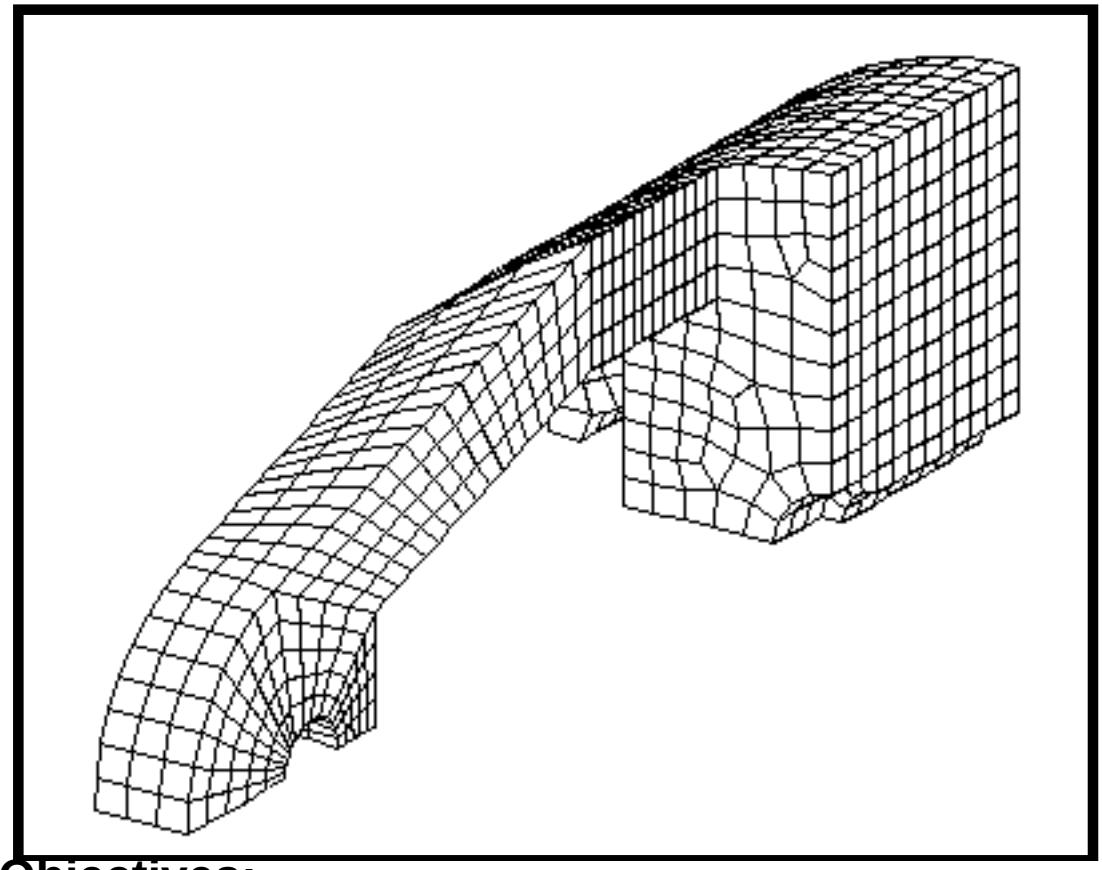
LESSON 8

Preparing Geometry for a Hex Mesh



Objectives:

- Create surfaces by Decomposing and Editing existing surfaces
- Create triparametric solids.
- Mesh triparametric solid with hex elements.

Model Description:

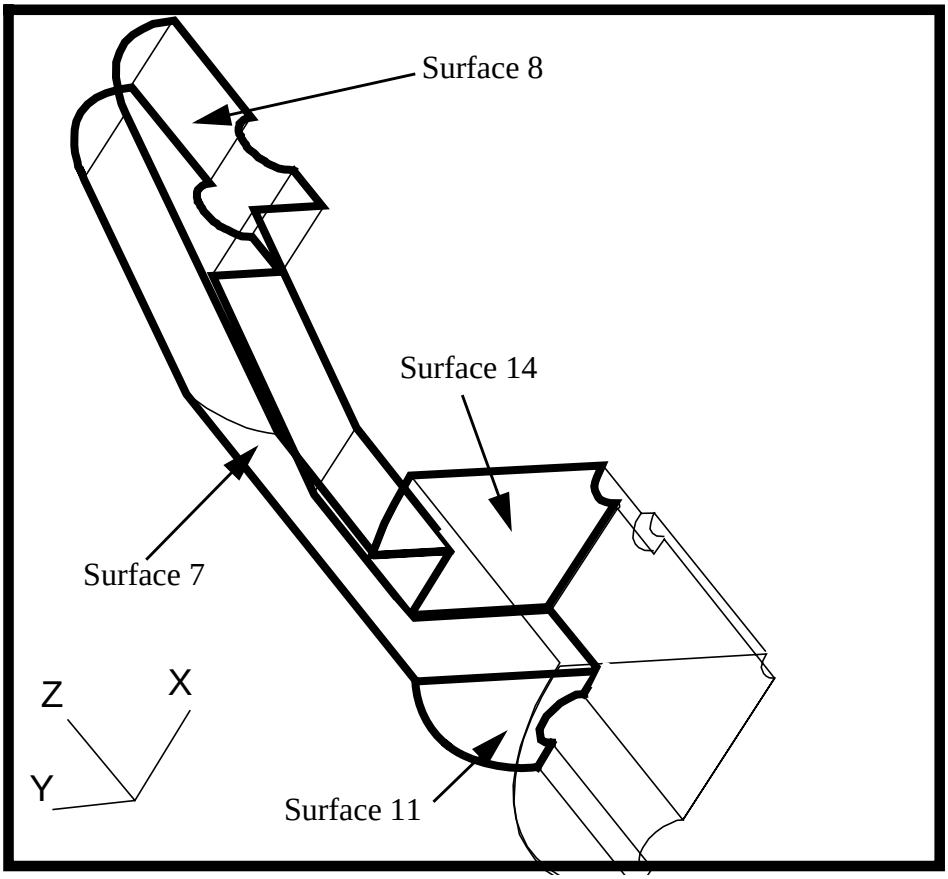
In this exercise, you will create a new database and then import CAD geometry. You will create several new surfaces by decomposing and editing some existing surfaces to complete the model.

Decomposition of the CAD geometry is required when IsoMeshing a solid. IsoMeshing requires that the solids must have 5 or 6 faces. Thus, one needs to decompose the n-edged surface into a number of 3- or 4-edged surfaces to create 5- or 6-faced solids.

Shown on next page is a drawing of the surfaces you will be decomposing and suggested steps for their constructions.

Session files will also be used to complete some of the geometry. You will also create curves using the Point method, edit surfaces using the Break and Edge Match option.

After the solid model is completely decomposed into triparametric solids, you will mesh the completed solid model with hex elements.



Suggested Exercise Steps:

- Open a new database called **Hex.db**.
- Import the IGES file **Gadget.igs** and run a session file.
- Create solids on model using surface method.
- Decomposing surfaces into smaller three- or four-sided surfaces.
- Create Surfaces by Editing existing surfaces using the Break option.
- Edge match some of the surface edges of the model.
- Create solid on the model using B-rep method.
- Mesh the base part of the model using extrude method.
- Associate the finite elements of the base part of model to the

geometric solid.

- Mesh the extension part of the model using solid method.
- Equivalence and verify the whole model.

Files:

All the files used in this exercise are listed below. Each listing includes the file, where it originated, its format (text/binary) and summary information as to how it relates to this exercise.

File	Supplied/Create	Description
Hex.db	Created	This is a P3/PATRAN database (binary) that is created in this exercise.The geometry of the model is imported from an IGES file.
Gadget.igs	Supplied	This is an IGES file which contains the geometry of the model for this exercise.
Ex_5_setup.ses	Supplied	This is a session file which perform bounding of some surfaces of the model.

Exercise Procedure:

Open a New Database

1. Create a new database called **Hex.db**.

File/New ...

New Database Name: **Hex.db**

OK

In the *New Model Preference* form set the following:

Tolerance: ◆ **Default**

Analysis Code: **MSC/NASTRAN**

Analysis Type: **Structural**

OK

Import an IGES file

2. Import the IGES file **Gadget.igs**.

File/Import...

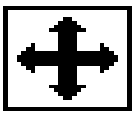
Object: **Model**

Source: **IGES**

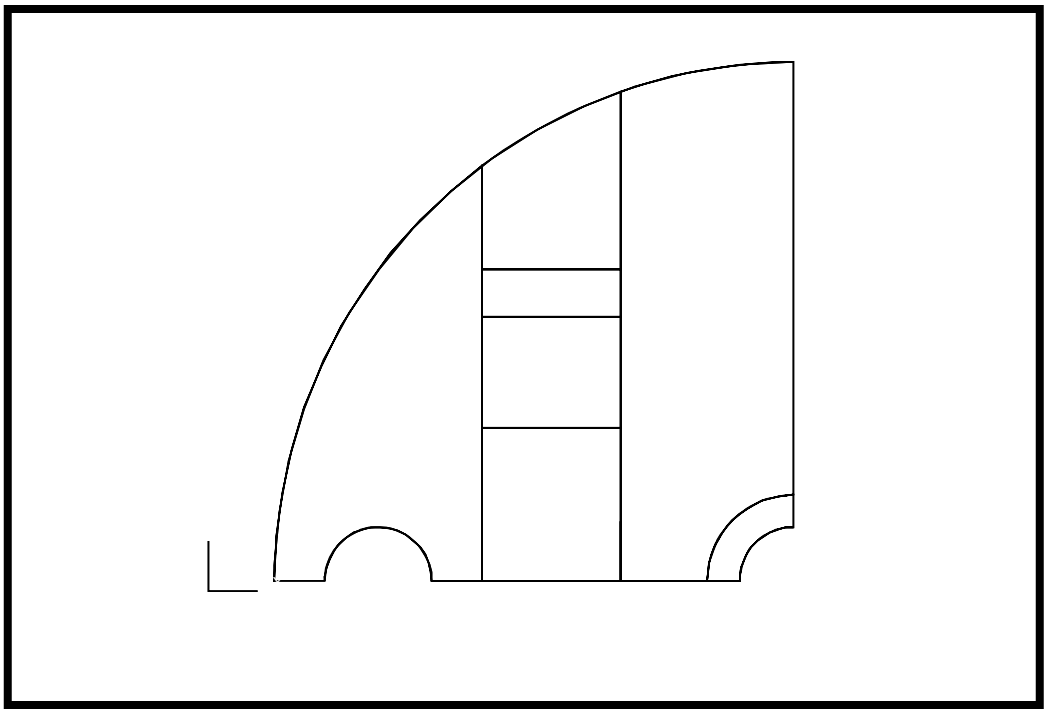
Import File: **Gadget.igs**

Apply

3. If the model is not visible, change the view by selecting the **fit view icon** in the toolbar:



Your viewport should appear as shown below.



4. Run the session file **ex_5_setup.ses** to complete the model with bounded surfaces.

Running a *.ses Session File

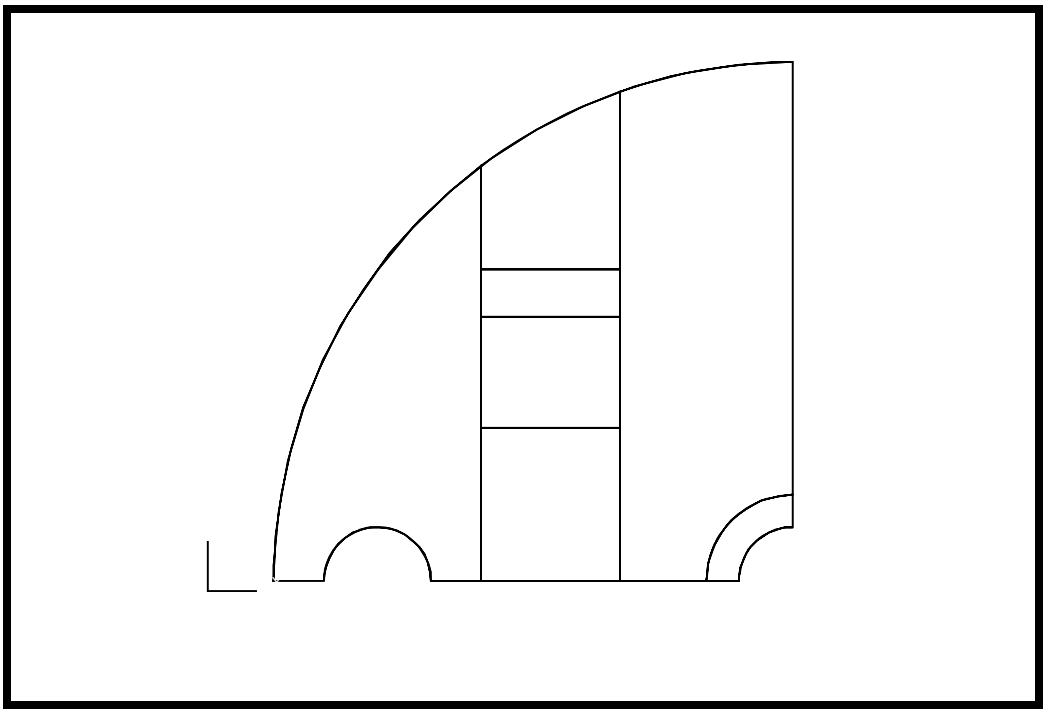
File/Session/Play ...

Play from file: `Ex_8_setup.ses`

Apply

The function of this session file is to use the curve method to create surfaces to bound the whole model.

After you run the file, the following should appear in your viewport.



5. Now post only the base part of the model.

Post Base Part of Model

Group/Post

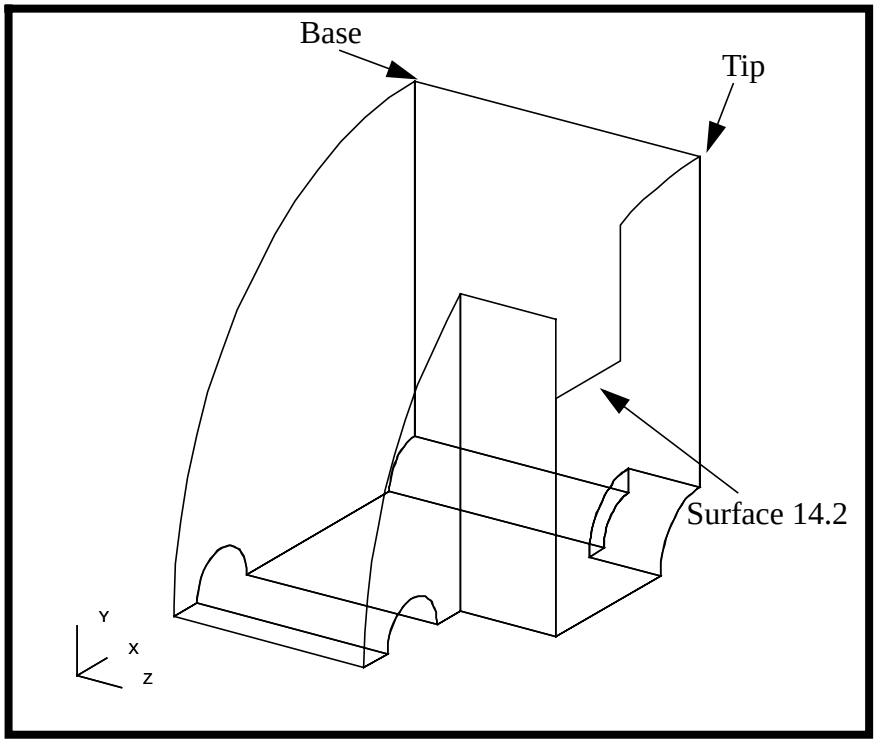
Select Groups to Post **geo_base**

Apply

Cancel

Change the view to **isometric 2**.

Base part of the model:



6. Create surface using curve method

First you must create another curve to enclose the surface by translating an existing curve

◆ **Geometry**

Action: **Transform**

Object: **Curve**

Method: **Translate**

Translation Vector

Click in the *Traslation Vector* databox and then select the tip and base icon

Then click on the Point icon

Now screen select point 6 and 7.

Curve List **Surface 16.3**

Apply

You need to trim the curve to fit the gap

Action: **Edit**

Object: **Curve**

Method: **Trim**

Trim Point List **Point 42**

Curve/Point List **Curve 1 (and the end point on the side of the curve that you want to trim**

Apply

Repeat this procedure for the top half of the curve

Action: **Edit**

Object: **Curve**

Method: **Trim**

Trim Point List **Point 5**

Curve/Point List **Curve 1 (and the end point on the side of the curve that you want to trim**

Apply

Create Surface Using Curve Method

Now you can create the surface

◆ **Geometry**

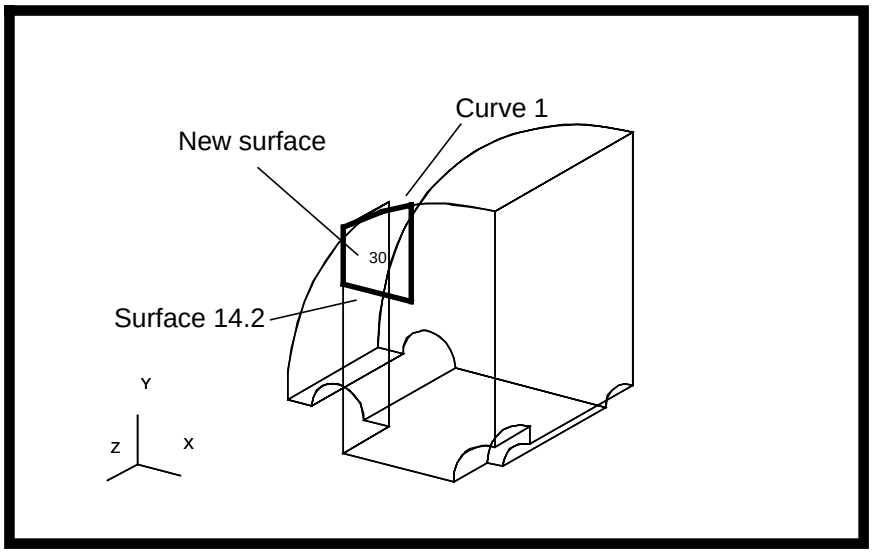
Action: **Create**

Object: **Surface**

Method: **Curve**

Option:	**2 Curve**
Starting Curve List	**Curve 1**
Ending Curve List	**Surface 14.2**

Note: Geometric ID numbers may not match exactly in this exercise. Refer to a figure whenever possible



7. Change the view of the viewport as follows:

Viewing/Angles...

Angles	**15 50 0**

Apply

Cancel

8. Create curve using point method.

Create Curve Using Point Method

◆ **Geometry**

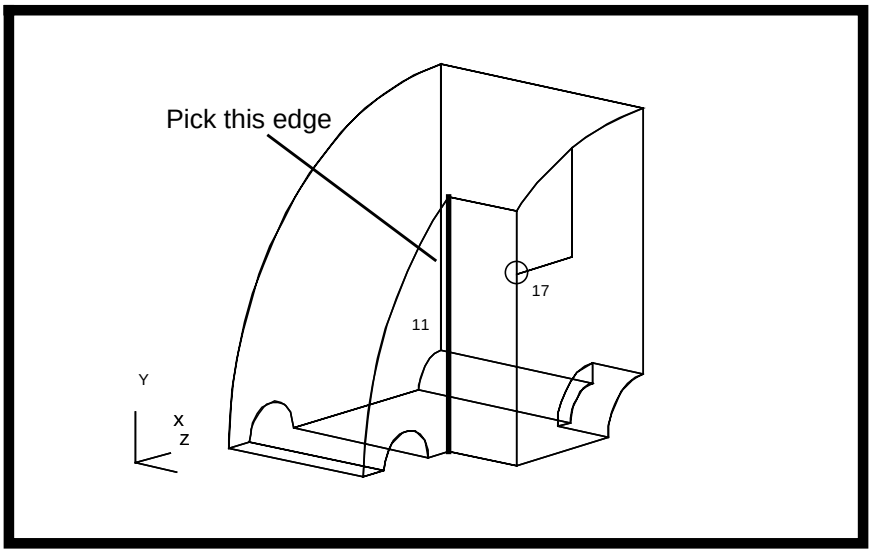
Action:	**Create**
Object:	**Curve**
Method:	**Point**

Option: **2 Point**

Starting Point List **Point 17**

For the end point, first select the following icon in the select menu:

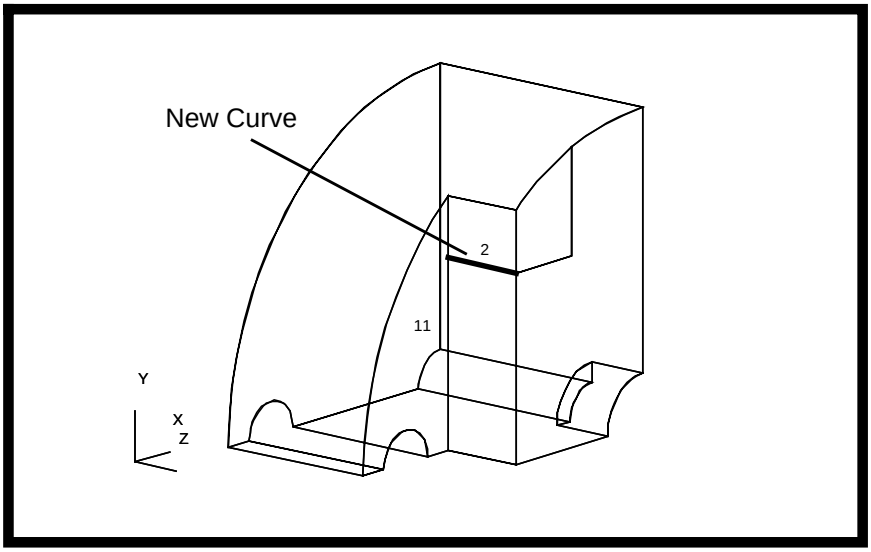
After that, click the following icon and then select the edge of surface 11 as follows:



Lastly, click the following icon and screen pick *point 17* again.

Ending Point List **Con..(Point 17)..(Surface 11.2)**

Your model should appear as follows:



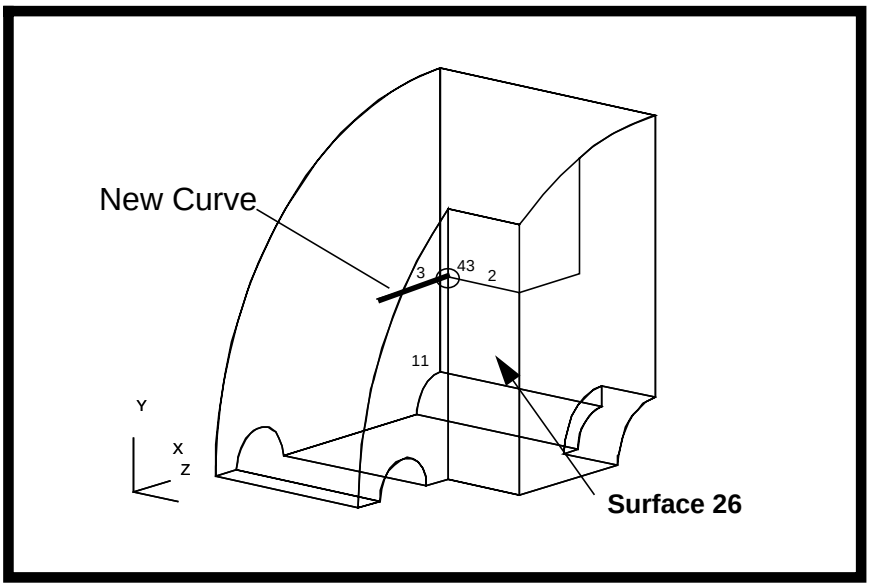
9. Create a curve on surface 11 as follows:

Create Curve using XYZ Method

◆ **Geometry**

Action:	**Create**
Object:	**Curve**
Method:	**XYZ**
Vector Coordinates List	**<-15 0 0>**
Origin Coordinates List	**point 43**

Apply



Edit Surface Using Break Method

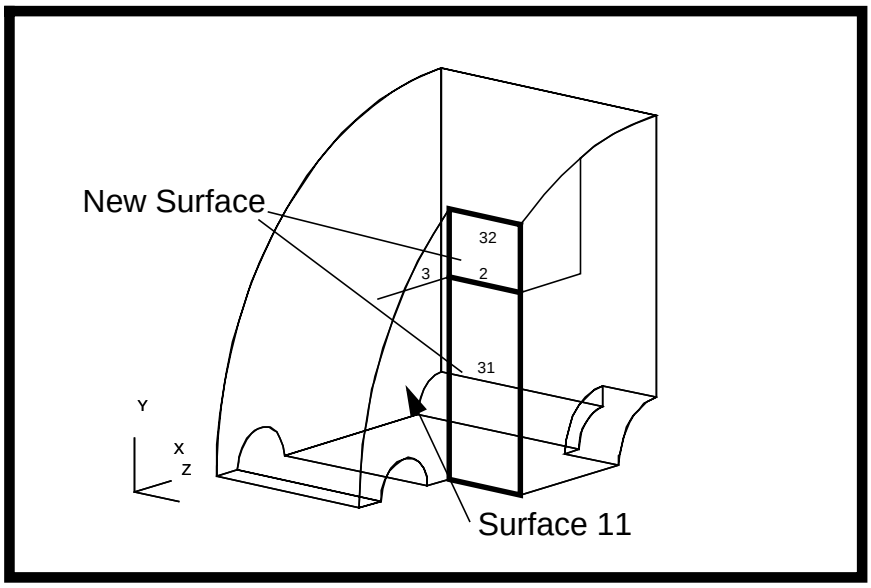
10. Edit *surface 26* using break method.

◆ **Geometry**

Action:	**Edit**
Object:	**Surface**
Method:	**Break**
Option:	**Curve**
Surface List	**Surface 26**
Break Curve List	**Curve 2**

Answer **Yes** to delete the original surfaces.

Surface 31 and *32* should be created as shown below.



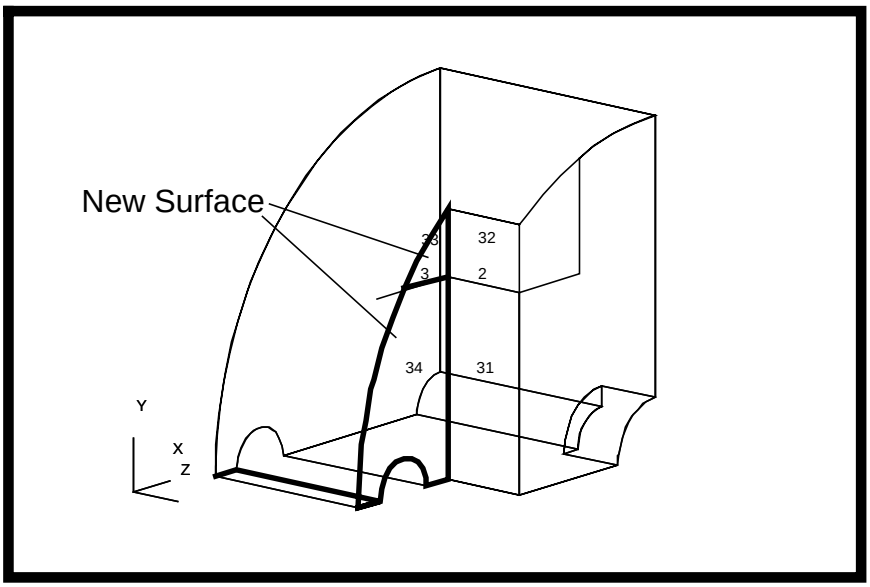
Again, apply the same method to surface 11 as follows:

◆ **Geometry**

Action:	**Edit**
Object:	**Surface**
Method:	**Break**
Option:	**Curve**
Surface List	**Surface 11**
Break Curve List	**Curve 3**

Answer **Yes** to delete the original surfaces.

Surface 33 and 34 should appear as shown below.



11. Delete curve 2 and 3 as follows:

◆ **Geometry**

Action: **Delete**

Object: **Any**

Geometric Entity List **Curve 2 3**

Apply

12. Now, try to change the geometry into a solid.

Create Solid Using B-rep Method

◆ **Geometry**

Action: **Create**

Object: **Solid**

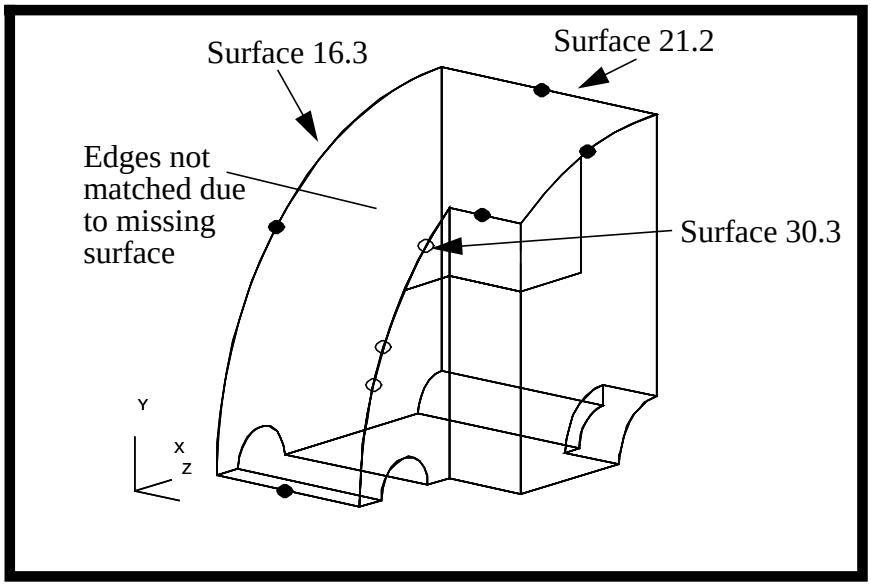
Method: **B-rep**

❒ **Delete Original Surfaces**

■ **Auto Execute**

Surface List **(Select all the surfaces on screen)**

Notice that an error message will come up since some of the edges are not matched (see figure below). Hence, we need to edge match the model before changing it into solid.



13. We must create a Trimmed Surface so the edges will match up

◆ **Geometry**

Action:	**Create**
Object:	**Surface**
Method:	**Glide**
Director Curve List	**Surface 21.2**
Base Curve List	**Surface 16.3**

Apply

Now you will trim the surface you just created

Action:	**Create**
Object:	**Surface**
Method:	**Trimmed**

Auto Chain...

Select a Start Curve	**Surface 30.3**

Choose a Curve to Continue **Surface 29.2**

OK

Click on next if the curve in the box is not the curve you want to select. If it is press OK. Continue around the edge of the surface clockwise until it is completely enclosed.

Cancel

Outer Loop List **Curve 2**

Surface List **Surface 32**

Apply

Respond **Yes** to both when promted to delete the original surface and curves

14. Edit surface using edge match method:

Edge Match the Model

◆ **Geometry**

Action: **Edit**

Object: **Surface**

Method: **Edge Match**

Option: **2 Surface**

Surface 1 List **Surface 30**

Surface 2 List **Surface 33**

Apply

15. Now try to create solid using B-rep method again.

Create Solid by B-rep Method

◆ **Geometry**

Action: **Create**

Object: **Solid**

Method: **B-rep**

❒ **Delete Original Surfaces**

Surface List **(Select all the surfaces on screen)**

Apply

A message should come up in the command window to state that solid 6 is created.

16. Create mesh seeds on the model.

Create Mesh Seeds on Model

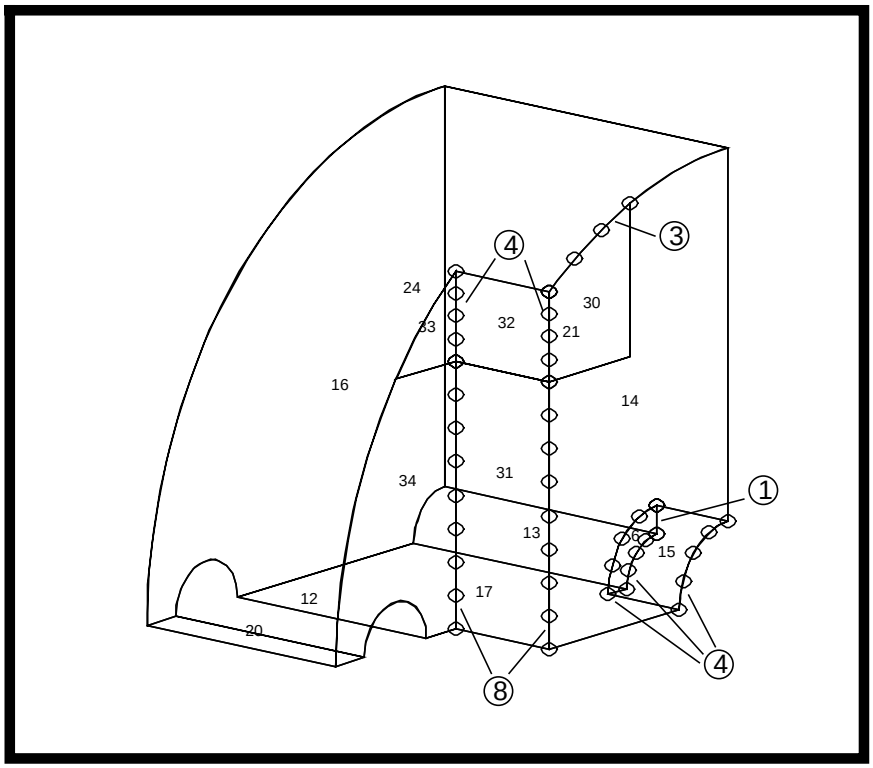
◆ **Finite Elements**

Action: **Create**

Object: **Mesh Seed**

Method: **Uniform**

Put the mesh seeds on the model by following the illustration shown below.



Create Group

17. Create a group for the finite elements of the base part of model.

Group/Create...

New Group Name **fem_base**

■ **Make Current**

Apply

Cancel

Create Mesh

18. Create mesh on model.

◆ **Finite Elements**

Action: **Create**

Object: **Mesh**

Method: **Surface**

Global Edge Length **4**

Element Topology **Quad4**

Mesher ◆ **Paver**

Surface List **Surface 14**

Apply

and

Global Edge Length **4**

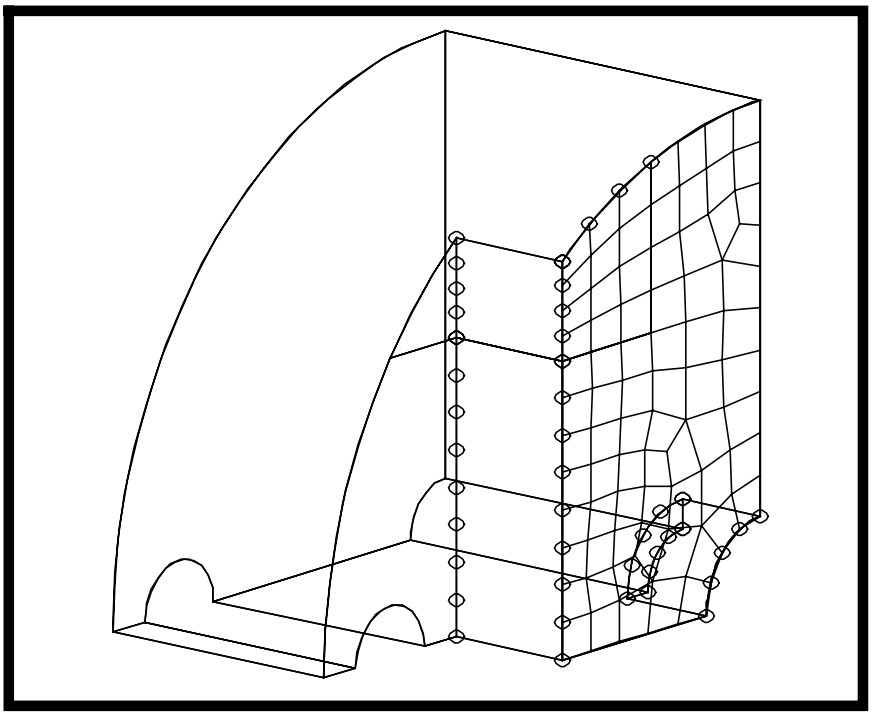
Element Topology **Quad4**

Mesher ◆ **Isomesh**

Surface List **Surface 30**

Apply

Turn off all the entity labels and your model should appear as shown below.



19. Sweep the elements using extrude method.

Sweep Elements

◆ **Finite Elements**

Action: **Sweep**

Object: **Element**

Method: **Extrude**

Mesh Control

◆ **Number of Elements**

Number **3**

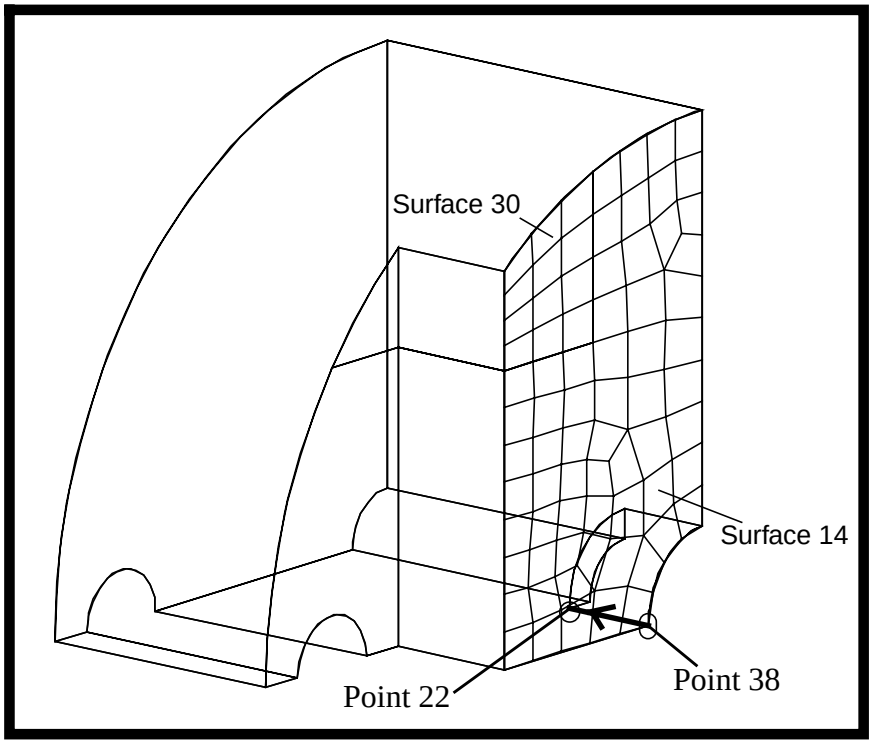
OK

Now click the Direction Vector databox and then select the following icons in the select menu:

First select this icon: 

Then select this:

Select point 38 to point 22 as the Direction Vector as follows:



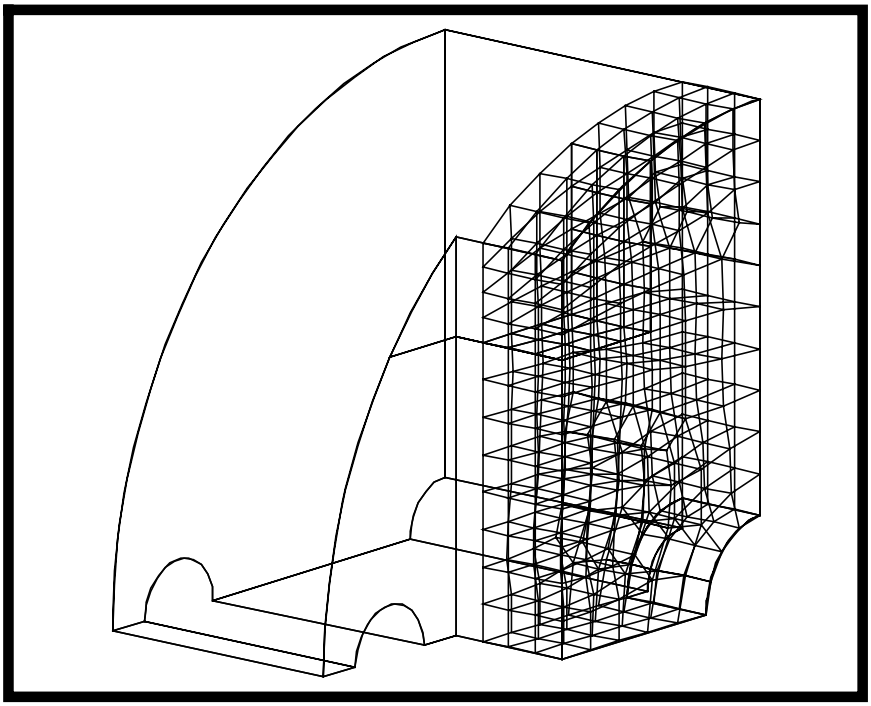
Direction Vector **Con..(Point 38)..(Point 22)..**

■ **Delete Original Elements**

Base Entity List **Elm 1:74**
(Select all the elements on surface 14 and 30)

Apply

The mesh should appear as follows:



20. Perform the above procedure again for the following entities:

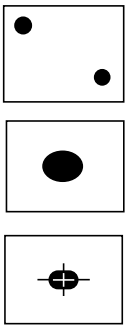
Mesh Control

◆ **Number of Elements**

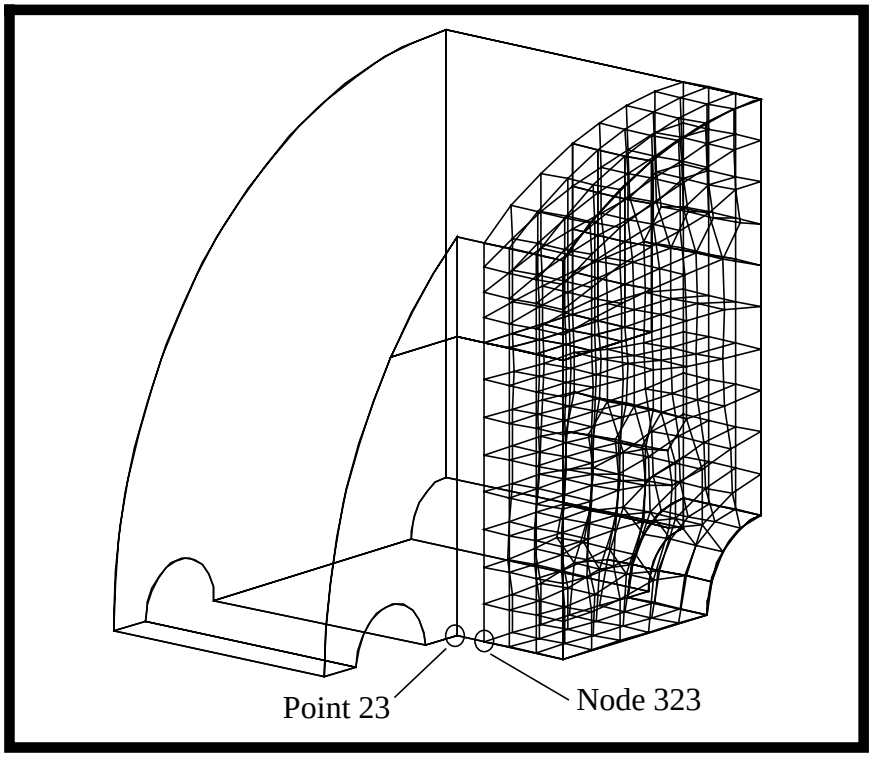
Number **1**

OK

Use the **beam**, **point**, and **node** icons to select the *Direction Vector.*



Select node 323 to point 23 as the Direction Vector.

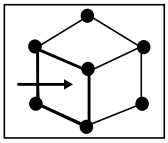


(Note: value of node may vary, due to meshing by paver.)

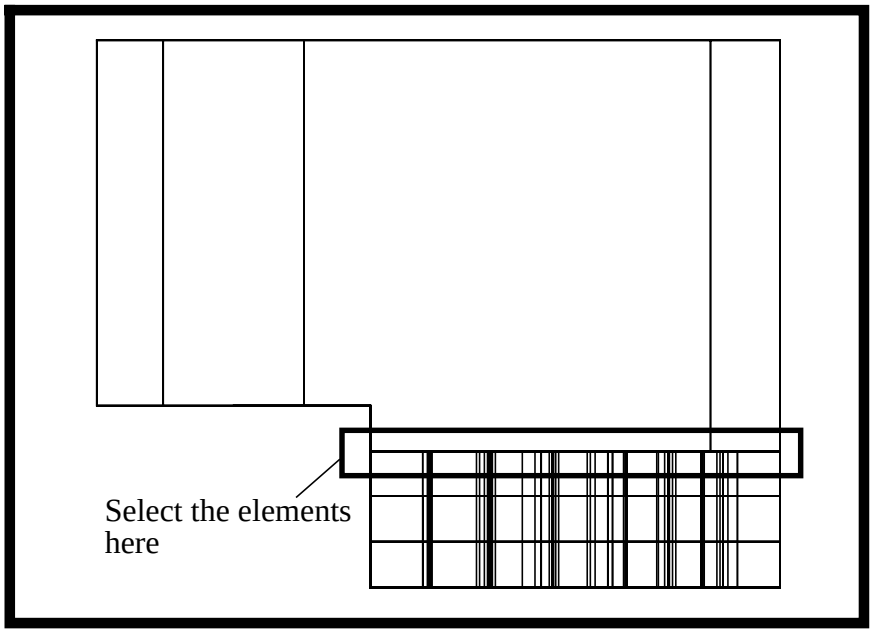
Now change the view to **Top view** by select the following icon in the toolbar:

Top view icon .

Click in the Base Entity List databox and then select the **element face** icon:



Select the sweep elements as follows:



Direction Vector **Con..(Node323)..(Point 23)..**

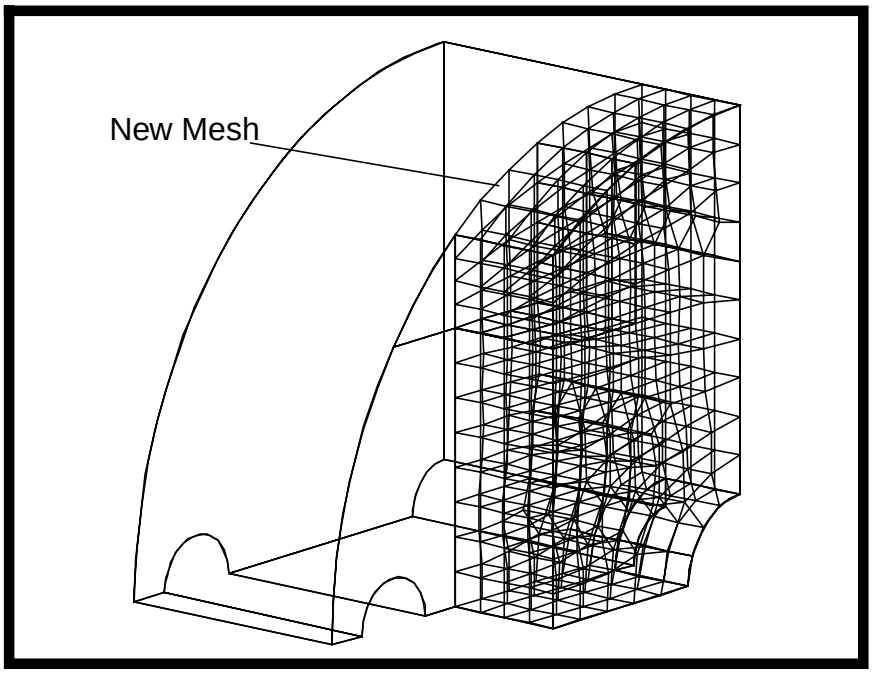
❒ **Delete Original Elements**

Base Entity List **Elm 223.5 ....296.5**

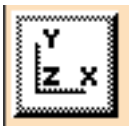
Apply

Now change the view angle back to **15 50 0** and the following should appear in your viewport.

.



21. Change the view to **default view** by select the following icon in the toolbar.



22. Now create some mesh on the model as follows:

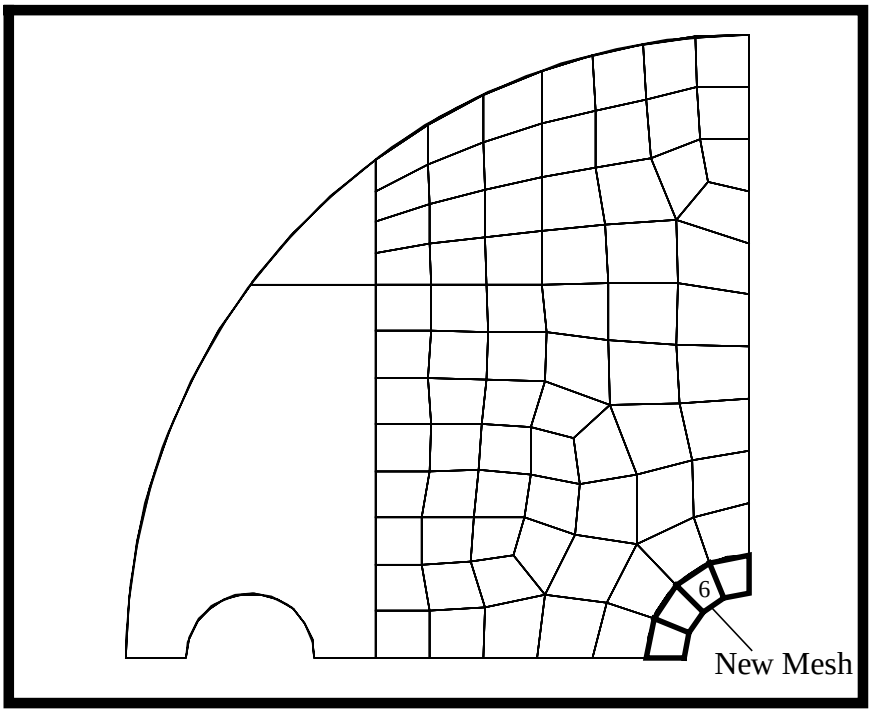
Create Mesh

◆ **Finite Elements**

Action:	**Create**
Object:	**Mesh**
Method:	**Surface**
Global Edge Length	**4**
Element Topology	**Quad4**
Mesher	◆ **Paver**
Surface List	**Surface 6**

Apply

The new mesh is shown below.



23. Again, sweep elements using the extrude method.

Sweep Elements

◆ **Finite Elements**

Action:	**Sweep**
Object:	**Element**
Method:	**Extrude**

Mesh Control...

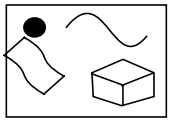
◆ **Number of Elements**

Number	**1**

OK

Use the same direction vector as last time (node 323 to point 23) and use the following select menu icons to select all the new created elements on surface 6 as the base entities.

First select this icon:



Then select this

Direction Vector **Con..(Node 312)..(Point 23).**

■ **Delete Original Elements**

Base Entity List **Surface 6**

Apply

A message should show up in the command window to state that 4 elements have been created.

24. Change the view to **Top view** and then perform the sweep element procedure again for the following entities:

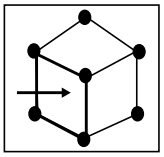
Mesh Control...

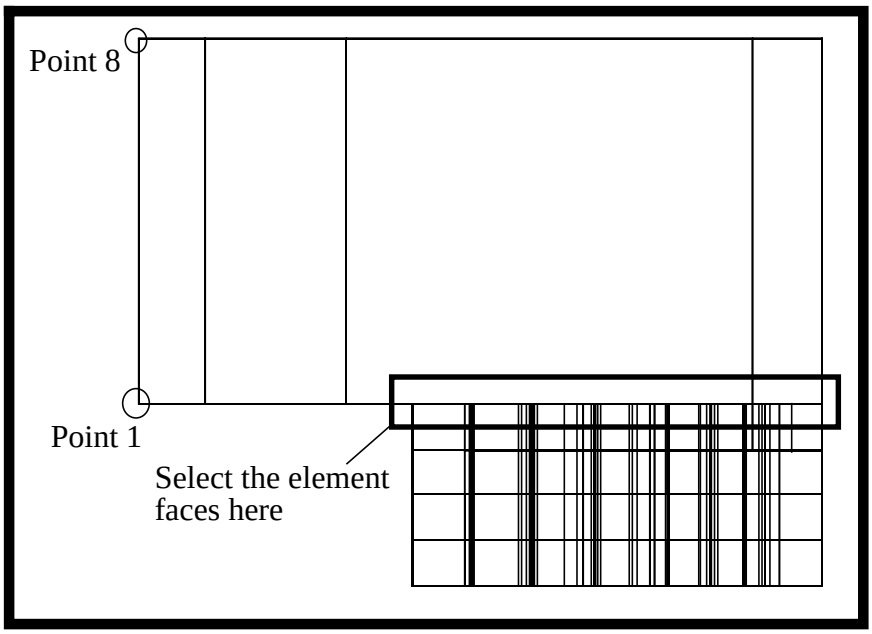
◆ **Number of Elements**

Number **8**

OK

Use point 1 to point 8 as the Direction Vector and use the following select menu icon to select the element faces shown below as the sweep elements.





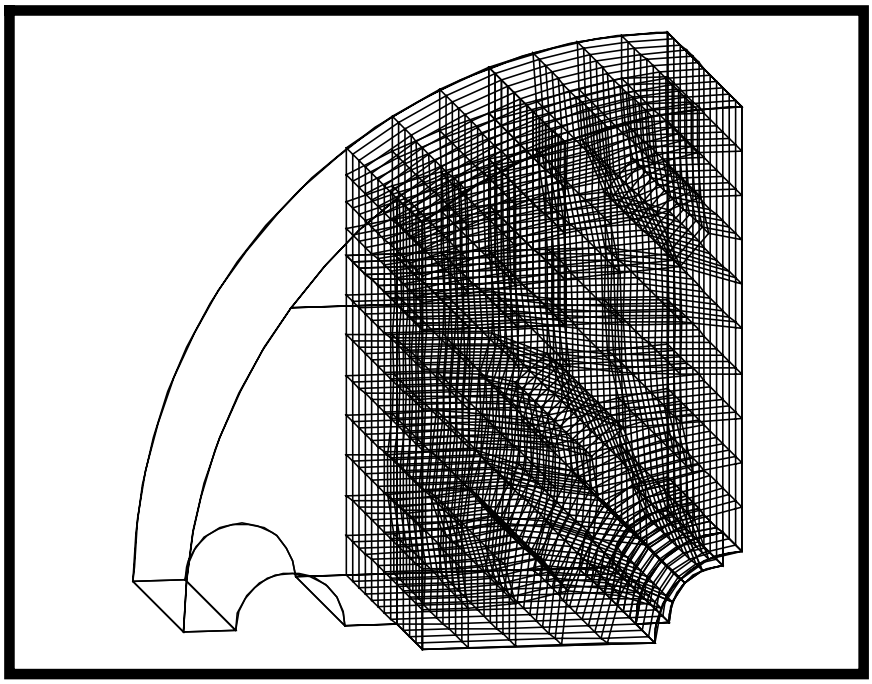
Direction Vector **Con..(Point 1)..(Point 8)..**

❒ **Delete Original Elements**

Base Entity List **Elm 297.5..370.5 375.5..378.5**

Apply

Change the view angle to **10 10 0** and your model should appear as follows:



Next, create mesh on the final surface of the model.

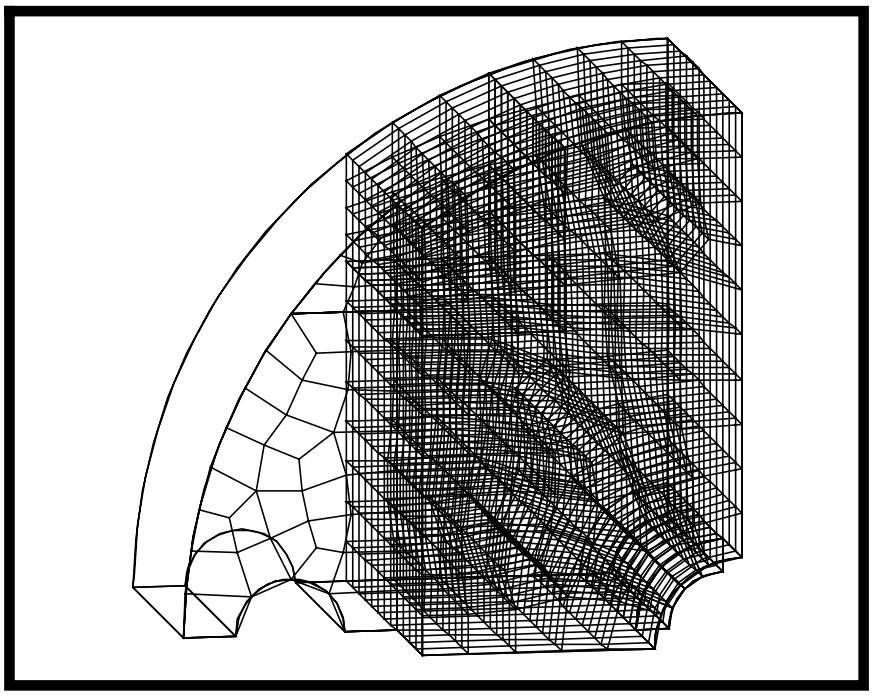
Create Mesh

◆ **Finite Elements**

Action:	**Create**
Object:	**Mesh**
Method:	**Surface**
Global Edge Length	**4**
Element Topology	**Quad4**
Mesher	◆ **Paver**
Surface List	**Surface 33 34** (The two unmeshed surfaces at the left of the model)

Apply

Mesh on surfaces 33 and 34 is shown below.



25. Sweep elements on surface 33 and 34 using extrude method.

Sweep Elements

◆ **Finite Elements**

Action: **Sweep**

Object: **Element**

Method: **Extrude**

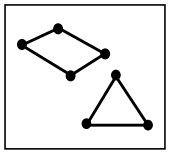
Mesh Control...

◆ **Number of Elements**

Number **8**

OK

Again, use point 1 to point 8 as the Direction Vector and click on the following select menu icon to select the elements on the surface 33 and 34 as base entities.



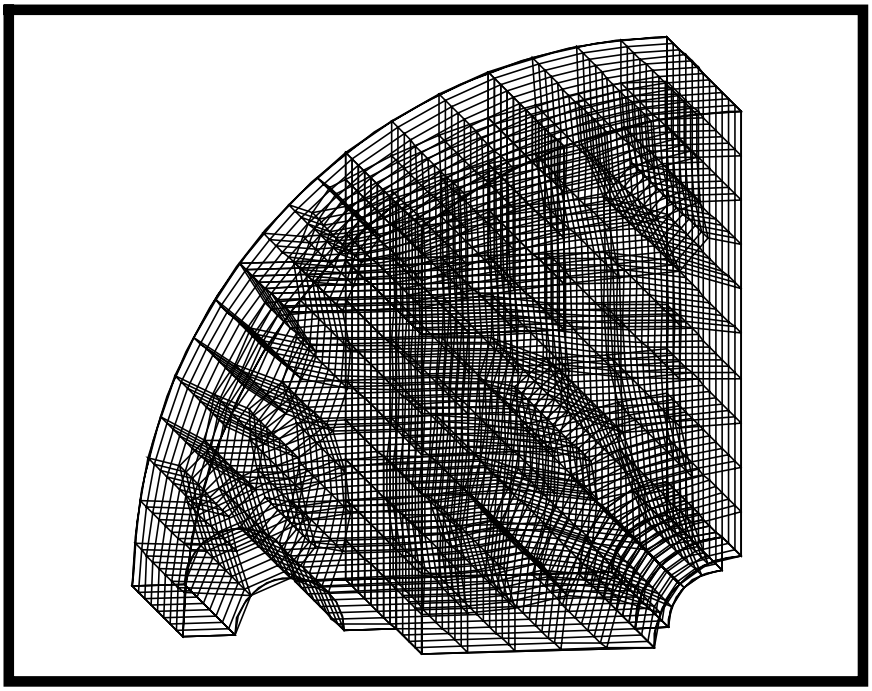
Highlight all newly created elements on the two surfaces.

■ **Delete Original Elements**

Base Entity List **Elm 1003:1038**

Apply

The model should appear as follows:



26. To get a better view of the model, apply the following:

Display/

Entity Color/Label/Render...

Render Style: **Element Fill**

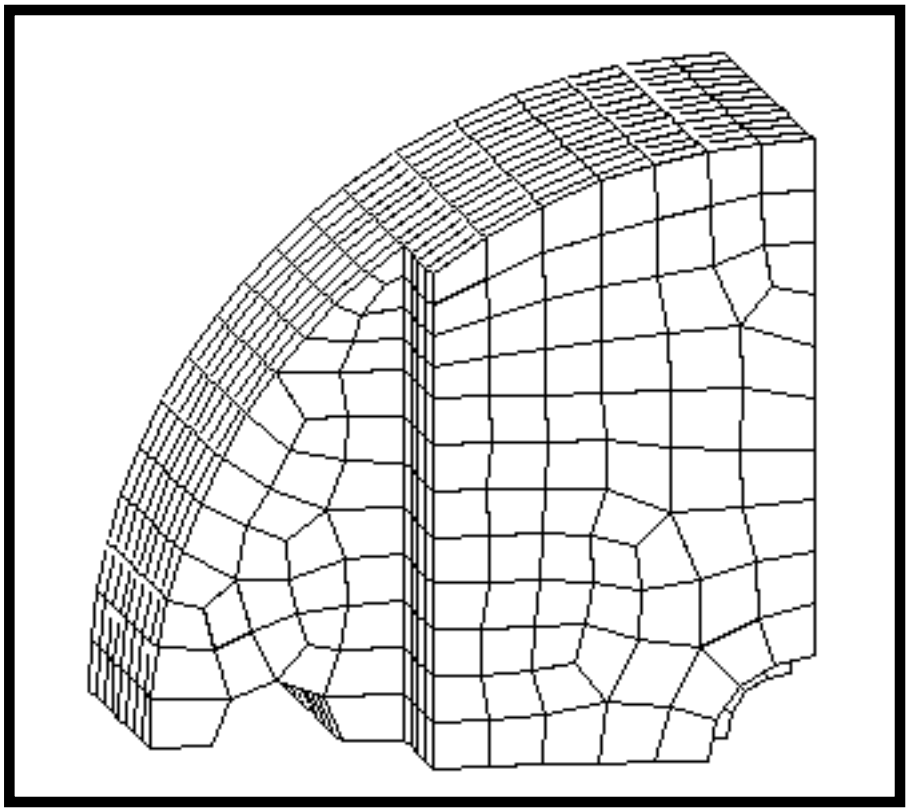
Apply

and

Display/Plot Erase...

Erase All Geometry

Click the repaint button in the Main window and your model should appear as shown below.



Change the display back to **Wireframe** and **Plot All Entities**.

27. Associate the finite elements of the base part of model to the geometric solid.

Create Finite Element

◆ **Finite Elements**

Action: **Associate**

Object: **Element**

Method: **Solid**

Element List **(select all hex elements on screen)**

Solid List **Solid 6**

Apply

When the process is done, the number of nodes that have been associated to the solid will be shown in the command window.

28. Now, post only the extension part of the model.

Post Extension Part of Model

Group/Post ...

Select Groups to Post **geo_extension**

Apply

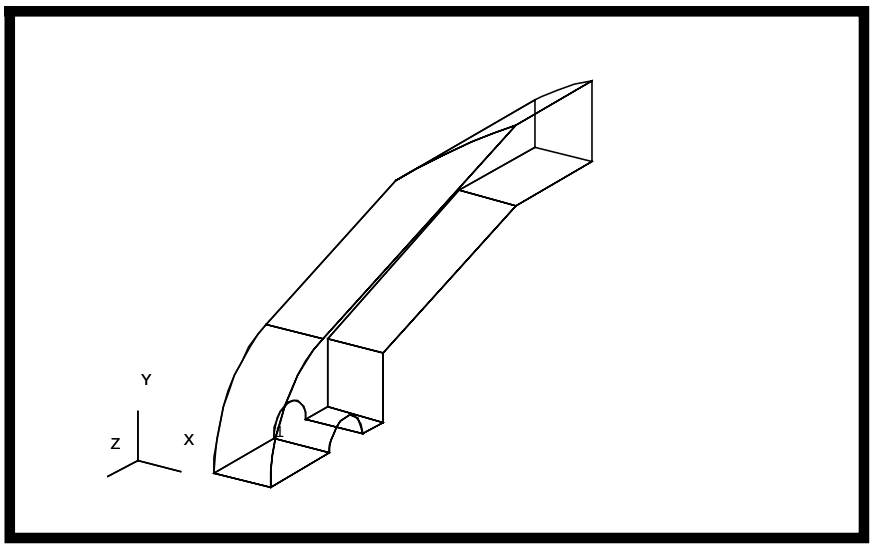
Cancel

29. Change the display of your viewport as follows:

Select the following icon:

Iso 1 View 

The extension part of the model:



30. Next, create some solids at the model.

Frist you must create a surface on top

◆ **Geometry**

Action:	**Create**
Object:	**Surface**
Method:	**Curve**
Option:	**2 Curve**
Starting Curve List	**Curve 1**
Ending Curve List	**Surface 3.4**

Apply

Create Solids Using Surface Method

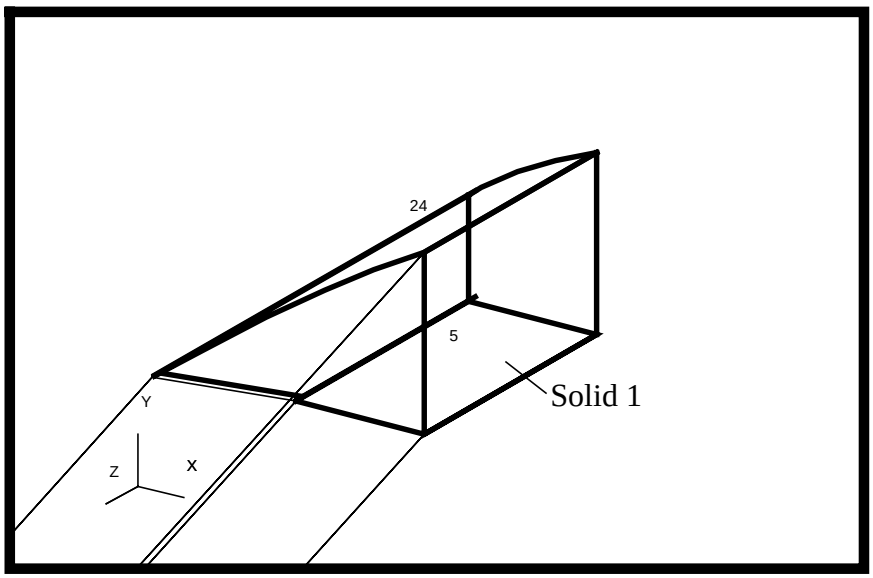
Now Create the solids

◆ **Geometry**

Action:	**Create**
Object:	**Solid**
Method:	**Surface**
Option:	**2 Surface**
Starting Surface List	**Surface 34**
Ending Surface List	**Surface 5**

Apply

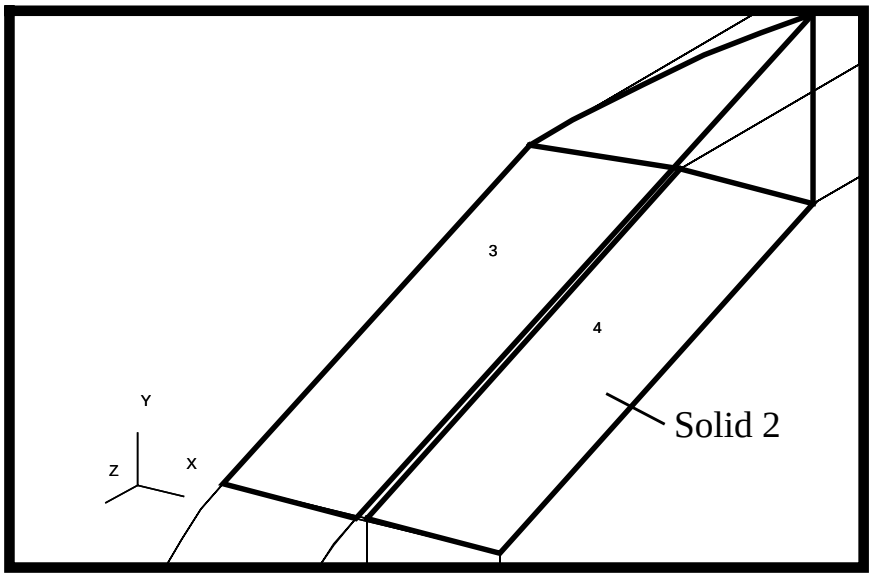
Solid 1 should appear as shown below.



Using Surface 3 and 4, perform the above procedure again to create solid 2.

Option:	**2 Surface**
Starting Surface List	**Surface 3**
Ending Surface List	**Surface 4**

Apply



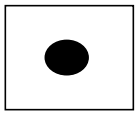
Decompose Surfaces

31. Next, create surfaces using decompose method as follow:

◆ **Geometry**

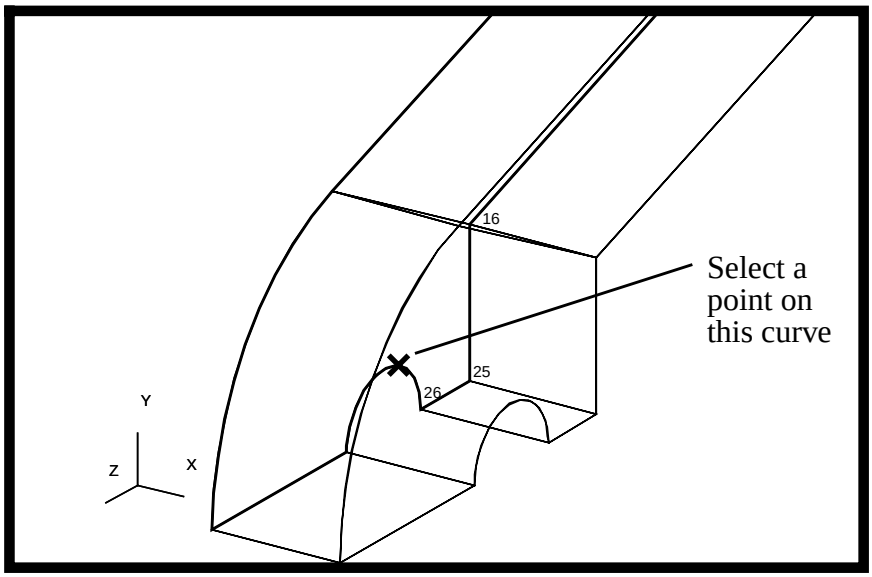
Action:	**Create**
Object:	**Surface**
Method:	**Decompose**
Surface	**Surface 25**
Surface Vertex 1 List	**Point 16**
Surface Vertex 2 List	**Point 25**
Surface Vertex 3 List	**Point 26**

For the first 3 vertices, use the **point select** icon



For the fourth vertex, first select the second icon in the select menu, **edge point**:

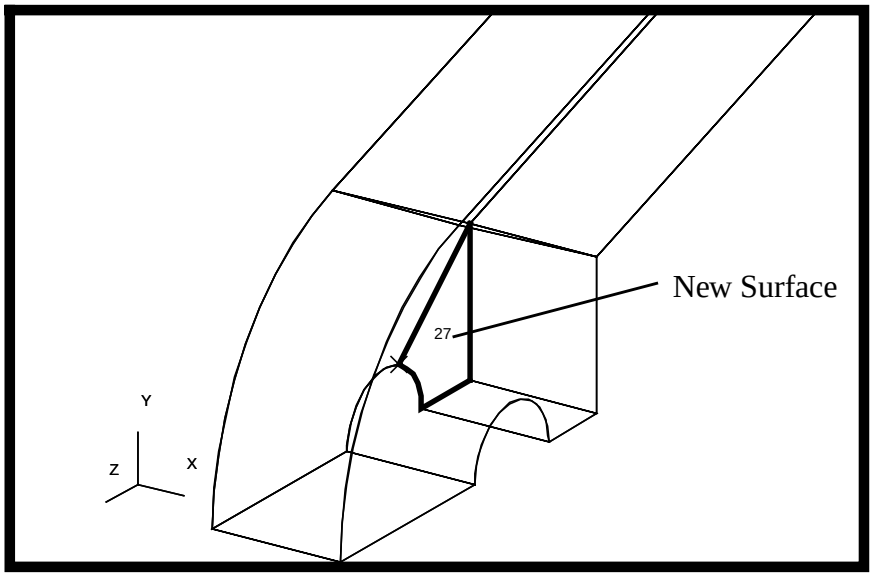
then select a point at the circular edge as follows:



Surface Vertex 4 List **Surface 25 (u 0.744...**

Apply

Your model should appear as follows:



Perform the above procedure again using the following entities: **2D elements**

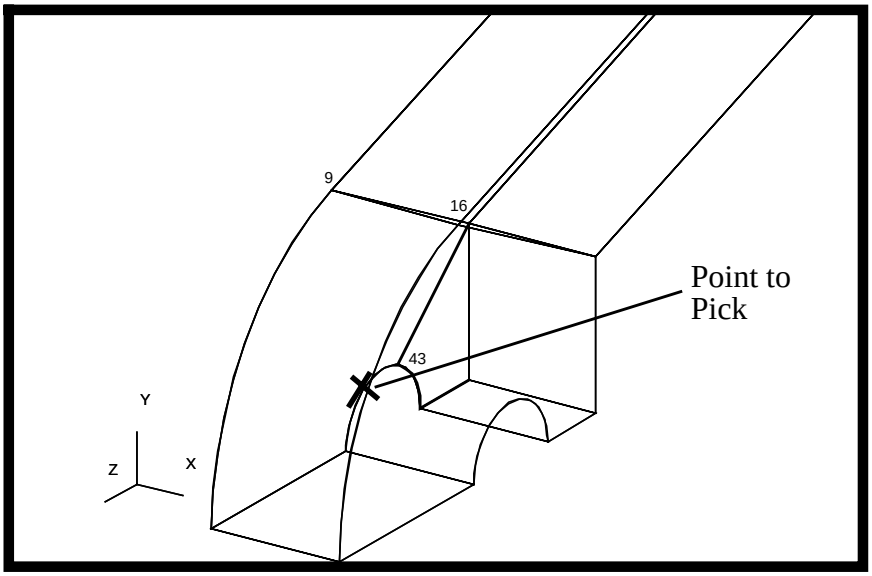
Surface **Surface 25**

For the first, second and third vertex, use the point pick icon in the select menu to pick the point.

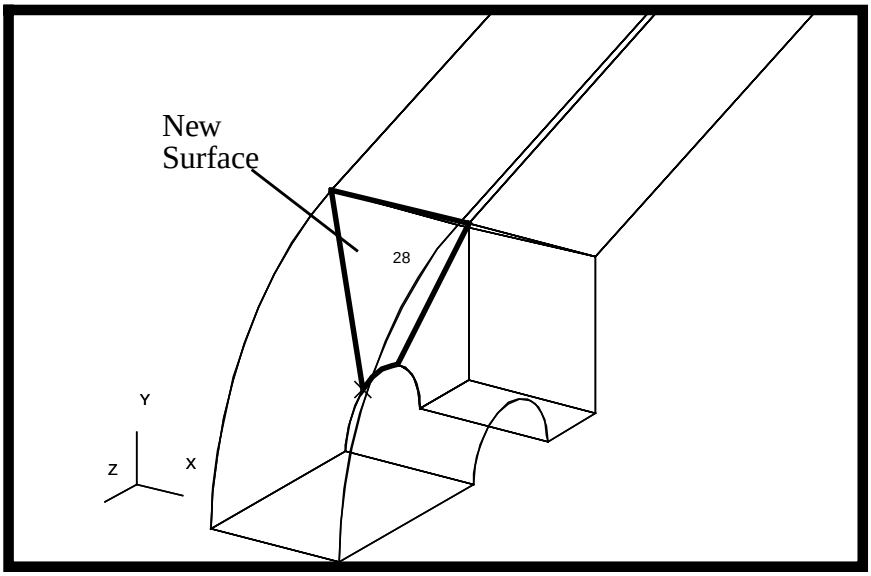
Again, to pick the fourth vertex, use the second icon in the select menu.

Surface Vertex 1 List	**Point 9**
Surface Vertex 2 List	**Point 16**
Surface Vertex 3 List	**Point 43**
Surface Vertex 4 List	**(Point on curve as shown below)**

Apply



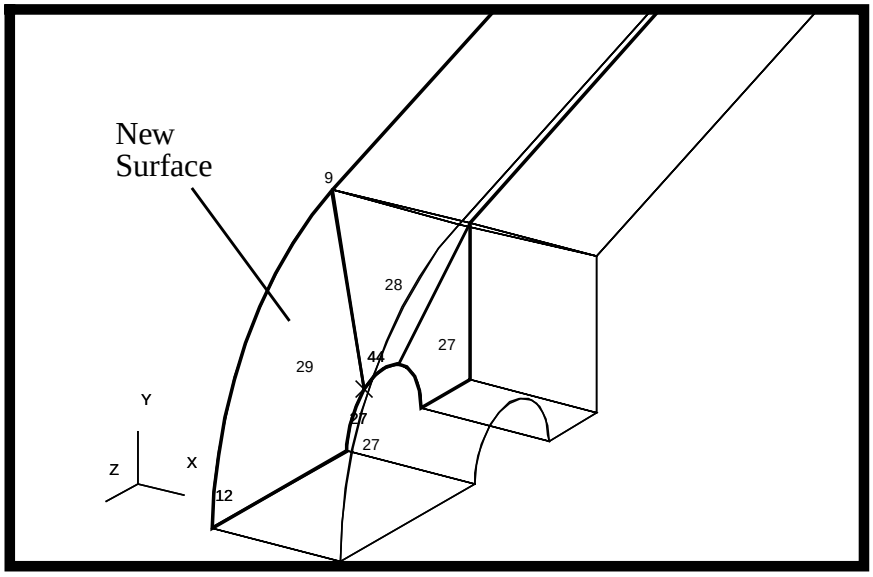
Your model should appear as follow:



Once again,

Surface Vertex 1 List	**Point 44**
Surface Vertex 2 List	**Point 27**
Surface Vertex 3 List	**Point 12**
Surface Vertex 4 List	**Point 9**

Apply



Create Solid Using Extrude Method

32. Next, using extrude method to create solid 3, 4 and 5 as shown below.

◆ **Geometry**

Action: **Create**

Object: **Solid**

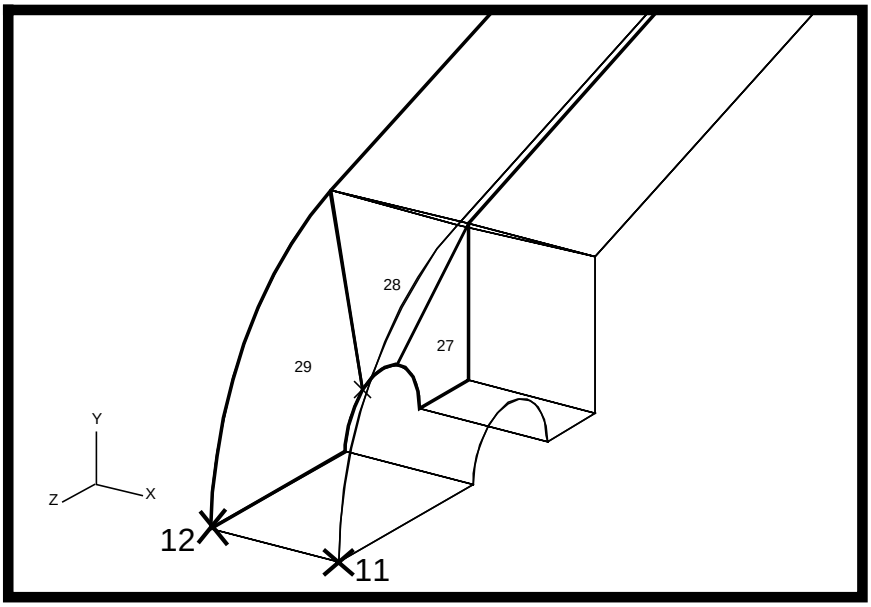
Method: **Extrude**

Now click the Translation Vector databox and then select the following icons in the select menu:

First select this icon:

Then select this:

Select point 12 to point 11 as the *Direction Vector*.



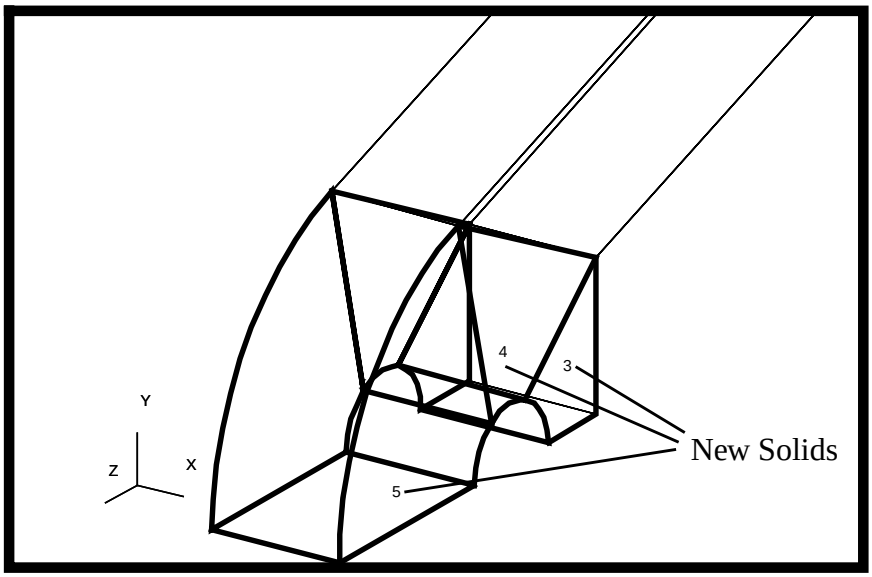
❑ **Autoexecute**

Translation Vector **Con..(Point 12)..(point 11)..**

Surface List **Surface 27 28 29**

Apply

Your model should appear as shown below.



33. Create a group for the finite elements of the extension part of model.

Group/Create

New Group Name **fem_extension**

■ **Make Current**

Apply

Cancel

Create Group

34. Change the view to **Iso 1 View** and then create a mesh on the model as follows:

Create Mesh

◆ **Finite Elements**

Action: **Create**

Object: **Mesh**

Method: **Solid**

Global Edge Length **4**

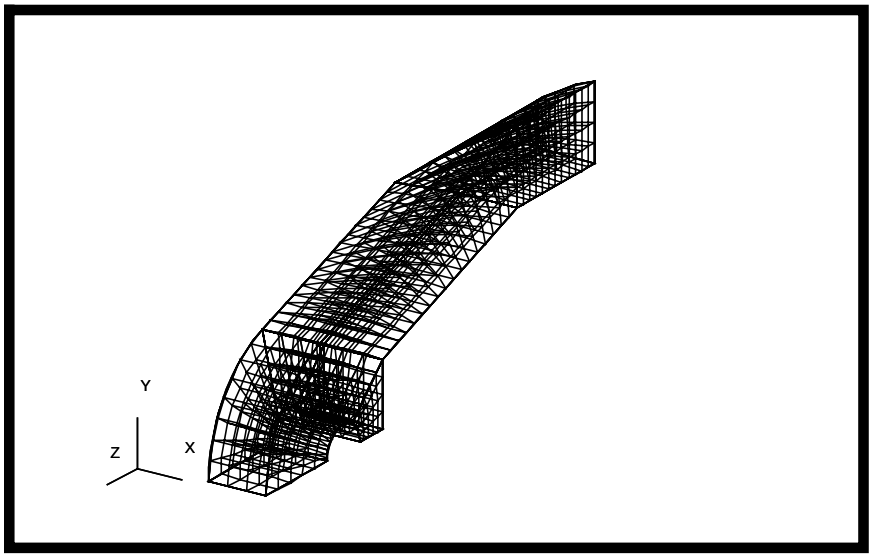
Element Topology **Hex 8**

◆ **Isomesh**

Solid List **Solid 1:5**
(Select all solids on screen)

Apply

The meshed model is shown below.



Create Group

35. Create a group for all the geometric part of the model.

Group/Create

New Group Name **geo**

Group Contents: **Add All Geometry**

Apply

After that, create a group for all the finite elements of the model.

New Group Name **fem**

■ **Make Current**

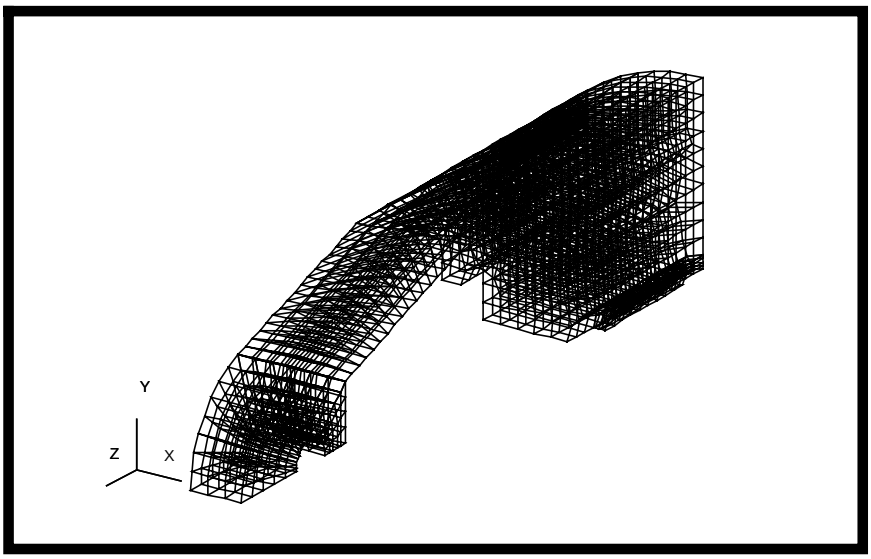
■ **Unpost all other groups**

Group Contents: **Add All FEM**

Apply

Cancel

The following should show up in your viewport.



36. Equivalence the model.

Equivalence the Model

◆ **Finite Elements**

Action: **Equivalence**

Object: **All**

Method: **Tolerance Cube**

Apply

37. Verify the model.

Verify the Model

◆ **Finite Elements**

Action: **Verify**

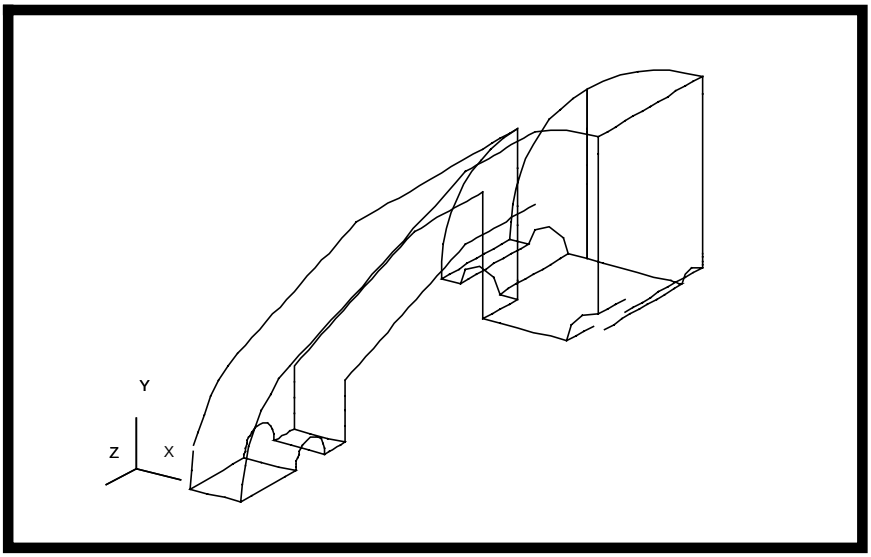
Object: **Element**

Test: **Boundaries**

Display Type ◆ **Free Edges**

Apply

The following should show up in your viewport.



38. Finally, change the display of the model as follows:

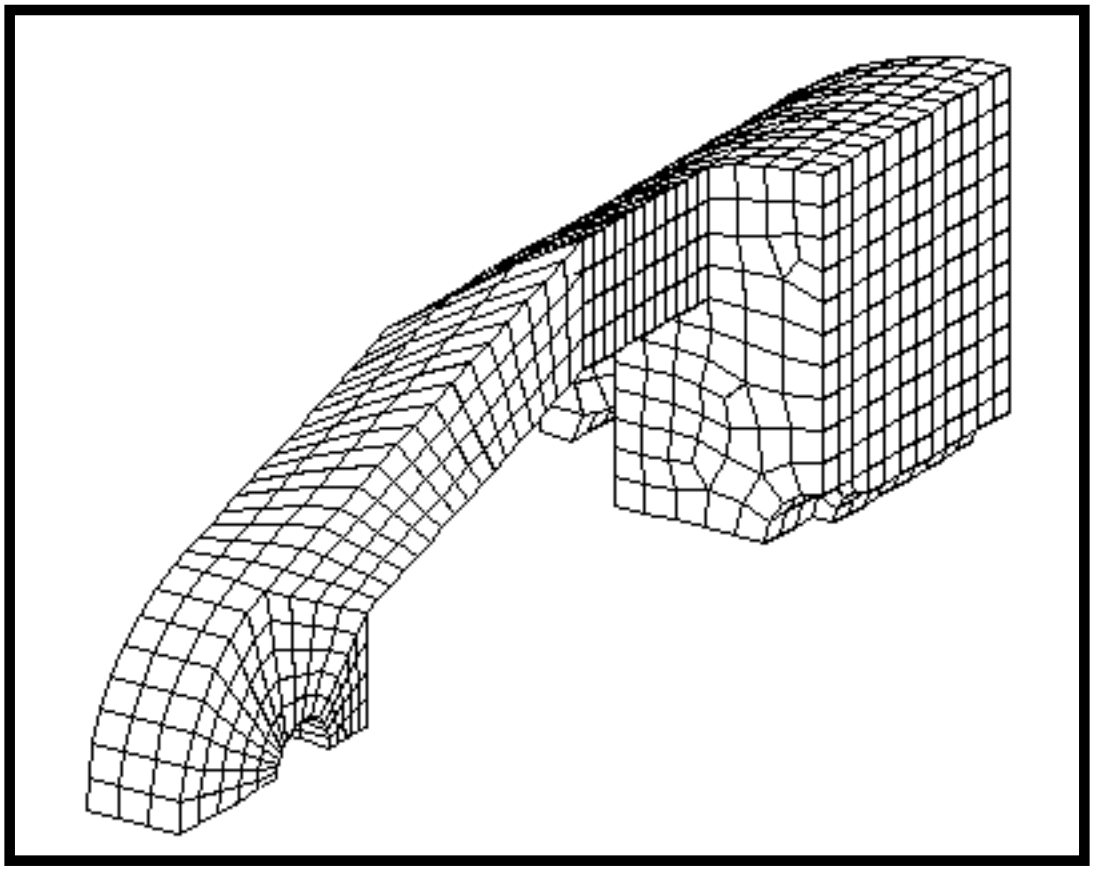
Display/

Entity Color/Label/Render...

Render Style: **Element Fill**

Apply

Your model should appear as show below.



Reset the *Render Style* back to **Wireframe.**

39. Close the database and quit PATRAN to complete this exercise.

File/Quit