

# GridPro Training –Part 1

## Terminologies

# Surface Definition

- Surface defines the region in space to be gridded
- In GridPro surfaces must be **faceted**
- The faceted surface must be created from the CAD geometry
- GridPro deals with 3 kinds of surfaces.
  - Linear surfaces
  - Triangles
  - Quads.
- Analytical surfaces defined by GridPro are
  - Plane
  - Ellipse
  - Ellipsoid.

# Linear Surface

- A linear surface is a surface which is defined by an  $I \times J$  array of points for some  $I$  and  $J$  in the file.
- The bilinear interpolation is used to determine the surface points within the array cells.
- No collapsed cells or merged data are allowed.
- This is represented by **\*.dat** or **\*.lin** as an extension.
- Each **dat** file has a connectivity file which gives the information about the connectivity.
- If there is no connectivity file, GridPro will use the surface data to generate it by some default rules.

# Contd...

- An example of connectivity file consists of following lines.

1 6 1 6 -1 2 2 0 0

2 3 1 3 -1 1 2 0 0

3 2 1 2 -1 4 2 0 0

4 5 1 5 -1 3 2 0 0

5 4 1 4 -1 6 2 0 0

6 1 1 1 -1 5 2 0 0

- Each line defines a surface piece and its connection to other pieces.
- It has the following format.

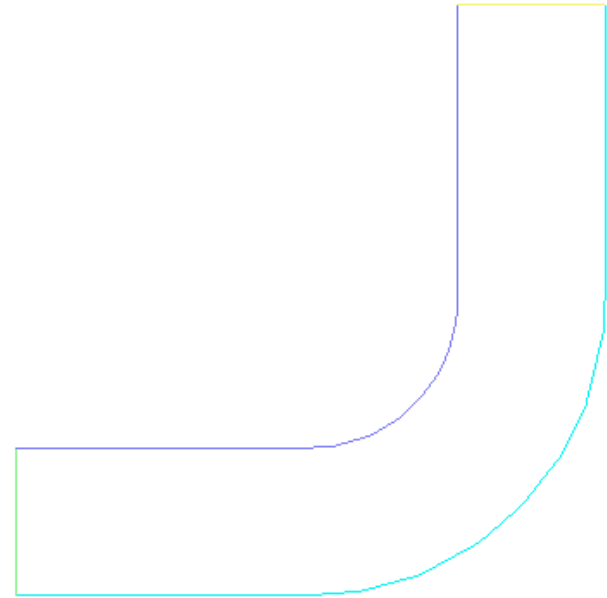
*sp\_id nxi sdi nxI sdI nxj sdj nxJ sdJ*

Where,

- *sp\_id* = An id number that labels the surface piece.
- *nxi sdi* = boundary condition for the i = IMIN side of current piece. *nxi* provides the neighbouring surface piece id. *sdi* indicates which side of the neighbour surface piece is connecting to the i = IMIN side of current piece. *sdi* = 1, -2, 2, and -2 means the i = IMIN side, i = IMAX side, j = JMIN side and j = JMAX side respectively.

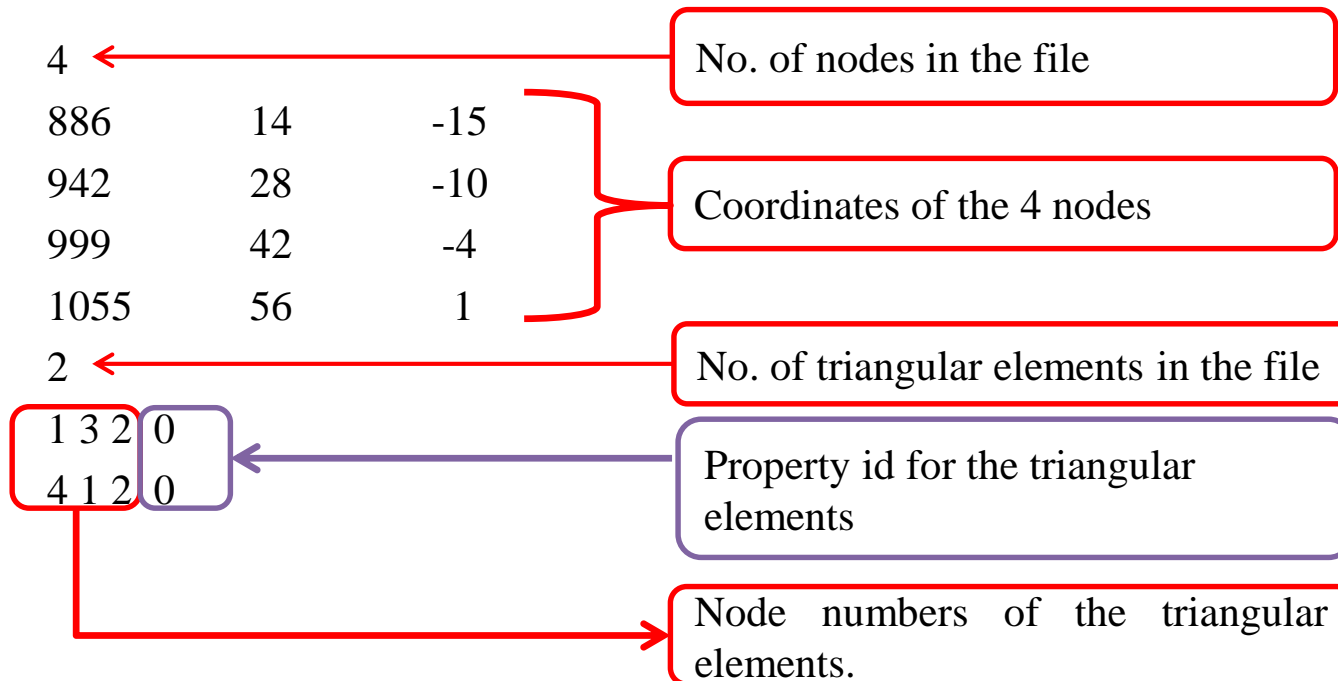
# Contd...

- $nxI\ sdI$  = Boundary condition for the  $i = IMAX$  side of the current surface piece
- $nxj\ sdj$  = Boundary condition for the  $j = JMIN$  side of the current surface piece
- $nxJ\ sdJ$  = Boundary condition for the  $j = JMAX$  side of the current surface piece
- The orientation of the surface will be synchronized to that of the first piece.



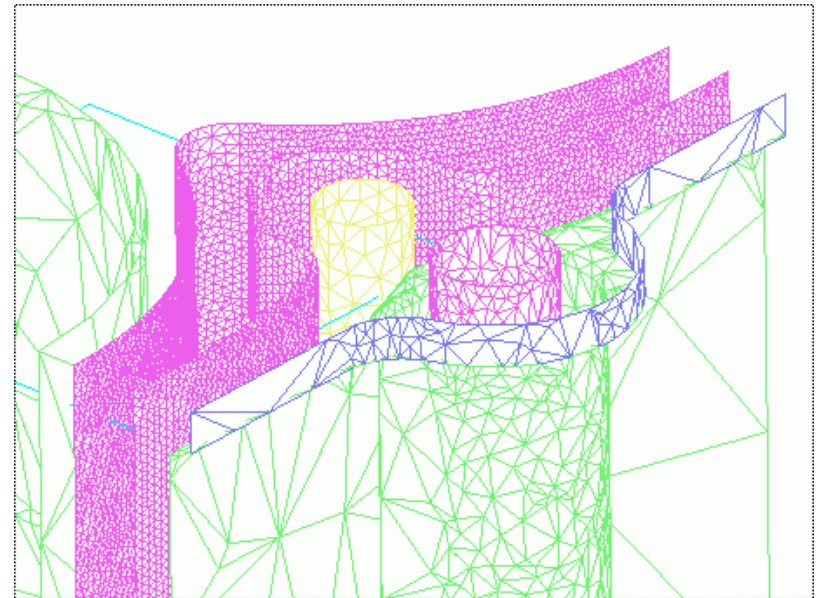
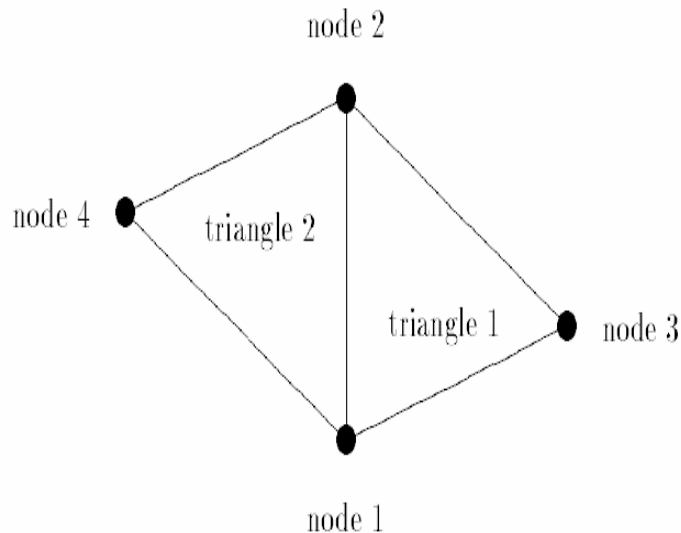
# Tria Surface

- The data format is similar to the quad surface.
- This is represented by **\*.dat** or **\*.tria** as an extension.
- The data format used by GridPro consists of the following lines.



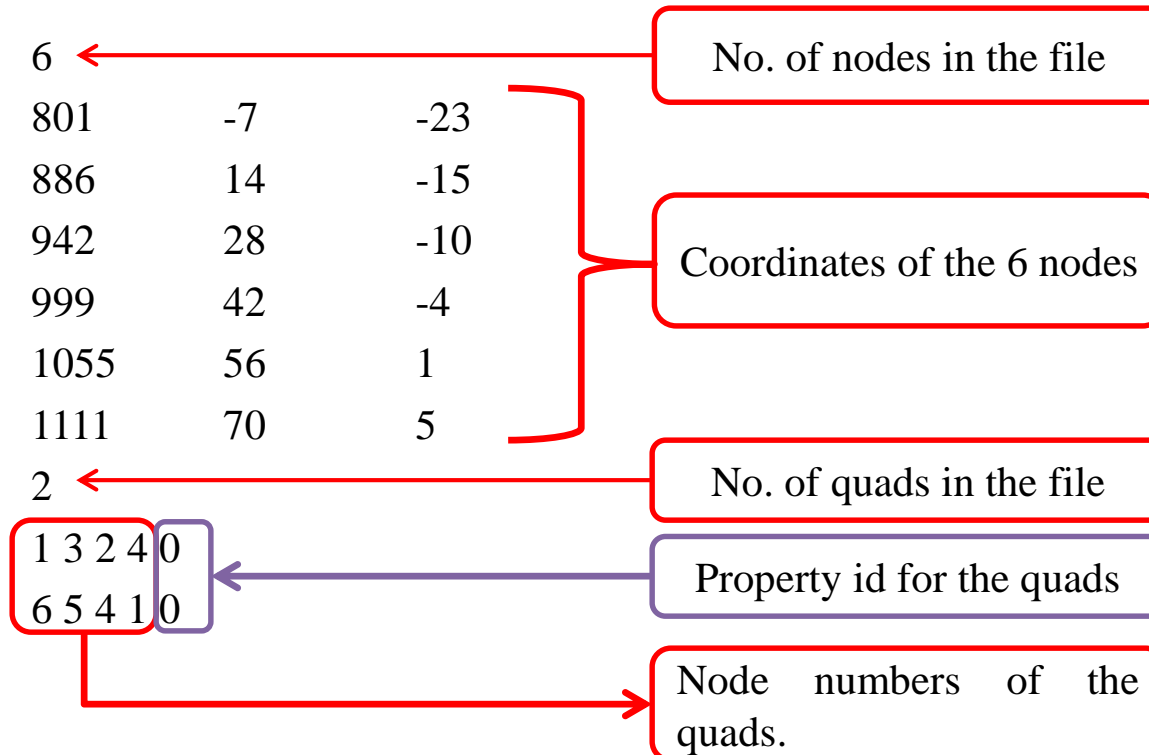
# Contd...

- Each **triangular** element is defined by 3 nodes.
- No degenerate sides are allowed for any of the triangular elements.



# Quad Surface

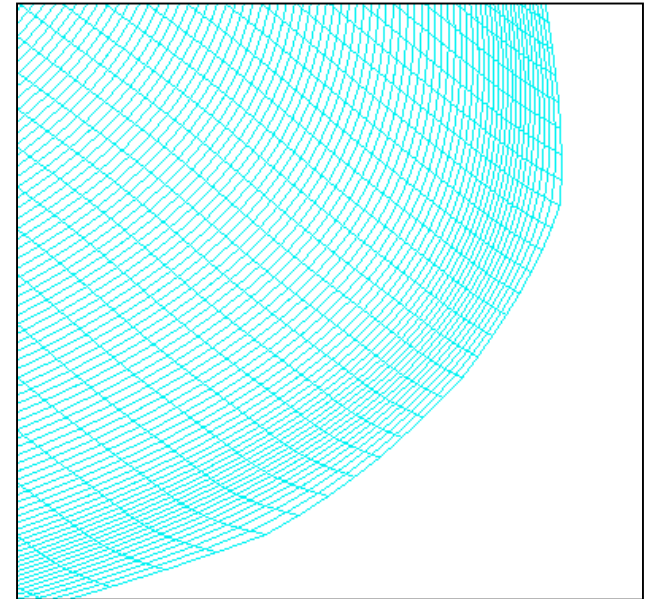
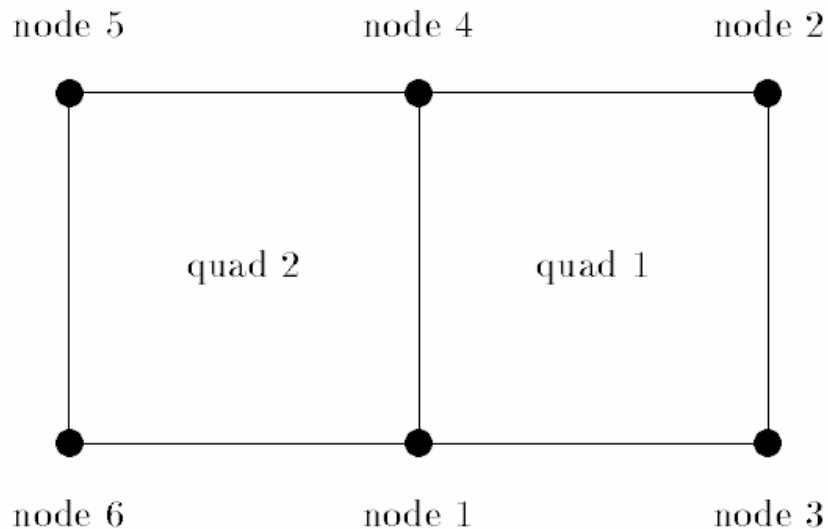
- A surface point is defined by bilinearly interpolating on the quad elements.
- This is represented by **\*.dat** or **\*.quad** as an extension.
- The data format used by GridPro consists of the following lines.





# Contd...

- Each **quad** element is defined by 4 nodes.
- The +side of a quad surface is determined by the first quad in the quad list.
- The positive side of the surface is the side where when one faces the first quad, the listing order of the nodes that defines the quad rotates anti-clockwise.



# Analytical Surfaces

```
surf| topo grid dim=3 corn=C read
duplicate current
reload current
delete current
LOAD: file
    -plane
    -ellip
    -implic
    -xpolar
    -xyz
    -scale plane
    -float
MAKE: Tube
    network of controlnet curves
Control net Surf
Controlnet TFI Surf
Load controlnet for Current surface
SAVE: surf as TIL
    : surf as TRIA
DELETE: current
    active
    inactive
    all
```

For plane

For ellipse

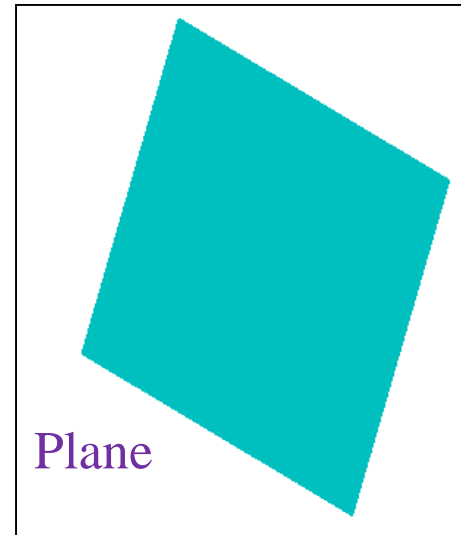
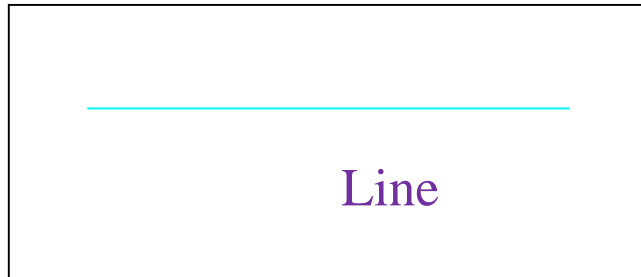
For periodic surface

For tube

For user defined surface

# Planes

- Planes represent one of the most simplest surfaces.
- It define the regions to be gridded. It acts as the bounding surfaces of the geometry.
- The general equation of the plane,  $\mathbf{ax+by+cz-d=0}$  is followed here in GridPro to represent the planes.
- In the GUI, the plane's **center** and its **normal vector** should be entered to create a plane.
- In 2D, a plane becomes **line**.



# Contd...

set surface parameters\_popup

surf id : 4 (don't change)

type : -plane

get cut-p para

center : 0 0 0

normal : 0 0 1 1

orient : 1 sided

E-wall :

norm-spc :

stretch :

m-grid :

label :

transformation sys

scale : 1

transl 1: 0 0 0

rot axis: 0 0 1

degree : 0

transl 2: 0 0 0

property: default

macro ld: AUTO

cancel ok

Use cut plane dimension

Center of the plane

Normal and Magnitude of the plane

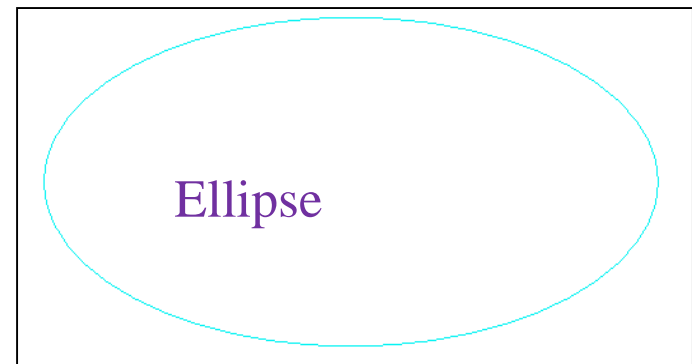
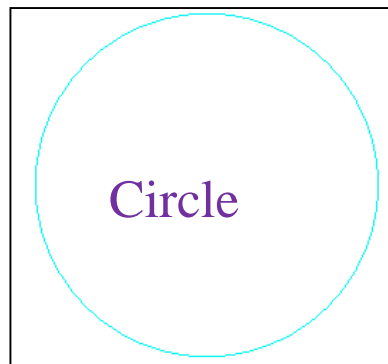
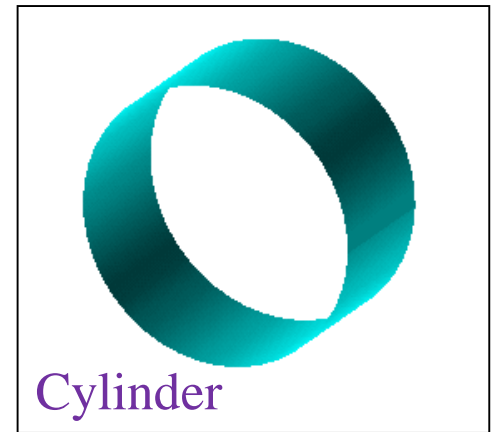
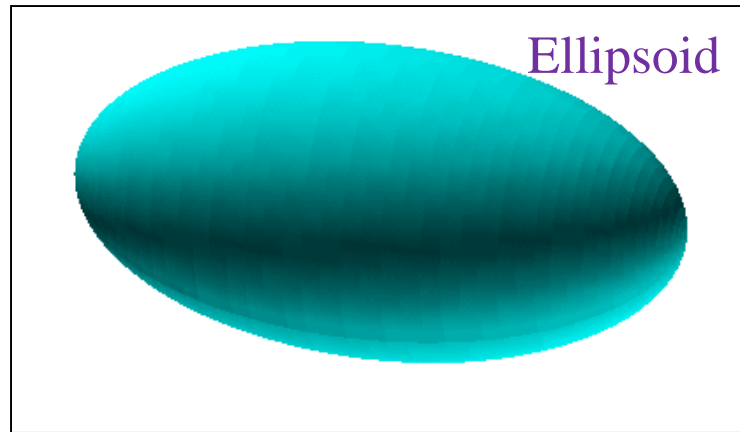
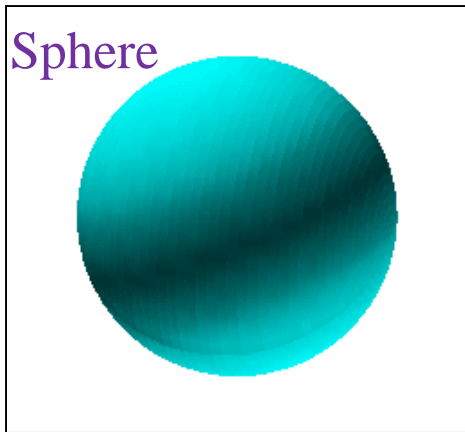
Orientation of the plane

Explained in advanced tutorial

# Ellipse/Ellipsoid

- An ellipse is a smooth closed curve which is symmetric about its horizontal and vertical axes.
- **Circle** or **sphere** is a special case of ellipse or ellipsoid respectively.
- **Cylinders** are the special case of ellipsoid in GridPro. It interprets cylinders as ellipsoids with one infinitely long axis.
- To create a cylinder, one axis's magnitude should be entered as a large value. E.g.  $1e+15$
- Most of the times, ellipse or ellipsoid is used as the bounding surfaces of the geometry (depends on the users need).
- In the GUI, the ellipse's **center** and its **vector** in all 3 directions should be entered to create an ellipse.

# Contd...



NOTE: For ellipse, the third dimension should be a larger value. For E.g.  $1E+15$

# Contd...

The screenshot shows a dialog box titled 'set surface parameters\_popup' with the following fields and values:

- surf id : 4 (don't change)
- type : -ellip
- center : 0 0 0
- semi-u : 1 0 0 1
- semi-v : 0 1 0 1
- semi-w : 0 0 1 1
- power : 2
- view scl: 1
- orient : 1 sided
- E-wall : (empty)
- norm-spc: (empty)
- stretch : (empty)
- m-grid : (empty)
- label : (empty)
- property: default
- macro ld: AUTO

At the bottom are 'cancel' and 'ok' buttons. Red arrows point from various fields to explanatory text boxes on the right:

- From 'surf id' to 'Use cut plane dimension'.
- From 'type' to 'Center of the ellipse'.
- From 'center' to 'Axis and magnitude of the ellipse in all 3 directions'.
- From 'semi-u', 'semi-v', and 'semi-w' to 'Shape of the ellipse'.
- From 'power' to 'Length of the cylinder'.
- From 'orient' to 'Orientation of the ellipse'.
- From the bottom section to 'Explained in advanced tutorial'.

Use cut plane dimension

Center of the ellipse

Axis and **magnitude** of the ellipse  
in all 3 directions

Shape of the ellipse

Length of the cylinder

Orientation of the ellipse

Explained in advanced tutorial

# Periodic Surfaces

- It can also be referred as symmetric surfaces. Some geometries are **translationally symmetric** or **rotationally symmetric**.
- For rotationally symmetric geometries, ‘**-xpolar**’ surface is used.
- For translationally symmetric geometries, ‘**-xyz**’ surface is used
- These surfaces comprise nothing more than the periodic borders of the object.
- In the GUI, the periodicity should be mentioned to create the periodic surfaces.
- The “xyz” period number corresponds to a length, and will relate to the length of the section. There is no representation for this surface in the GUI.
- The “-xpolar” surfaces, you specify a period in degrees. This degree measure must be a factor of 360. This surface is represented as torus.



# Contd...

set surface parameters\_popup

surf id : 4 (don't change)

type : -xpolar

period : 0

norm-spc:

stretch :

m-grid :

label :

transformation sys

scale : 1

transl 1: 0 0 0

rot axis: 0 0 1

degree : 0

transl 2: 0 0 0

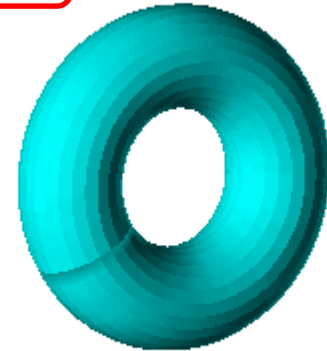
property: default

macro ld: AUTO

cancel ok

Period of the rotation

Explained in  
advanced tutorial



# Internal surface and External Surface

## External Surface:

- External surface is a surface with grid only on one side of it, either on the positive normal or the negative normal.
- Any surface loaded into GridPro is a an external surface.

## Internal Surface:

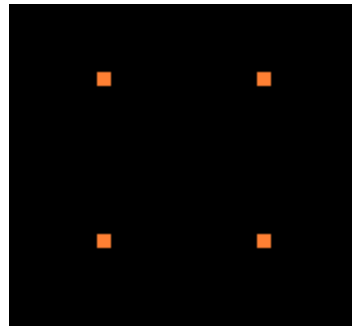
- An internal surface is a surface for which both sides of the surface are to be gridded.
- It can be specified with any surface type that can be used for an external surface. However, the orientation of the surface must be suppressed with the – O(2-sided) in the surface definition statement.
- The grids on both sides of an internal surface will be matched on the surface.

## Purpose:

- Internal surfaces are used for various purposes like sharp feature definition, local enrichment of Grid (adaptive grid), setting internal properties, shock capturing etc.

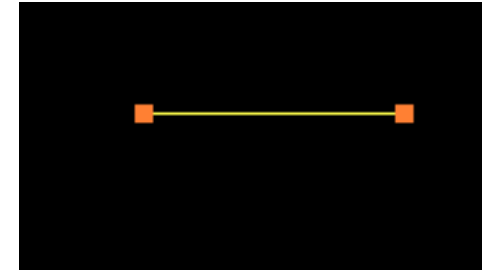
# Topology Terminologies

- **Topology** is defined as the connectivity information of block corners and the surfaces assignments of the corners and the initial position of the corners.
- It is used by the grid generator to define the block region of the grid in space.
- **Corner** is defined as a point in space which is represented as ordered pair of numbers (  $x, y, z$  ) where  $x, y, z$  is the coordinates of the point in  $x, y, z$  axis respectively.

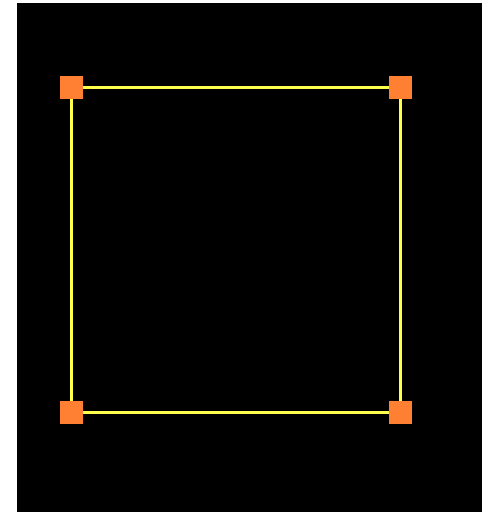


# Contd...

An **edge** is a line segment joining two adjacent vertices in a face.

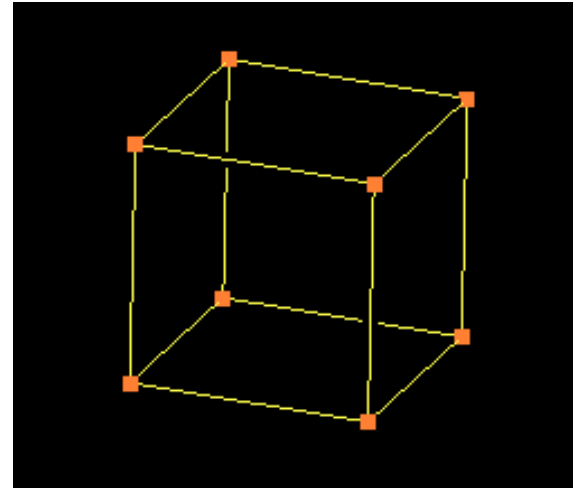


A **face** is a closed sequence of edges. Exactly two faces meet at every edge of a block.

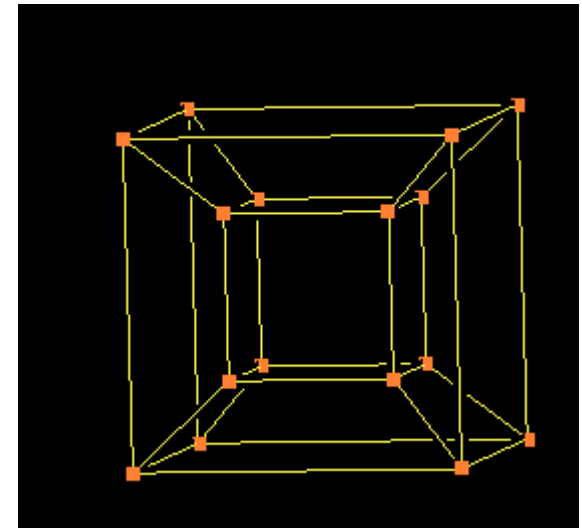


# Contd...

A **block** is a closed sequence of faces.

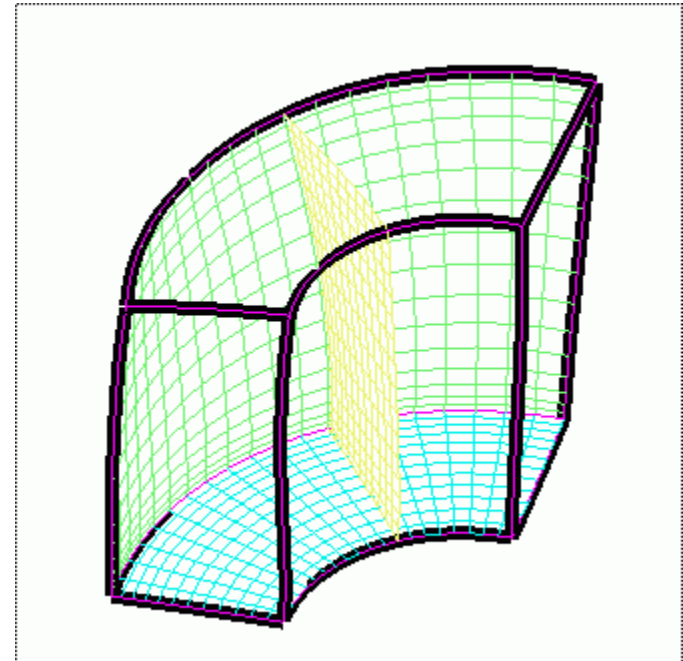
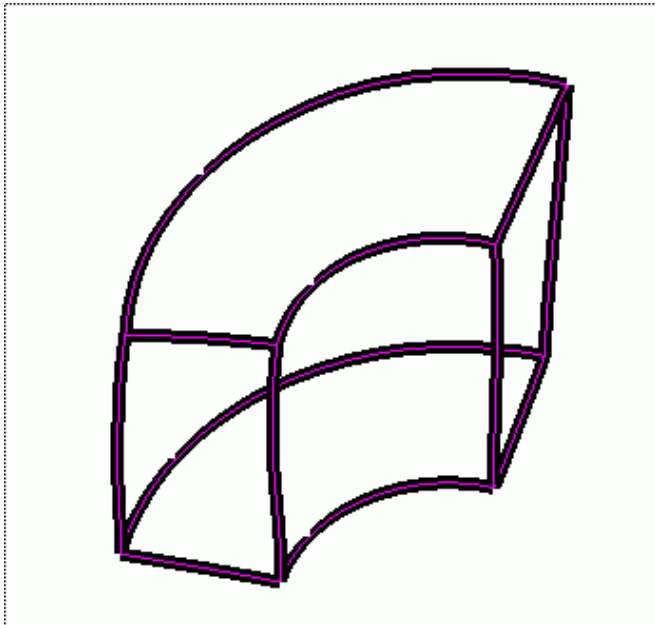


Collection of blocks linked together to form a **wireframe**. In a wireframe, there are more faces meet at an edge.



# Block Structured Grid

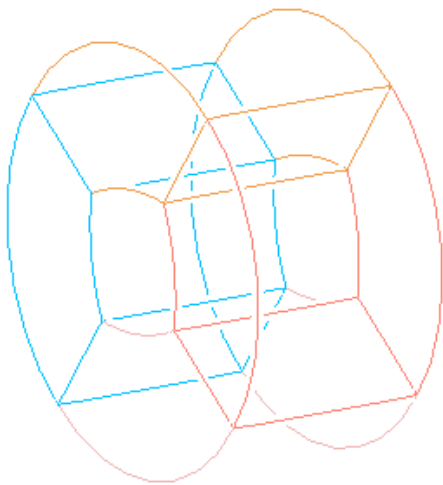
- All blocks have **6 faces**, **12 edges** and **8 vertex points** and can exist in any shape and size
- Edges contain the distribution of points in the  $i, j, k$  directions



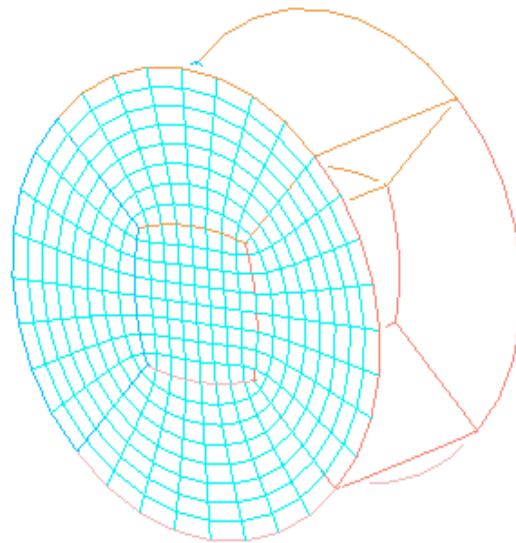
## Contd...

- The **blocks** of the grid contains edges outlines, center of mass and skeletons(links from center of mass to the center of each face).
- A **face** is the grid about a boundary of a block.
- A **slice** is a grid that cuts through a block.
- A **sheet** is simply a collection of linked faces or a collection of linked slices. A sheet composed of linked faces is called a **face sheet**, and a sheet composed of linked slices is called a **slice sheet**.
- A face sheet composed of the faces of the outer boundaries of all outer, activated blocks is called a **shell**.

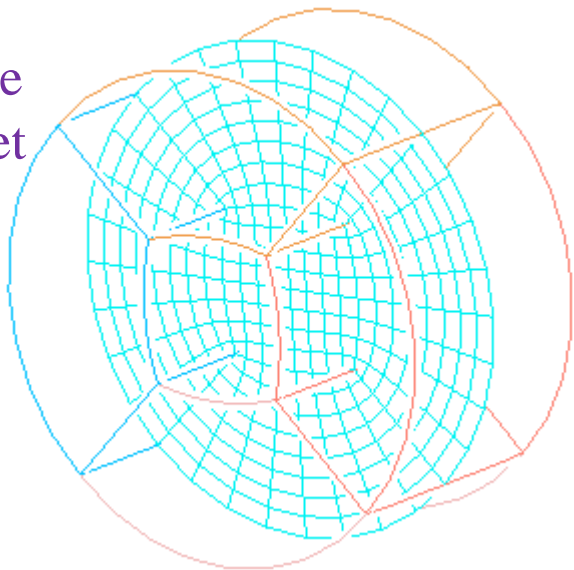
Grid  
with  
blocks



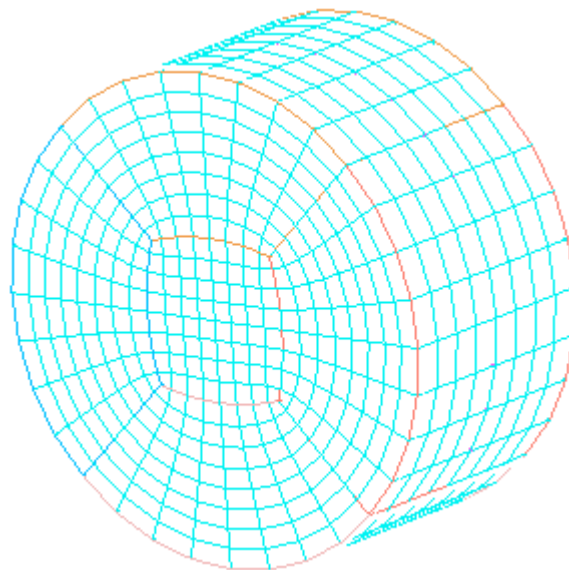
Face  
Sheet



Slice  
sheet



Shell





Continued in.....Terminologies and Concepts