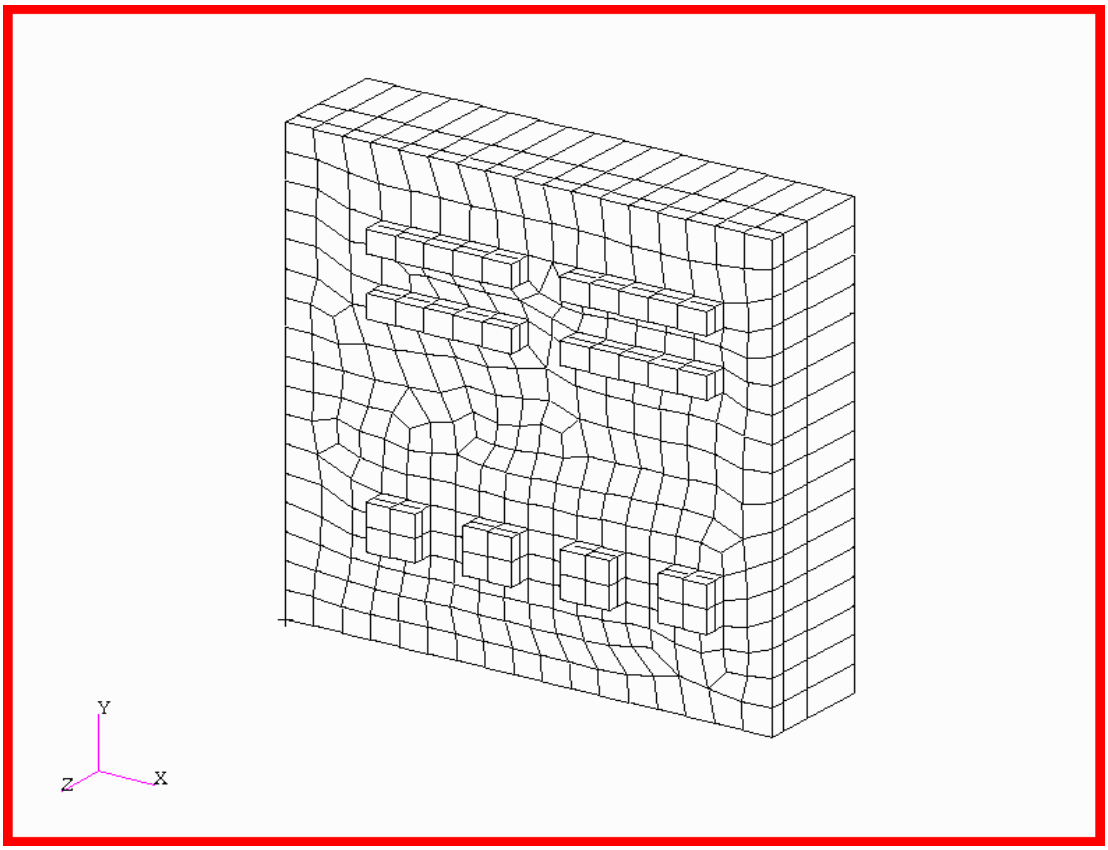
# Exercise 2

# *Hybrid Microcircuit Finite Elements*




## Objective:

- In this exercise you will mesh the 3D Hybrid Microcircuit model in two steps.
- You will use both the IsoMesh and Paver mesher options to create a surface mesh. These surface elements will then be swept into solid elements.

# Model Description:

In this exercise you will create a mesh for the 3D hybrid microcircuit model. You will use a finite element construction method called 2 1/2 D-meshing to create your 3D finite element model. This algorithm is an extension to the IsoMesh or Paver algorithms because it will create elements where no geometry exists.

The mesh will be created in a two step process. First the surface geometry will be meshed using both the IsoMesh and Paver options. The resulting surface elements will be used as a template to create a solid mesh of hexahedral elements. Finally the quadrilateral surface elements are deleted.

# Exercise Overview:

- Open the existing database named **microcircuit.db**.
- Using **Show**/**Surface/Normal** verify that all surface normals point in the +Z direction. If necessary, edit normals using **Edit/Surface/Reverse**.
- Delete Surface 1 by using **Delete/Any** and selecting Surface 1.
- Mesh the regions containing the devices using **Create**/**Mesh/Surface** and the **IsoMesh** *Mesher.*
- **Sweep/Element/Normal** to create device hex elements.
- Switch to the **Paver** *Mesher* and mesh the remaining trimmed surface geometry.
- **Sweep/Element/Normal** with **One Way Bias** in the - Z direction from all surface quads to create substrate hex elements.
- Use **Finite Elements/Delete/Any** and the *Select Menu* filter to delete all surface quad elements.
- Unclutter the display by hiding labels.
- **Quit** MSC/PATRAN.

# Exercise Procedure:

## Open an existing database

1. Open the existing database named **microcircuit.db**.

Within your window environment change directories to the microcircuit.db working directory. Run MSC/PATRAN by typing **p3** in your xterm window.

Next, select **File** from the *Menu Bar* and select **Open…** from the drop-down menu. Select the name **microcircuit.db** from the *Database List* box.Select **OK** to open the database.

MSC/PATRAN will open a Viewport and change various *Control Panel* selections from a ghosted appearance to a bold format.

From the *Menu Bar* select **Viewing/Named View Options...** Select **isometric_view** then **Close**. Select **Viewing/Fit View** to readjust the display, if necessary. This will provide a convenient view for verifying normal vectors.

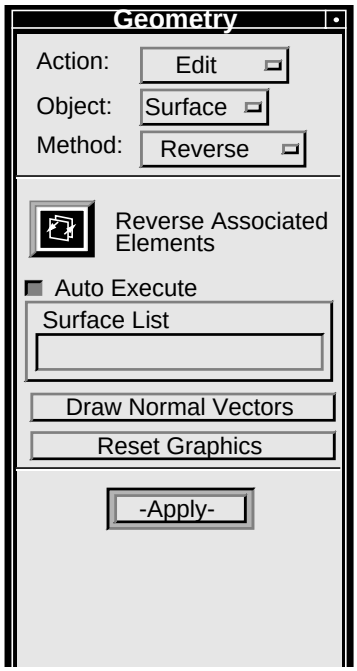
## Verify surface normals

2. Verify that surface normals point in the +Z direction.

Select the **Geometry** *Applications radio button*. Set the *Action*, *Object*, and *Method* to **Show/Surface/Normal**. Select **Set Normal Vector Length** and enter a *Normal Vector Length* of **0.01**. Click in the *Surface List* box and drag a rectangle around all the displayed geometry.

**All normal vectors should point in the global +Z direction.**

If some surfaces have incorrect normal vectors use **Edit/ Surface/Reverse** in the Geometry form, as shown below, to point the normals in the +Z direction.




**Delete Surface 1**

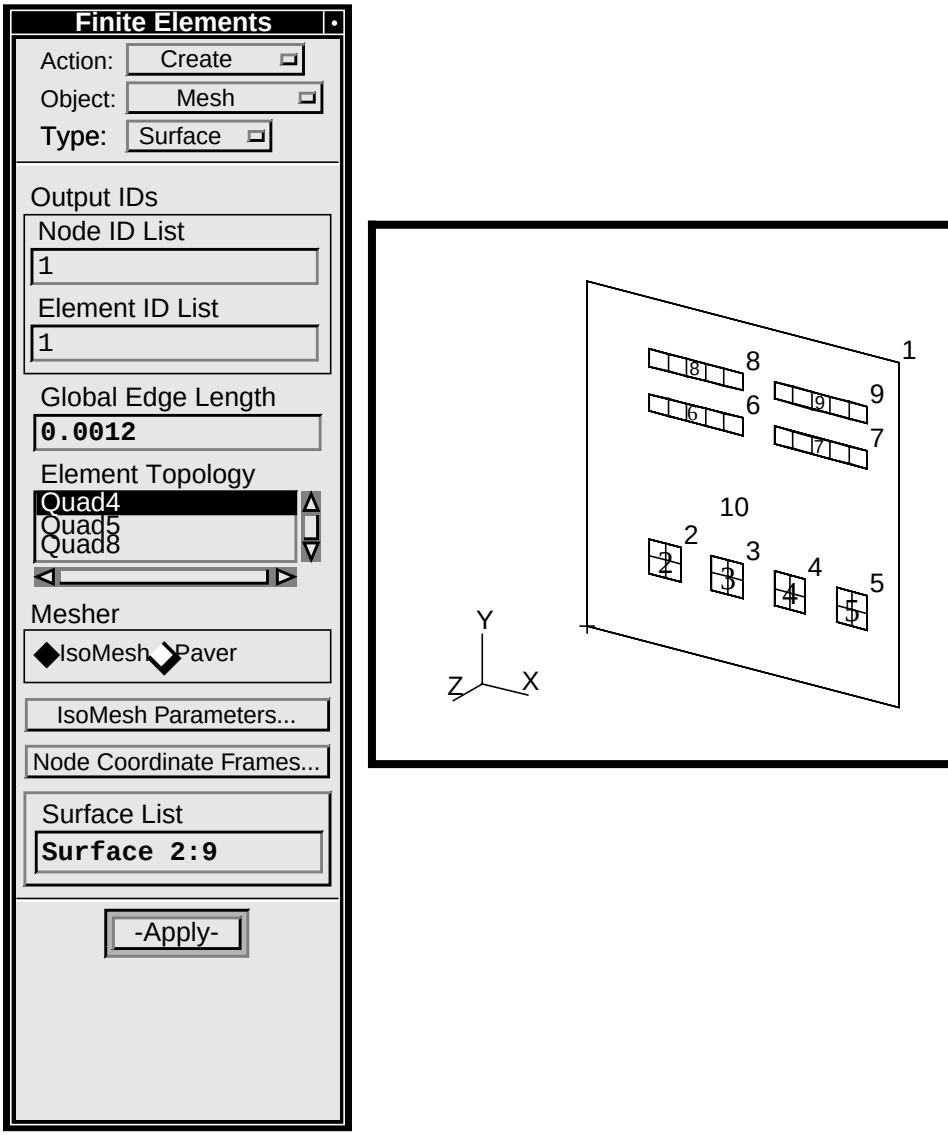
3. Delete Surface 1.

Set the *Action* and *Object* to **Delete/Any**. Click in the *Geometric Entity List* box and select Surface 1 from the viewport. Use the shift-right mouse button to cycle pick between Surface 10 and Surface 1 or select Surface 1 from the Selection list window, if necessary. Select **Apply** to delete Surface 1. Repaint the screen with the *Refresh Graphics* paint brush icon.

## IsoMesh device regions

4. Mesh the device regions with an IsoMesh.

Select the **Finite Elements** *Applications radio button*. Set the *Action*, *Object*, and *Type* to **Create**/**Mesh**/**Surface**. Set the *Global Edge Length* to **0.0012**. Click in the *Surface List* box and while holding down the <*shift*> key select the eight interior device surfaces with the left mouse button. The completed form is shown below.





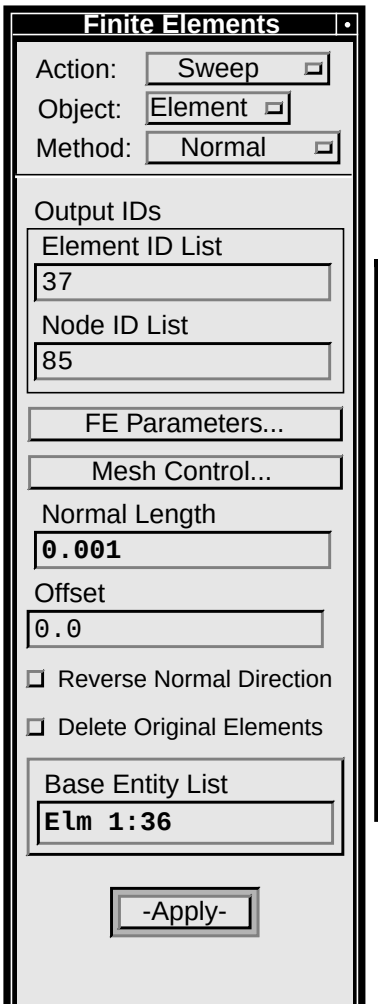


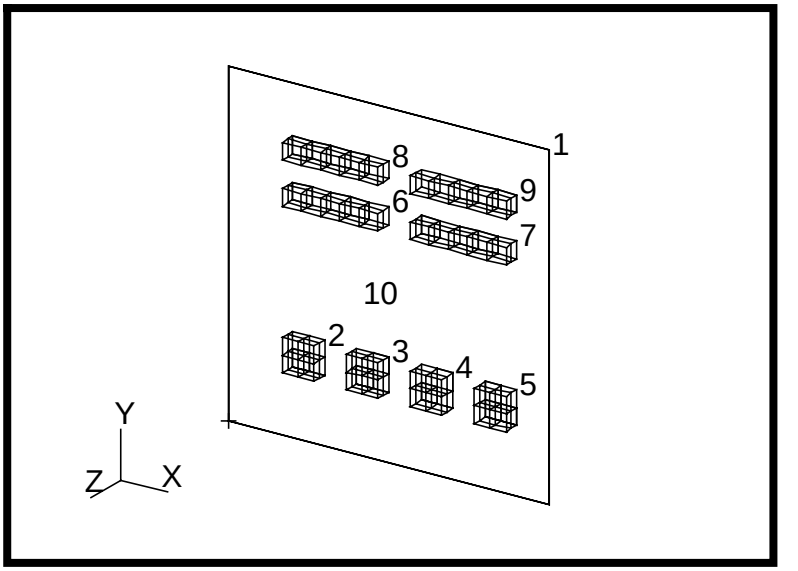
Select **Apply** to complete the meshing function. The display should appear as shown above. If it does not, select the *undo* icon and analyze the error to a resolution.

**Create device hex elements**

5. Create device hex elements.

Set the *Action*, *Object*, and *Method* to **Sweep/Element/ Normal**. (If the Mesh Control form appears click **OK** to accept the defaults.) Change the *Normal Length* to **0.001**. Click in the *Base Entity List* box and drag a rectangle around the eight sets of quad elements. Select **Apply** to complete the meshing function. The completed form and resultant display are shown below.




**Create the substrate Paver mesh**

6. Mesh the remaining trimmed surface with Paver.

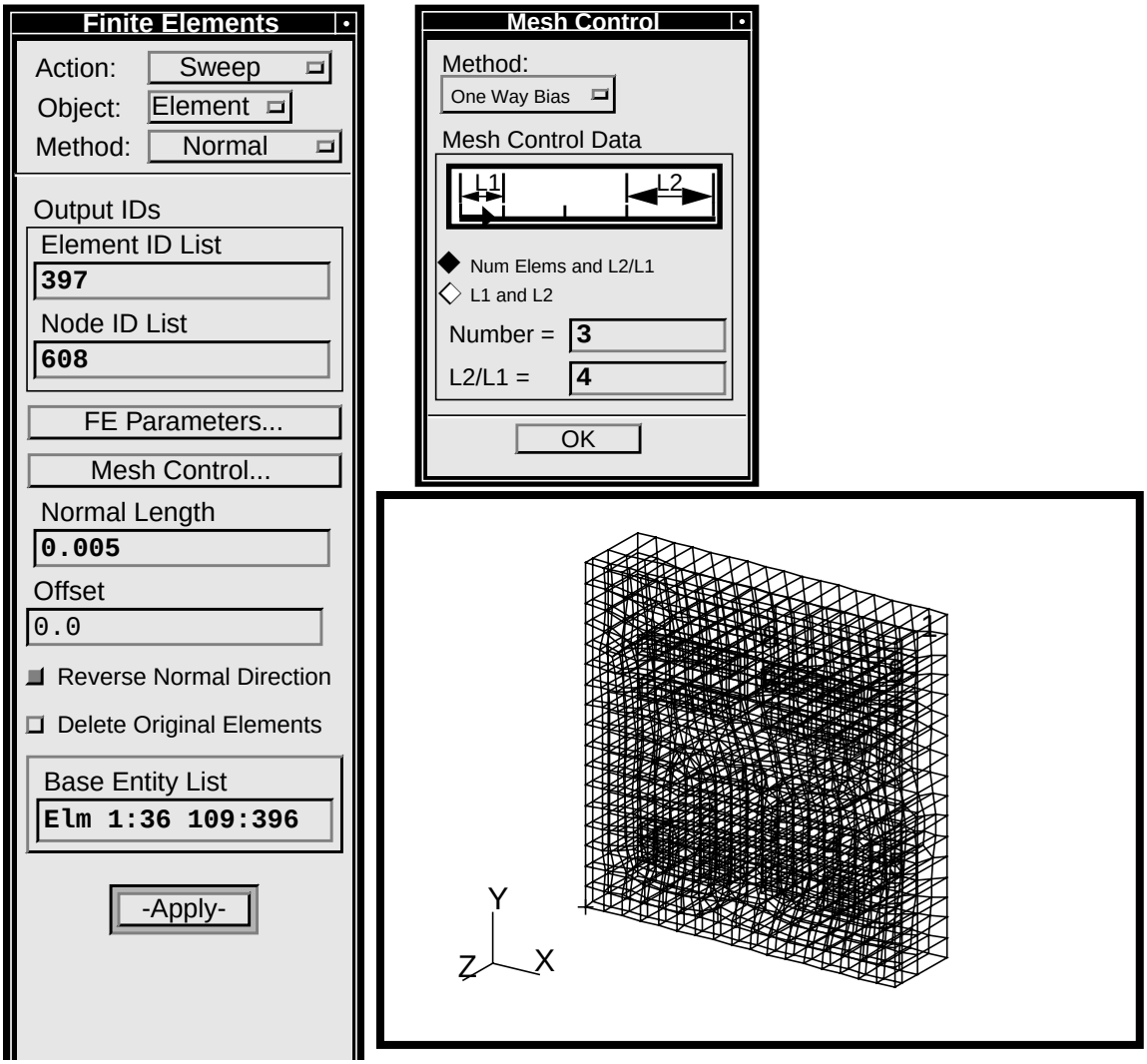
Set the *Action*, *Object*, and *Method* to **Create**/**Mesh**/ **Surface**. The *Global Edge Length* should be set to **0.0012**. Select **Paver** as the *Mesher* option. Click in the *Surface List* box and select the remaining unmeshed trimmed surface, Surface 10. Select **Apply** to complete the function. If you experience anyproblems selecting Surface 10, use *Preferences/Picking.../(Single Picking) Centroid*.

## Create the substrate hex mesh

7. Sweep a one-way-biased mesh of hex elements in the - Z direction from all surface quads.

Set the *Action*, *Object*, and *Method* to **Sweep/Element/ Normal**. (If the Mesh Control form does not appear click on **Mesh Control...**) In the Mesh Control form change the *Method* to **One Way Bias** set *Number* to **3** and *L2/L1* to **4**. Select **OK** to close the Mesh Control form.

In the Finite Elements form set *Normal Length* to **0.005** and **turn on *Reverse Normal Directions***. Click in the *Base Entity List* box and drag a rectangle around all of the elements in the viewport. (The default *Select Menu* filter will allow selection of only the quad/tri elements.) The form should appear as shown below.



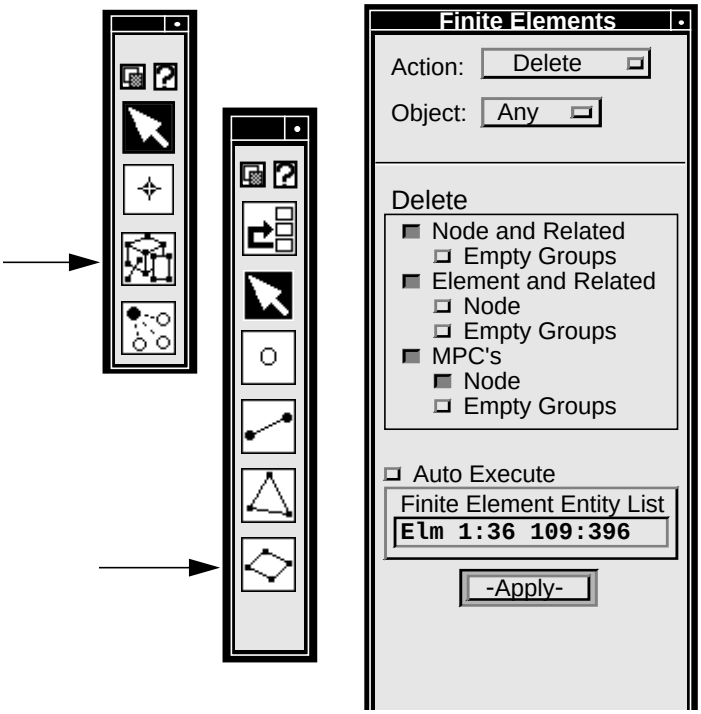

Select **Apply** to complete the meshing function. The resultant display is shown above.

**Delete all quad elements**

8. Delete all surface quad elements.

In the Finite Elements form set *Action and Object* to **Delete/Any**.

Click in the *Finite Element Entity List* box. In the *Select Menu* choose the quad element filter icon (third from the top), in the second level *Select Menu* choose the quad element filter (fifth from the top), and drag a rectangle around all entities displayed in the viewport. The form should now appear as shown below.




Select **Apply** to complete the function.

## Unclutter the display

9. Unclutter the display by hiding labels.

To simplify the display of your model select **Display** from the *Menu Bar* and select **Plot/Erase...** from the drop-down menu. When the Plot/Erase form appears select **Erase All Geometry**. Select **OK** to close the form.

Select **Display** from the *Menu Bar* and select **Entity Color/Label/Render…** from the drop-down menu. When the Entity Color/Label/Render form appears select **Hide All Entity Labels**. Click in the *Render Style:* box and select **Hidden Line** or use *Hide Labels* and *Hidden Line* icons shown to the right. Select **Apply** then **Cancel** to complete the function.


Your model should now appear as shown on the front panel of this exercise. Reset the *Render Style* to **Wireframe**.

## Quit MSC/ Patran

10. **Quit** MSC/PATRAN.

Select **File** on the *Menu Bar* and select **Quit** from the drop-down menu.