Section

8

Tutorial

Objective:

To provide a template for creating a patch definition with background source information for a generic type airplane configuration.

Given:

- GridTool executable
- IGES(International Graphics Exchange Standard) File : **Class.igs**

Begin by creating a new work directory with the **Class.igs** file.

GridTool can be executed by typing ***GridTool*** or ***GridTool option filename***. A list of the command line arguments is as follows:

Arguments (option filename)		Action
-h		**help**
-d3m	**d3m_filename**	**read a d3m file**
-f	**restart_filename**	**read a restart file**
-gf	**GRIDGEN_filename**	**read a GRIDGEN formatted file**
-g	**GRIDGEN_filename**	**read a GRIDGEN binary file**
-pf	**PLOT3D_filename**	**read a PLOT3D formatted file**
-p	**PLOT3D_filename**	**read a PLOT3D binary file**
-IGES	**IGES_filename**	**read an IGES file**
-felisa		**run GridTool in FELISA Mode**
-CURVES	**CURVES_filename**	**read in a CURVES file**
-dat	**dat_filename**	**read a dat file**

The GridTool interface consists of a main panel with several contact sensitive buttons to bring up sub-panels. These sub-panels can be activated by pressing their buttons from the Main panel window. When a panel is activated, the button color changes from blue to green. By placing the mouse cursor over any button and clicking with any of the three mouse buttons, the corresponding sub-panel will be displayed.

I. INPUT/OUTPUT PANEL

- Locate the *Input/Output* panel on the screen or depress the [I/O] button on the GridTool *Main* panel to activate it.

  Steps to READ a file:

  a. Select a project name and enter it in the [Project Name] field.

  b. Type in the filename in the [File Name] field or select it from the Files Browser by placing the mouse over the filename and clicking with any of the mouse buttons.

  c. Select the type of file format, ASCII or Binary, by placing the mouse in the [File Format] field and clicking with the leftmost mouse button, or press the right mouse button and select from the drop-down menu.

  d. Select the appropriate file type by placing the mouse in the [File Type] field and clicking with the leftmost mouse button. To view all the menu choices available, place the mouse in the [File Type] field and click with the rightmost mouse button. Drag down to select and highlight the file type.

  e. Press the [READ] button to read the file.

  f. Stow the *Input/Output* panel by pressing the red [STOW] button on the *Input/Output* panel or pressing the [I/O] button from the GridTool *Main* panel.

Example: Reading an IGES file.

[Project Name] : Class
[File Name] : Class.igs
[File Format] : ASCII
[File Type] : IGES
Press [READ] button.

Example: Writing a RESTART file.

[Project Name] : Class
[File Name] : Class.rst
[File Format] : ASCII
[File Type] : Restart
Press [WRITE] button.

The GridTool restart file is the main file that is used in the program. Once a new project is started in GridTool, a new restart file should be generated. The restart file contains all the information in the database that you have created. Frequent updating of the restart file is recommended. The restart file will contain the latest software configuration setup and subsequent additions and changes made.

II. DISPLAY WINDOW PANEL

Geometry that is read in through the Input/Output panel is displayed in the DISPLAY WINDOW. When the IGES file is first read in, only the boundary curves of the entities are displayed with the orientation axis at the origin. The mouse and hot keys, or the Viewing Controls panel can be used to manipulate the geometry in 3-D space. The Viewing Controls panel will be discussed in section lll.

Hot Key Operations:

- The Hot Key [x] – toggles the axis display on/off.

    a. To remove the axis, press the hot key [x] on the keyboard.
    b. To restore the axis, repress the hot key [x] on the keyboard.

- Hot Key Manipulations for Rotation:

    The geometry can be rotated about two sets of axis, the world (body) coordinate system and the screen coordinate system. Both axis system rotations using the numeric keypad are explained as follows.

World (Body) Axis Rotation: [num lock] [/] [*] [page down] [-]

The [num lock], [/], [*], and [-] hot keys are located on the top row of the numeric keypad. The world (body) axis system is relative to the geometry.

[num lock] – rotation about the world x-axis.
[/] – rotation about the world y-axis.
[*] – rotation about the world z-axis.

The rotation continues as long as the hot keys are pressed down.

Pressing together both:

[page down] [num lock] - 90 degree rotation about the world x-axis.
[page down] [/] - 90 degree rotation about the world y-axis.
[page down] [*] - 90 degree rotation about the world z-axis.

Pressing together both:

[-][num lock] – reverses the direction of the world x-axis rotation.
[-][/] – reverses the direction of the world y-axis rotation.
[-][*] – reverses the direction of the world z-axis rotation.

Screen Axis Rotation: [7] [8] [9] [page down] [-]

The [7], [8], [9] and [-] hot keys are located on the numeric keypad. The screen x-axis is to the right, y-axis is up, and z-axis is out of the screen (Right Hand Rule).

[7] – rotation about the screen x-axis.
[8] – rotation about the screen y-axis.
[9] – rotation about the screen z-axis.

Pressing together both:

[page down] [7] - 90 degree rotation about the screen x-axis.
[page down] [8] - 90 degree rotation about the screen y-axis.
[page down] [9] - 90 degree rotation about the screen z-axis.

Pressing together both:

[-][7] – reverses the direction of the screen x-axis rotation.
[-][8] – reverses the direction of the screen y-axis rotation.
[-][9] – reverses the direction of the screen z-axis rotation.

- The Hot Key [r] – resets the default view (cursor needs to be inside of Display Window before hot key is pressed). Pressing the [Reset] button in the Viewing Controls panel may also restore the initial view.

Example: Manipulating the geometry using hot keys.

Press hot key [r] to reset the geometry to the xy plane.

Press hot key [num lock] down for a few seconds to rotate geometry about the world x-axis.
Press hot key [/] down for a few seconds to rotate geometry about the world y-axis.
Press hot key [*] down for a few seconds to rotate geometry about the world z-axis.

Press hot key [7] down for a few seconds to rotate geometry about the screen x-axis.
Press hot key [8] down for a few seconds to rotate geometry about the screen y-axis.
Press hot key [9] down for a few seconds to rotate geometry about the screen z-axis.

Press [r] to reset the geometry.

Mouse Operations:

The mouse can be used either in a default mode or in a PLOT3D mode. The mode can be changed by pressing the [PLOT3D] button, which is located in the Viewing Controls panel. The operations of the mouse are explained below for both the default and PLOT3D modes:

Mode	Movement	Left Mouse	Middle Mouse	Right Mouse
Default	Right	Translate Rt		N/A
Default	Left	Translate Left		N/A
Default	Up	Translate Up	Zoom Out	N/A
Default	Down	Translate Down	Zoom In	N/A
PLOT3D	Right	Rotate Screen y	Rotate Screen z	Translate Rt
PLOT3D	Left	Rotate Screen –y	Rotate Screen –z	Translate Left
PLOT3D	Up	Rotate Screen x	Zoom Out	Translate Up
PLOT3D	Down	Rotate Screen –x	Zoom In	Translate Dn

III. VIEWING CONTROL PANEL

- Press [Control] button on the GridTool Main panel to activate the Viewing Controls panel. This panel contains the mechanisms for also manipulating the geometry in 3-D space.

- Geometry Rotations and Manipulations in 3-D Space

  a. Reset –Resets the geometry in the Display Window.

  b. Ortho – Orthographic perception.

  c. D. Cue – Depth perception cue.

  d. Center of Rotation – The center of rotation is allowed to be moved to any arbitrary point in space. When this button is pressed, a Center of Rotation panel appears. The center of rotation can be moved to any existing point by using the “x, y, and z” sliders or to the centers of the <u>active</u> surface, curve, patch, or point by pressing the corresponding button.

  e. MOUSE PLOT3D – toggles mouse mode between default and PLOT3D. The mouse operations (default and PLOT3D) are listed above in section ll.

  f. Clip – Clipping can be conducted in the z-direction of the viewing screen by moving the positioner. The clipping tool is set at the maximum viewing volume, starting from the –z direction and at the other extreme from the +z direction. Moving the bars closer together will shorten the viewing volume.

  g. Rotation and Translation Rates – Sensitivity rates for rotation and translation can be adjusted by pressing the up/down arrows along side the [Rot] and [T/Z] buttons. Each time the arrow keys are pressed, the sensitivity rate is increased/decreased by a factor of three. To reset to the default value, press the [Rot] or [T/Z] button. Note: These sensitivity rates correspond to both Screen and World Axis systems.

  h. Screen Viewing Plane – The screen viewing plane can be changed to any of the following: X-Y, Y-X, Y-Z, Z-Y, Z-X, and X-Z.
  The first axis label listed is in the direction pointing to the right of the screen, and the second axis label listed points up to the top of the screen.

i. World Axis Rotation – operation can be performed by moving “x, y, and z” sliders. Ninety degree rotations can be made about the “x, y, and z” world axis by pressing the [90] button under each World Rotation “x, y, and z” slider.

j. Screen Axis Rotation –Screen axis rotations can be performed as follows:

z-axis rotation – Move ball in Screen Rotation z display to rotate geometry about z Screen axis. While placing mouse cursor over ball, press any of the three mouse buttons and drag to conduct rotation. Ninety degree rotation can be performed by pushing [90] button at lower left corner of Screen Rotation z display.

y-axis rotation – Move y slider to rotate about y Screen axis. Ninety degree rotation about y-axis can be performed by pushing [90] button to the right of the y Screen slider.

x-axis rotation – Move x slider to rotate about x Screen axis. Ninety degree rotation about x-axis can be performed by pushing [90] button above the x Screen slider.

k. Screen Zoom - Moving the Zoom slider up or down will cause the geometry to zoom out and in relative to the Screen axis system.

l. Screen Translation - Moving the Translation positioner will cause the geometry to by translated in the corresponding direction.

Example: Manipulating the geometry using Viewing Control panel.

Press [Reset] to reset the geometry.

Move World Rotation x-slider up/down to rotate geometry about the world x-axis.
Move World Rotation y-slider up/down to rotate geometry about the world y-axis.
Move World Rotation z-slider up/down to rotate geometry about the world z-axis.

Move Screen Rotation x-slider up/down to rotate geometry about the screen x-axis.
Move Screen Rotation y-slider up/down to rotate geometry about the screen y-axis.
Move Screen Rotation z-ball around to rotate geometry about the screen z-axis.

Press [Reset] to reset the geometry.

Zoom geometry in/out of the viewing screen with the Zoom slider.
Translate geometry within the Display Window with the Translation positioner.

Press [Reset] to reset the geometry.

Press [x-z] button to view geometry in x-z plane.
Press [z-y] button to view geometry in z-y plane.

IV. SURFACE ATTRIBUTES

The *Surface Attributes* panel is used to set surface properties, such as the color, direction, and number of display paths.

- Press [SURFACES] button from the GridTool *Main* panel to activate the *Surface Attributes* panel.

This panel controls the attributes of the geometric entities that are read into the program via the *Input/Output* panel. Entities may be designated as either surfaces or curves.

- On/Off Browser

a. Using the mouse, click and drag on the entity descriptors displayed in the On/Off browser. It will be helpful to zoom/rotate the geometry to get a look at the surface definition. A typical entry in this window might appear as:

(A) O 1 (21 x 15) (S) Family Name

(A)	- contains a () for non-active entities or displays (A) for the active entity.
O	- means the entity is not currently displayed (Display Type is Off).
1	- indicates the entity's sequence in the file.
(21 x 15)	- is the entity size in units of 'display paths'
(S)	- indicates that the entity is a surface (S) and (C) is a curve.
Family Name	- is a user-specified group name for related entities (families).

The highlighted entities will be displayed in the DISPLAY WINDOW. Initially, entity #1 is highlighted in RED in the On/Off browser on the *Surfaces* panel to show that it is the "active" entity. The active surface is always drawn in magenta in the DISPLAY WINDOW.

b. To make a different surface entity active, the hot key [s] may be used. Place the mouse over the intended surface and press hot key [s] from the keyboard.

Hot Key [s] - makes a surface active.
Hot Key [shift] [s] - places the center of rotation to the active surface.

Example: Activating a surface.

1. First, highlight the fuselage entity descriptor in the On/Off browser. Place the mouse over the fuselage surface in the Display Window and press hot key [s] from the keyboard. The color of the fuselage should change to magenta, indicating that this surface is now the active surface.

2. Next, highlight the tail descriptor in the On/Off browser. Place the mouse over the tail surface in the Display Window and press hot key [s] from the keyboard. The color of the tail now changes to magenta and the fuselage returns to its original color.

   Note: When you make an entity active in the DISPLAY WINDOW, you will see the entity descriptor text in the On/Off browser turn from white to red and the letter (A) will appear to indicate it is the currently active entity.

3. Click on the surfaces in the On/Off browser with the leftmost mouse button to display or turn off the surfaces in the DISPLAY WINDOW.

- Changing the Display Type

  a. First, choose the SELECTION TYPE by placing the mouse in the [Selection Type] Field and pressing the right mouse button to view the choices. Select the appropriate choice.

  b. Then select the DISPLAY TYPE by placing the mouse in the [Display Type] Field and pressing the right mouse button to view the choices. Select the desired type.

  c. The appropriate changes will take place in the DISPLAY WINDOW.

> Example: Changing the display type.
>
> [Selection Type] : All
> [Display Type] : Shaded
>
> You will see all the surfaces displayed in the shaded mode. To now change the nose display to wireframe, while leaving the other surfaces displayed as shaded, first change:
>
> [Selection Type] : Single
> [Display Type] : Wireframe
>
> Now click (twice) the nose entity in the On/Off browser.

- Changing the Family of an entity

  Grouping related entities can ease data manipulation in GridTool. For example, it is advantageous to group entities into 'families' such as those associated with the nose, wing, tail, and fuselage. This is accomplished by changing entity family descriptions, which appear in the On/Off browser.

  a. Setup geometry so that all entities are displayed in Wireframe Mode:

     [Selection Type] : Single
     [Display Type] : Wireframe

  b. Turn-off all but Surface #1 by clicking with the mouse button on Surfaces #2-5.

This leaves the nose surface on. Note (IMPORTANT): A surface being displayed does NOT imply that it is the active surface. In fact, the active surface may not even be displayed at any given time.

To change an entity's family name:

a. Highlight the current family name in [Family] field (Default: Addams) or press [Esc] button to clear the input field.
b. Type a new name in the [Family] field.
c. Press the [Change Family] button to activate the change.

Example: Changing the family.

1. Type "nose" in the [Family] field.
2. Press [Change Family] button.

You will see surface number #1 family change to nose in the On/Off browser.

Repeat this procedure to change all the five surface families to :

Entity #2 fuselage
Entity #3 tail
Entity #4 lwing
Entity #5 uwing

- Change Display Path of an Entity

Display paths are used for rendering the surfaces. The default display paths are based on the knot vectors defining the NURBS surfaces. The number of display paths drawn on a surface can be modified to provide a coarser or finer detailed rendering of the surface. The current display path counts are displayed in parenthesis in the On/Off browser.

a. To Change the Display Path:

- Display the surface(s) that will be changed.
- Enter values in the [Number of Display Path] Field.
- Press [Change DP] button.

Values of the Display Path:

Entering positive values in the [Number of Display Path] Field, [M N], changes the display paths to M x N.
Entering negative values in the [Number of Display Path] Field, [-M -N], multiplies the default U display path count by M and the default V display path count by N. Therefore [-1 –1] gives the default display paths. When entering negative values, the total number of display paths for a surface may be calculated by:

Number of 'U' display paths: M(U-1)+1
Number of 'V' display paths: N(V-1)+1

Example: Changing the display paths.

A particular entity will appear in the On/Off browser as:

() W 1 (19 x 37) (S) nose

where U = 19 and V = 37

Setting [Number of Display Path] to :

[-1 -1] gives [19 37] - default

[-2 -1] gives [37 37]

[-2 -2] gives [37 73]

[-3 -3] gives [55 109]

[5 5] gives [5 5]

Press the [Change DP] button after each new set of values entered.

- Change Direction of a Surface

To change the directions of a surface:

a. Press the [Arrows] button.
b. Turn on all appropriate surfaces.
c. Press [Switch Dir] button.
d. Press [Arrows] again to turn off arrows.

Rotating the surface will show whether the normal to the surface points inward or outward as indicated by the arrow.

- Change the Background Color
    a. Press Background button.
    b. Background color can be changed by using the three sliders for colors or by inputting the RGB color number in the input-fields.

- Changing Surface Color (Background Button toggled off)
    a. Turn on appropriate surface.
    b. Surface color can be changed also by using the three sliders for colors or by inputting the RGB color number in the input-fields.

V. POINTS/CURVES PANEL

a. Locate the [Pts/Curves] button on the GridTool *Main* panel. Press it to bring down the *Points/Curves* panel. The points and curves menu is used to construct the curves that will eventually become the edges of patches. This panel can be used to create, modify, and delete points and curves. A curve is represented by a link-list of points. These points can be placed on a surface (surface points) or somewhere in space (XYZ points). For surface points, the parametric coordinates, u and v are stored in the data base, in addition to the x, y, and z coordinates.

b. Use the *Surfaces* panel to display the nose surface in the DISPLAY WINDOW and make the nose surface active. Shut-off all other surfaces.

c. Go to *Point/Curves* panel. Press [Next Curve] button and then press [Next Point] button. This sequence starts the construction of a curve where this newly created point is the active point. This new point is placed where the last point was on the active surface, and the user can then move this new (active) point to any location. Move cursor over any intersection of display paths on the active surface and press hot key [t] to move the active point to this new location.

    Hot Key [t] – move the <u>active</u> point (red point) to any intersection of the display paths on the <u>active</u> surface (magenta surface).
    Hot Key [m] - moves the <u>active</u> point (red point) to an <u>existing</u> point on a curve (this curve does not have to be on the <u>active</u> surface).

Note:
Hot Key [p] – makes an existing point on an existing curve active (red point). This hot key does not move the previously active point to this existing point location.

d. Next, press [Next Point], where again the new (active) point is placed where the last point was on the active surface. The user can then move this new (active) point to any location by moving the cursor to another intersection point on the active surface and press hot key [t]. Now you see a curve defined by two points. The active curve is colored in red and the points on the curve are displayed in green except for the active (red) point. All green points signify that all the points on the curve lie on the same surface.

e. Press the [Enrich] button with the default -1 to place evenly distributed points along the curve. Typing a specified amount of points in the [Enrich] field will place that many points between two existing points on that curve.

Example: Creating a curve.

Make a curve with 10 points and then 28 points.

1. Start by pressing [Next Curve] and then [Next Point]. Place the cursor on any display path intersection of the active surface and press hot key [t]. Then press [Next Point] and place the cursor over the second desired point and press hot key [t]. You will have a curve highlighted in red with one green and one red (the active point) endpoint.

2. Enter the number 8 in the [Enrich] input field. Press the [Enrich] button. You will see eight points appear between the two endpoint to make a total of 10 points on the curve.

3. Then type in the number 2 in the input field and press [Enrich] button. Two points will appear between every set of two points between the original curve, for a total of 28 points.

In addition to using the hot keys [t] and [m], the active point can be moved to any location on the active surface by:

1. Typing in the parametric coordinates in the "U & V" input box;
2. Moving the "U & V" positioner;

3. Moving the “U & V” sliders.

To move the active point to space:

1. Convert point to a “XYZ” point by pressing [On Surface] button.
2. Once the active point is an XYZ point, the “x, y, and z” sliders can be used to move the point to anywhere in space.

A summary of the attributes of the curve is displayed in the Points/Curves menu. It gives the attributes of the active curve, such as:

- Total Number of Curves.
- The number of points of the active curve.
- The length of the curve.
- The family of the current curve.

Remaining Features:

To Split a curve:

a. Activate a curve by moving the cursor over the curve and pressing hot key [c].

Hot Key [c] -makes a curve active.

b. Press hot key [p] on one of the points on the active curve. This is the point at which the curve will be split.

Hot Key [p] -make a point active.

c. Hit [Split Curve]. One curve turns green while the other remains active and is thus shaded red.

d. Press hot key [c] on each curve to activate.

To combine two existing curves:

a. Make one of the curves active.
b. Press [Combine #] button.
c. Make the other curve active.
d. Press the [Combine Curves] button.

To copy a Curve:

a. Activate the curve.

b. Press [Copy Curve] button.

To project a Curve:

a. Display the projection surface.
b. Activate the curve.
c. Press the [Project Curve] button.

To smooth a curve:

a. Activate the curve.
b. Press the [Smooth Curve] button.

Notice that all the points turn blue. The points are not on the surface anymore. Project points to the appropriate surface by projecting the curve.

To delete a curve:

a. Activate the curve.
b. Press [Delete Curve] button.

To delete a point:

a. Activate the point on the curve.
b. Press [Delete Point] button.

To insert a point:

a. Activate the intended curve.
b. Activate the point to insert the new point ahead of.
c. Press [Insert Point] button.

To project a point:

a. Display projection surface.
b. Activate the point.
c. Press [Project Point] button.

To auto-edge a surface:

a. Activate the surface.
b. Press [Auto Edge] button.

This will automatically generate curves about the surface boundary.

To Collapse 2 or more points:
(This option collapses endpoints of curves to a desired point)

a. Activate the point to which the others will be collapsed.
b. Place a tolerance in the [Gap Size] Input field.
c. Press [Collapse Points] button.

A message will appear to tell you how many endpoints lie within the tolerance (not including the active point). Press yes or no to proceed with the collapse. (Hint: You should know before hand the number of endpoints that should collapse. If it gives you a number that you are not expecting, answer 'no' and inspect the curves and points.)

Delete Unused:

Any curve that is not part of an existing patch will be deleted by pressing this button.

Example: Constructing curves on a surface.

Placing curves on the nose. Keep in mind that these curves will become the patch edges.

1. Press the [Delete Unused] button to remove all curves that are not part of an existing patch.
2. Activate the nose surface.
3. Press [Auto Edge] button to place curves around the boundaries.
4. Notice that three curves have been added to the nose region. Press hot key [c] on each of the curves to activate. The curves should be similar to the ones depicted in Figure 1.
5. Split the longest curve, Curve 2 in Figure 1, along the streamwise coordinate to make 4 curve. See Figure 2.
6. Starting from the point you split the longest curve, make a new curve:

- Press [Next Curve] button, [Next Point] button, followed by placing the cursor over the desired point location and pressing hot key [t].
- Press [Next Point] followed by using the U&V slider bars in the lower right corner of the *Points/Curves* panel to move the new active point (the second point) at the singularity. This can be conducted by using the U bar in the left direction to move the active point at the singularity. The slider bar moves the active point along the display path.
- Press [Enrich] with –1 option. At this time, you should have 5 curves on the nose surface. See Figure 2.

Practice by putting curves on remaining surfaces, keeping in mind that the curves will serve as edges of the patches.

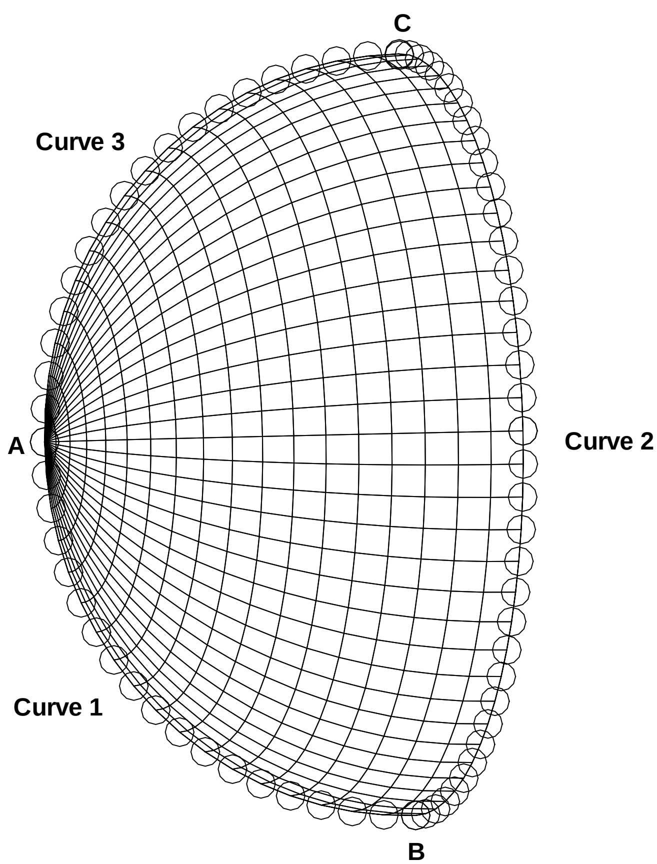


Figure 1. Nose surface with bounding curves.

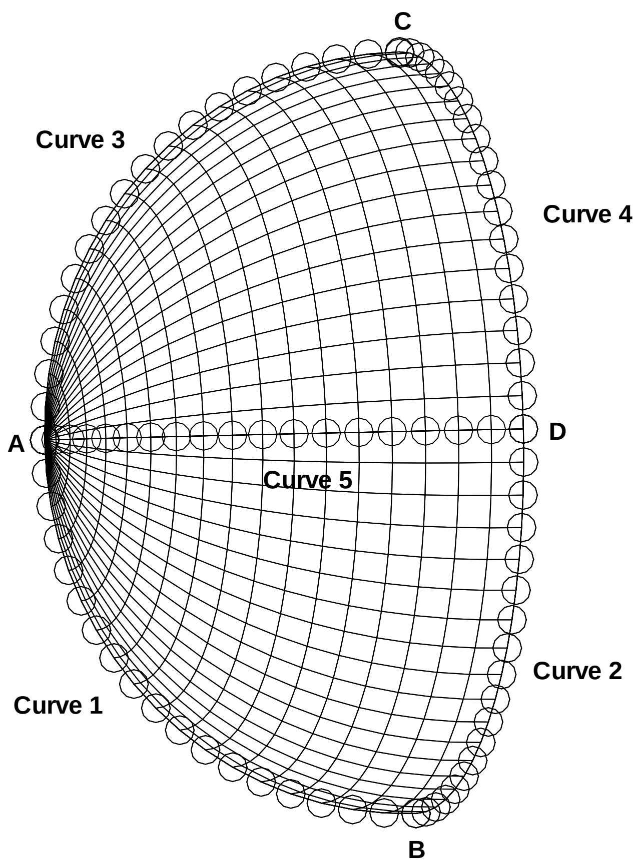


Figure 2. Nose surface with five curves.

VI. PATCHES PANEL

- Press [Patches] button from the GridTool *Main* panel.

- Hint: Put a 0.0 tolerance in the [Shrink] field on the *Misc* subpanel to have a patch edge coincide with the curve. Otherwise, there will be a noticeable gap between the patch edges and the underlying curves. The gap is used for display purposes only and does not suggest that there is an actual gap between the patch edge and the curves.

- To define a Patch:

  a. Activate the curve intended as the first edge of the patch.
  b. Press [Next Patch] button, then Press [Accept Edge].

  GridTool will suggest a curve to define the next patch edge. If this is the desired curve, press [Accept Edge] button. If not, press [Find Edge] button until the appropriate curve is activated. Continue accepting edges until the patch is closed. The pink arrow(which indicates the direction normal to the patch) will change from dotted to solid. Make sure that the normal is pointing in the right direction. Press [Reverse Patch] if the patch is improperly oriented.

Example: Building two patches.

Using the Curves built for the nose, build 2 patches:

1. Activate one of the curves on the nose.
2. Put a 0.0 [Shrink] value in the *Misc* Table.
2. Press [Next Patch] [Next Edge] [Accept Edge]
3. Either [Accept Edge] or [Find Edge].
4. Make a three-sided patch.
5. Reverse patch if normal is pointed inward of the nose.
6. See Figure 3.

Figure 4 gives an example of “ideal” patch definition for the Class model. Figures 5 and 6 give different views of the patched surface definition.

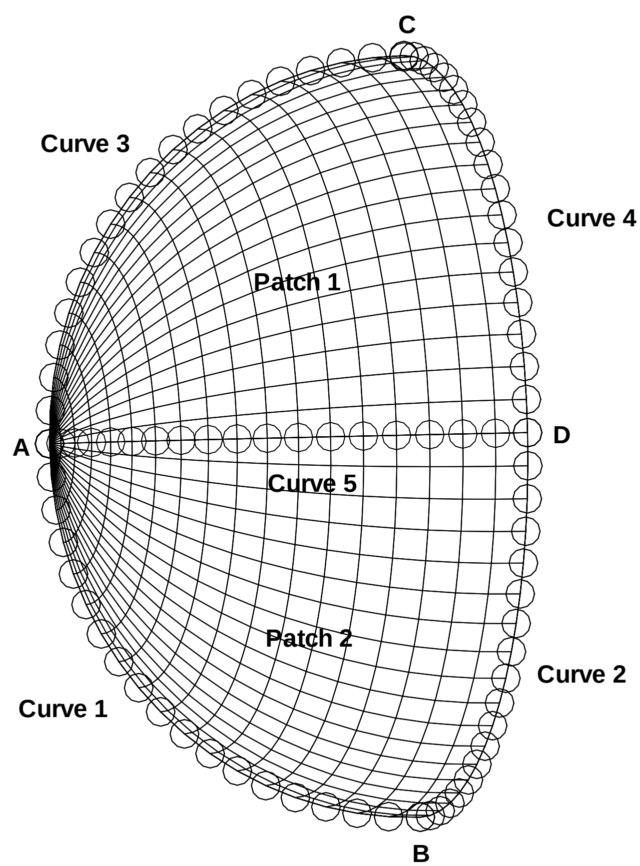
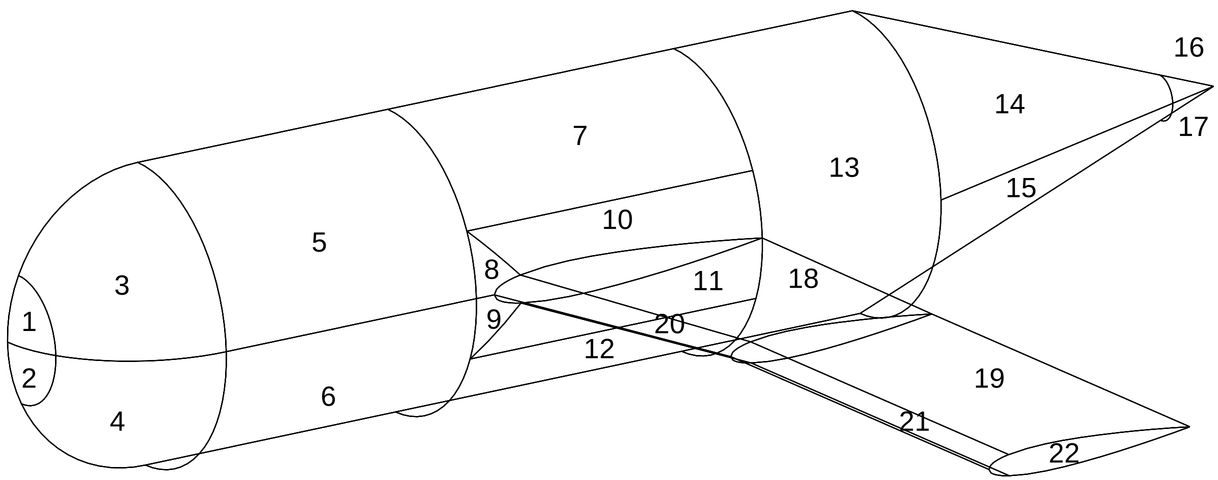


Figure 3. Curves making up patches 1 and 2 on the nose surface.



Patches 18-21 cover only the top portion of the wing. Similar patches are assumed on the lower portion of the wing.

Figure 4. Basic patch definition of the Class model.

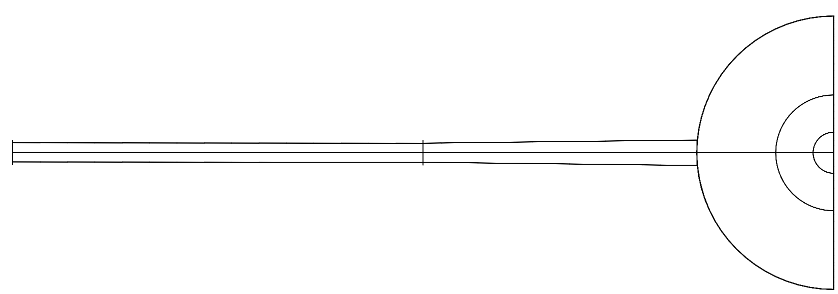


Figure 5. Nose view of the Class model.

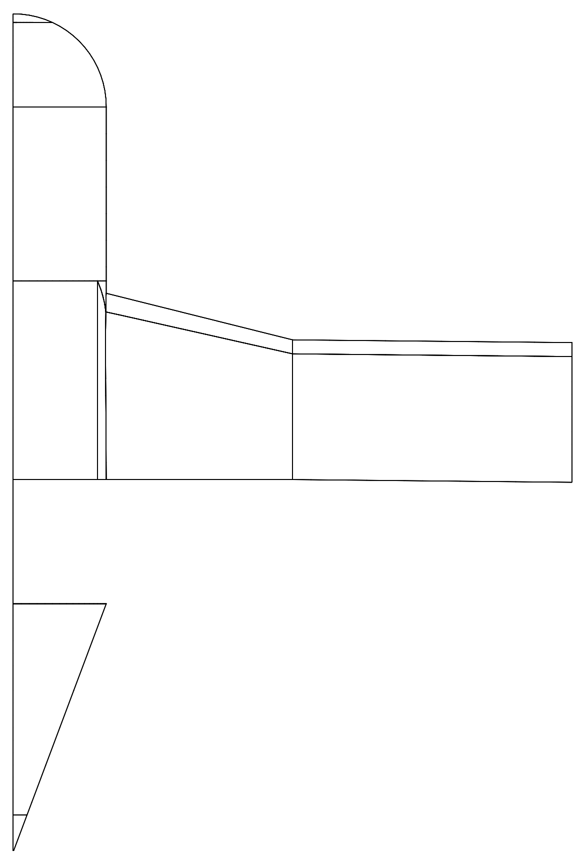


Figure 6. Planform view of the Class model.