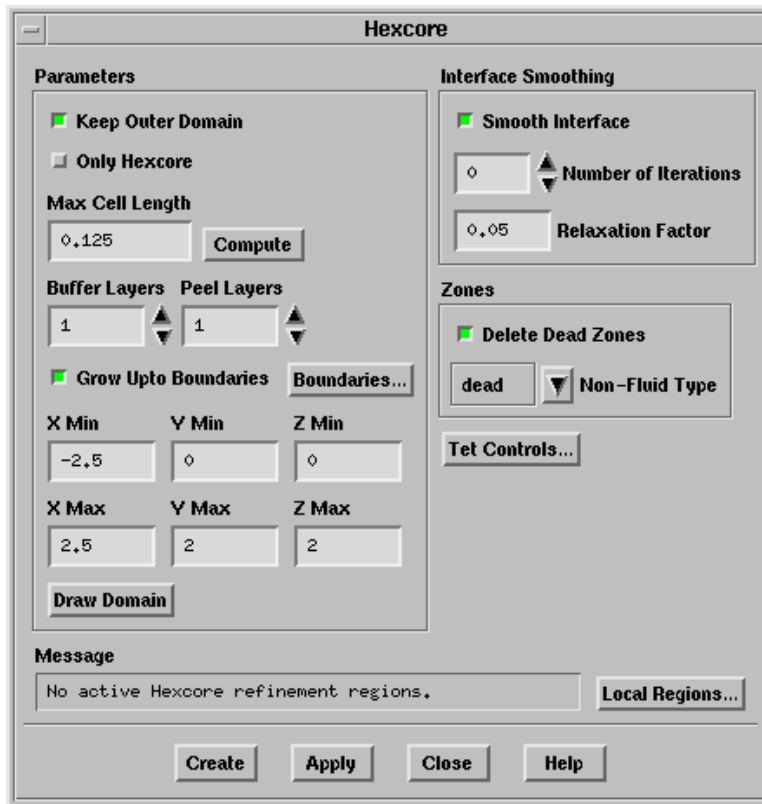
Boundary → Manage...



1. Select ground, inlet, outlet, outlet-side, outlet-top, and symmetry in the Face Zones selection list.
2. Select Delete in the Options list.
3. Retain the Delete Nodes option and click Apply.
A Question dialog box will appear, asking you to confirm if you want to delete the selected zones.
4. Click Yes in the Question dialog box.
5. Select all the zones in the Face Zones selection list and click Draw.
6. Close the Manage Face Zones panel.

Step 3: Set the Hexcore Meshing Parameters

Mesh → Hexcore...



1. Enable Keep Outer Domain in the Parameters group box.
2. Retain the setting of both Buffer Layers and Peel Layers to 1.
3. Enable Grow Upto Boundaries.
4. Enter the domain extents as follows:
 $X \text{ Min} = -2.5$, $Y \text{ Min} = 0$, $Z \text{ Min} = 0$
 $X \text{ Max} = 2.5$, $Y \text{ Max} = 2$, $Z \text{ Max} = 2$
5. Click Draw Domain to view the size of the domain.
6. Enter 0.125 for Max Cell Length.
7. Enable Delete Dead Zones in the Zones group box.

Enabling Delete Dead Zones ensures that the volume mesh is not generated inside the sedan body and the wheels, thereby making the meshing process faster.

8. Click Create.
9. Close the Hexcore panel.
10. Examine the mesh generated.

Display → Grid...

- (a) Deselect the previous selections and select **boundary** in the Face Zone Groups selection list.
- (b) Click the **Attributes** tab and enable **Filled** and **Lights** in the Options group box.
- (c) Click the **Colors...** button to open the Grid Colors panel.
- (d) Select **Color by ID** in the Options list and close the Grid Colors panel.
- (e) Display the **back** view.

Display → Views...

- i. Select **back** from the Views list.
 - ii. Click **Apply** and close the Views panel.
- (f) Click **Display** in the Display Grid panel (Figure 6.2).

In Figure 6.2, you can see that the hex cells are generated upto the extents of the domain defined in the Hexcore panel. For easy recognition, the newly created zones are named wall-x-max, wall-x-min, wall-y-max, etc.

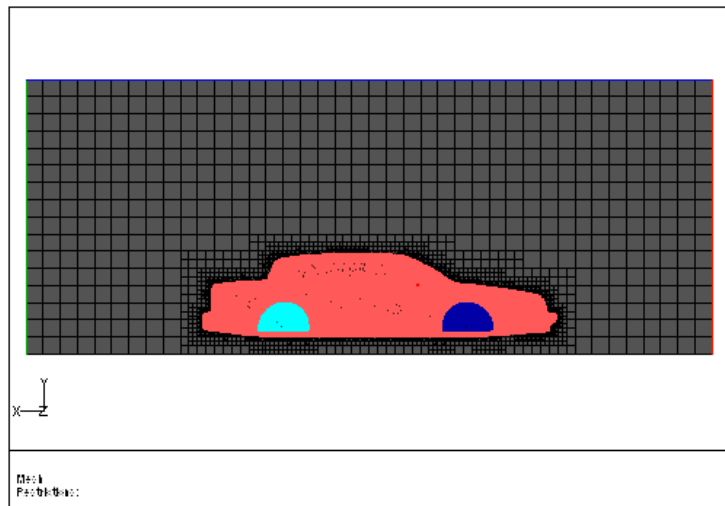


Figure 6.2: Hexcore Mesh Upto Domain Boundaries

- (g) Zoom in to the region shown in Figure 6.3.

In Figure 6.3, you can see that the mesh on the boundaries is made up of quad cells, except near the sedan.

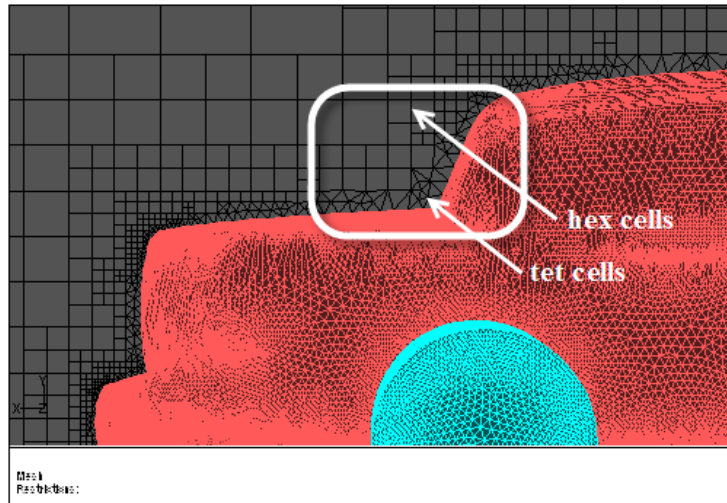


Figure 6.3: Hexcore Mesh Upto Domain Boundaries—Zoomed View

Step 4: Automatically Generate the Hexcore Mesh Upto the Boundaries with Prism Layers

In this step, you will set parameters for creating prism layers on the sedan body before generating the hexcore mesh. The outer boundaries must be retained for the prisms to attach onto them. You will use the automatic mesh generation procedure.

1. Read the mesh file (`sedan.msh`).

→ → Boundary Mesh...

The mesh file contains the boundary mesh of the sedan as well as the outer box.

2. Display the grid.

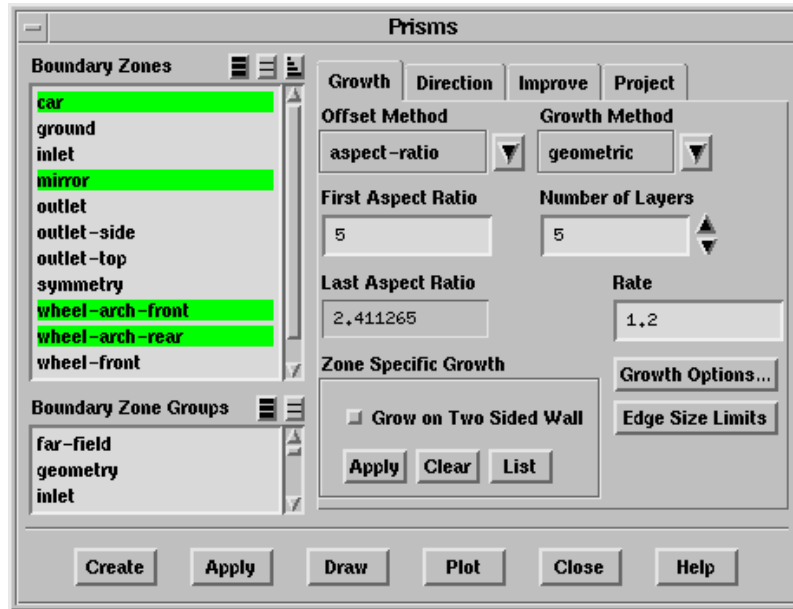
→ Grid...

3. Set the meshing parameters.

→ Auto Mesh...

The Prisms option is greyed out as no prism parameters have been set.

- (a) Set the prism meshing parameters.
 - i. Click the Set... button in the Boundary Layer Mesh group box to open the Prisms panel.

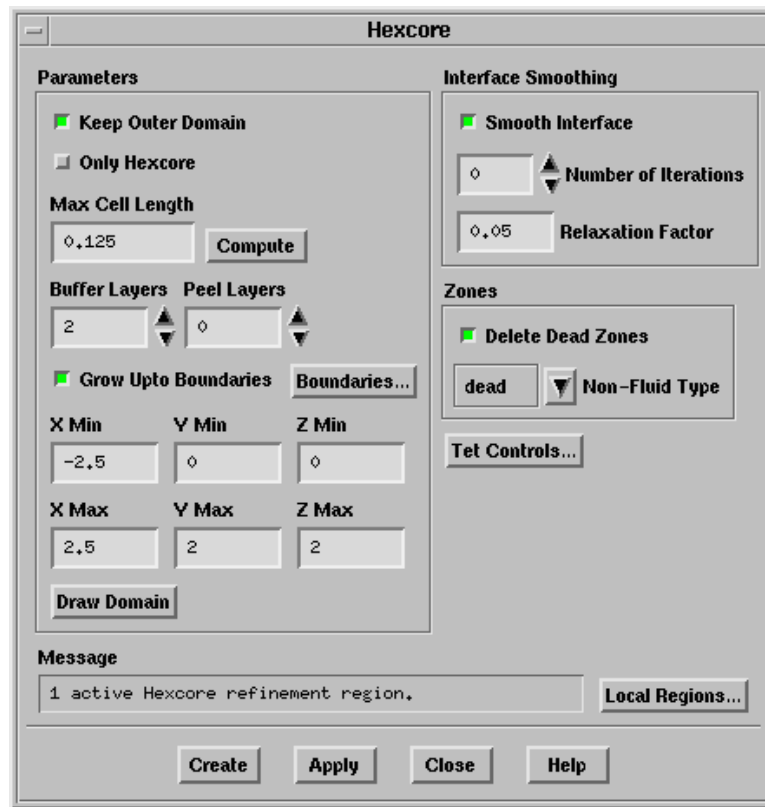


- ii. Select car, mirror, wheel-arch-front, and wheel-arch-rear in the Boundary Zones selection list.
- iii. Select aspect-ratio in the Offset Method drop-down list. and enter 5 for First Aspect Ratio.
- iv. Select geometric in the Growth Method drop-down list and enter 1.2 for Rate.
- v. Set Number of Layers to 5.
- vi. Click Apply in the Zone Specific Growth group box.



It is necessary to apply the prism growth parameters on specific zones for TGrid to retain the growth parameters in memory. The Prisms option in the Auto Mesh panel will be visible only after applying zone-specific growth.

- vii. Close the Prisms panel.
 - viii. Enable Prisms in the Boundary Layer Mesh group box in the Auto Mesh panel.
- (b) Set the hexcore meshing parameters.
- i. Select Hexcore in the Volume Fill list and click the Set... button to open the Hexcore panel.

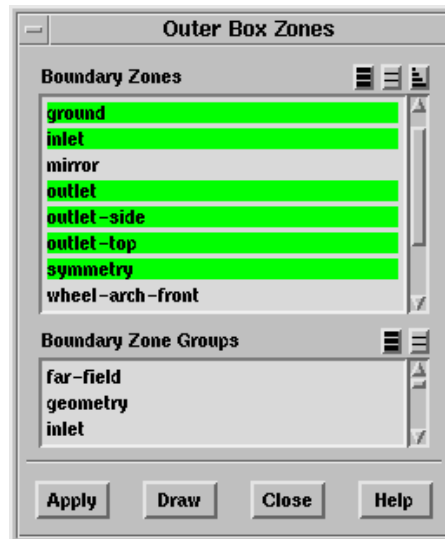


ii. Enable Keep Outer Domain in the Parameters group box.

iii. Enable Grow Upto Boundaries.

The outer box already exists, hence, you need to select the zones to be replaced.

iv. Click the Boundaries... button to open the Outer Box Zones panel.



- A. Select ground, inlet, outlet, outlet-side, outlet-top, and symmetry in the Boundary Zones selection list.
- B. Click Apply and close the Outer Box Zones panel.

The domain extents will automatically be set to the size of the bounding box. Make sure the domain extents are as follows:

X Min -2.5, Y Min 0, Z Min 0

X Max 2.5, Y Max 2, Z Max 2

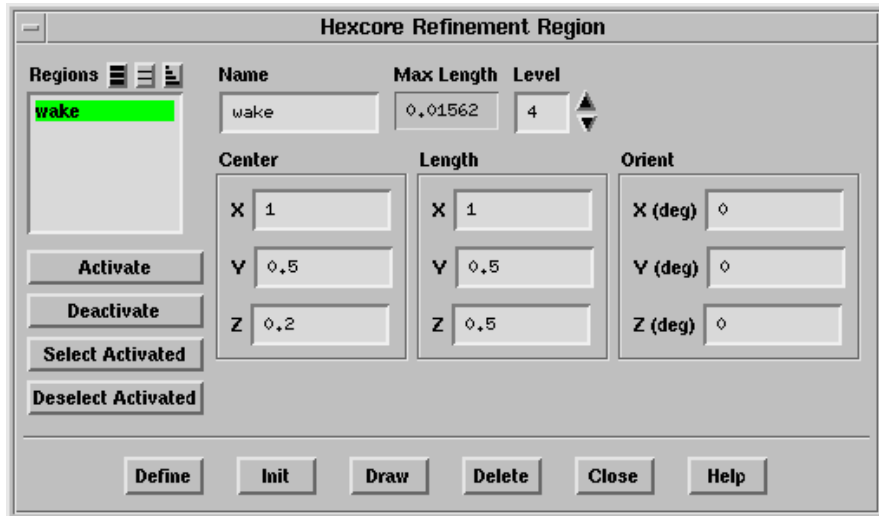
- v. Click Draw Domain to check the size of the domain to be meshed.
- vi. Enter 0.125 for Max Cell Length.
- vii. Set Buffer Layers to 2.

Setting the number of buffer layers to 2 ensures smoother size variation.

- viii. Set Peel Layers to 0.

The peel layer controls the gap between the hexahedra core and the geometry. The lower the peel layer specified, the fewer the tetrahedral cells generated.

- ix. Enable Delete Dead Zones in the Zones group box.
- x. Click the Tet Controls... button to open the Tri/Tet panel.
 - A. Retain the default settings in the Initialization tab.
 - B. Click the Refinement tab and retain the selection of geometric in the Cell Size Function drop-down list.
 - C. Enter 1.3 for Growth Rate and click Apply.
 - D. Close the Tri/Tet panel.
- xi. Define the local refinement region.
 - A. Click the Local Regions... button to open the Hexcore Refinement Region panel.



B. Enter wake for Name.

C. Set Level to 4.

The hexcore is based on a Cartesian grid, hence, the maximum length inside the local region is defined as a factor of the Max Cell Length defined. The maximum length in the region is equal to $\frac{MaxCellLength}{2^{(level-1)}}$.

In this case, the Max Length is equal to $\frac{0.125}{2^{(4-1)}} = 0.01562$.

D. Enter (1, 0.5, 0.2) for Center and (1, 0.5, 0.5) for Length, respectively.

E. Retain the default orientation.

F. Click Draw and check the region extents and maximum length within the region.

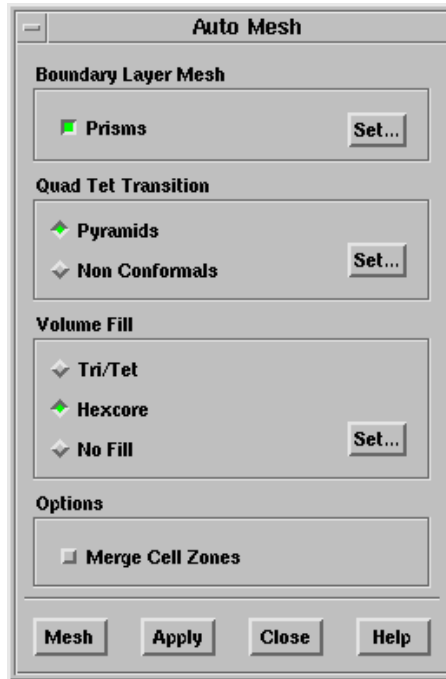
G. Click Define to create the region.

H. Retain the selection of wake in the Regions selection list and click Activate.

I. Close the Hexcore Refinement Region panel.

TGrid will report (in the Message field in the Hexcore panel) that there is one active hexcore refinement region.

xii. Click Apply and close the Hexcore panel.



- (c) Click Mesh.
 - (d) Close the Auto Mesh panel.
4. Examine the mesh.

Display → Grid...

You can see that there are two sets of the outer box zones—the original triangular mesh zone (e.g., ground:old) and the new zone created during hexcore meshing (e.g., ground).

- (a) Deselect the previous selections and select car, ground, inlet, mirror, outlet, outlet-side, outlet-top, symmetry, wheel-arch-front, wheel-arch-rear, wheel-front, and wheel-rear in the Face Zone Groups selection list.
- (b) Click the Attributes tab and enable Filled and Lights in the Options group box.
- (c) Click the Colors... button to open the Grid Colors panel.
- (d) Select Color by ID in the Options list and close the Grid Colors panel.
- (e) Display the back view.

Display → Views...

- (f) Click Display in the Display Grid panel.
- (g) Display the refinement region along with the mesh.

- i. Click the Local Regions... button in the Hexcore panel to open the Hexcore Refinement Region panel.

Mesh → Hexcore...

- ii. Make sure **wake** is selected in the Regions selection list and click **Draw**.
- iii. Close the Hexcore Refinement Region panel.

In Figure 6.4, you can see that the hex cells are generated upto the boundaries defining the outer box. You can also see the refinement region.

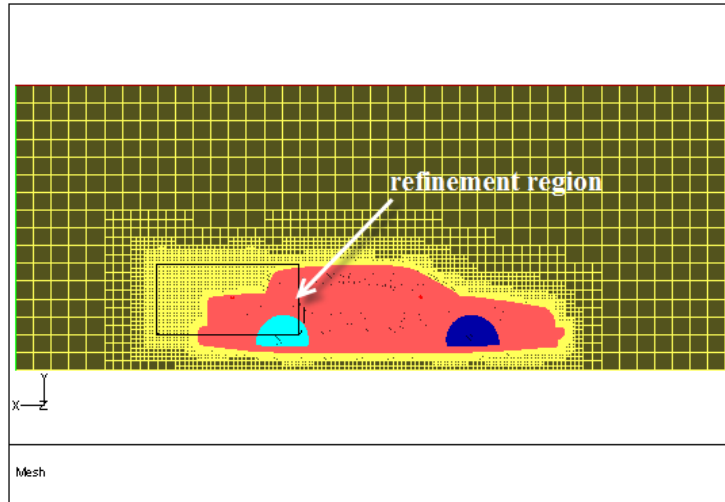


Figure 6.4: Hexcore Mesh Upto Outer Box Boundaries

- (h) Separate the hex cells from the tet cells for better visualization.

```

> /mesh/separate/separate-cell-by-shape
Cell Zone [ ] fluid*

Moved 595067 cells from fluid-# to fluid-#:#
Moved 1060007 triangular faces from interior-# to new zone interior-#:#.
Moved 134450 triangular faces from interior-# to new zone interior-#:#.
Moved 2559 mixed faces from ground to new zone ground:#.
Moved 1935 quadrilateral faces from symmetry to new zone symmetry:#.
Moved 1270 mixed faces from symmetry to new zone symmetry:#.

Interior face zone interior-#:# changed to boundary face zone.
  38 nodes moved to existing boundary node zone boundary-node-#
    
```

where, # denotes the respective zone IDs. The exact ID may vary on different platforms.

- (i) Click the **Bounds** tab in the **Display Grid** panel and enable **Limit by Z**.
- (j) Enter **0.37** for **Minimum** and **Maximum** in the **Z Range** group box.
- (k) Click the **Cells** tab in the **Display Grid** panel and select all the zones in the **Cell Zones** selection list.

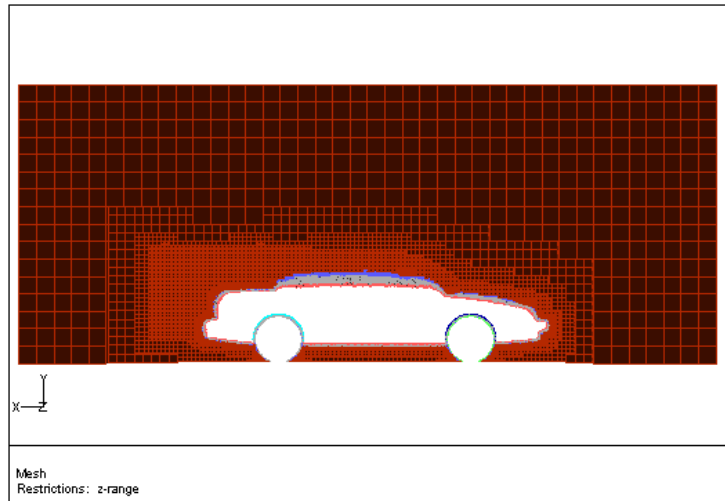


Figure 6.5: Slide of Cells at $z = 0.37$

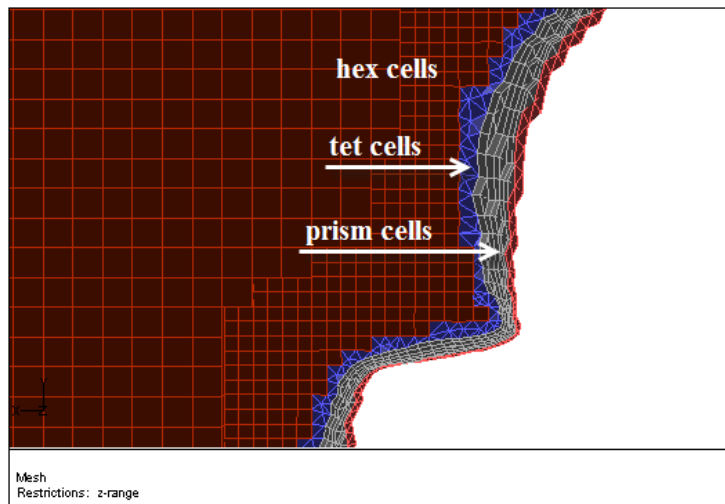


Figure 6.6: Hexcore Mesh Upto Domain Boundaries—Zoomed View

- (l) Enable All in the Options group box and click Display.
- (m) Zoom in to the region shown in Figure 6.6.

In Figure 6.6, you can see that the mesh on the boundaries is made up of quad cells, except near the sedan.

5. Delete the old outer box zones.

Boundary → Manage...

- (a) Select ground:old, inlet:old, outlet-side:old, outlet-top:old, outlet:old, and symmetry:old in the Face Zones selection list.
- (b) Select Delete in the Options list and retain the Delete Nodes option.

(c) Click **Apply**.

A Question dialog will appear, asking you to confirm if you want to delete the selected zones.

(d) Click **Yes** in the **Question** dialog box.

(e) Close the **Manage Face Zones** panel.

6. Check the mesh.

Mesh → **Check**

7. Save the mesh file.

File → **Write** → **Mesh...**

8. Exit TGrid.

File → **Exit**

Summary

This tutorial demonstrated the generation of a hexcore mesh upto the domain boundaries for a sedan car. It also demonstrated the creation of prism layers and the use of local refinement regions in conjunction with the hexcore mesh generation.

