PolyCAD Help Contents

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What is PolyCAD?

PolyCAD is a 3-D visualisation tool, allowing the user to create, modify and view 3-D structures. Sophisticated shading and lighting features are available, which enable you to produce highly realistic views of the models and shapes you create.

For the creation of objects the following features are available:

- Rubberband drawing of polygons with up to six sides.

- Automatic determination of polygon ordering. Vertices can be placed in clockwise or anti-clockwise order.

- Automatic triangulation of *concave* and *non-planar* polygons.

- Automatic *back face* generation.

- Automatic rejection of self-intersecting or pathological polygons.

- Two *snap-to* grid resolutions for ease of model construction.

- Keyboard commands to change the viewpoint while the cursor retains its (x,y,z) position.

- Projected views updated as you draw; showing the exact (x,y,z) position of the cursor.

- Easily accessible colour and shade palette for polygon fill.

Once built an object can be changed using the following editing features:

- Accurate polygon selection.

- Delete polygons.

- Add back faces.

- Change from front face to back face and vice versa.

- Change polygon fill colour.

PolyCAD's viewing features include:

- Three hidden surface routines including *Binary Space Partition* (BSP) which can handle intersecting polygons and cyclic overlap.

- Interactive rotation of object with mouse or keyboard.

- Black or white background option.

- *Lambert, Gouraud* and *Phong* shading techniques.

- Interactive setting of object size.

- Interactive setting of spotlight position and ambient lighting level.

In addition to the above the registered version of PolyCAD includes:

- A *Palette Panel* to interactively change the colours and shades used in the design and viewing of your object.

- The ability to create and save objects of up to 1256 polygons or vertices. ***Note:*** *In the unregistered version of PolyCAD you can save objects only if they have fewer than 256 polygons or vertices, although you can read and create larger objects.*

Using PolyCAD

PolyCAD is quick to learn, straightforward to use and, with a little experience, complex models can be produced in a short time. This section will teach you how to use PolyCAD effectively by explaining the steps, commands and shortcuts involved in producing simple 3-D objects.

As a first step, you should become accustomed to selecting the <u>design views</u> that are displayed on the drawing area. Selecting the appropriate view while designing is crucial to correctly placing <u>vertices</u> in 3-D space.

Before creating a <u>polygon</u>, there are a number of options which you should select. It is often easier to place vertices correctly by switching on the <u>grid</u>. The <u>views</u> option will help with spatial orientation, showing the position of the cursor in all three dimensions. You should also select the <u>colour and shade</u> of the polygon and decide whether it requires a <u>back face</u>. Finally if you wish to see the polygons colour filled as you construct them, switch on the <u>polygons</u> option.

All objects that you produce will be made from polygons with 3 to 6 sides and <u>vertices</u>. Do not attempt to create a polygon with more than 6 of each as this will be rejected. One further point to note: for the system to resolve the front face / back face issue, you should complete the polygon in a <u>design view</u> which displays the front face.

<u>Constructing a pyramid</u>

We now have a 3-D object which can be rotated, scaled and viewed under various light and shading conditions.

<u>Rotating and viewing your object</u>

After viewing your object we may now decide to remove some polygons, change colours or add back faces.

<u>Editing and changing attributes</u>

You have now learnt most of the fundamentals of PolyCAD. Now go and be creative!

Reference Information

Menu Commands

File

Mode

Options

Design

Edit

View

Keyboard Commands

Design	**(D)**
Edit	**(E)**
View	**(V)**
Design Views	**(F1 - F6)**
Delete Polygon	**(Del)**
Cancel drawing or edit	**(Esc)**

Toolbar Functions

Status Information

x = -100   y = 600   z = 0   Front   Scale 0.8   BSP Sort

Polygons = 0/1256   Vertices = 0/1256

65
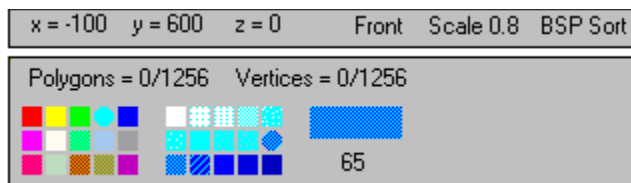
Object File Format

For the convenience of users the PolyCAD files describing objects are in a readable ASCII format. We do not encourage you to edit these files by hand since doing so can lead to unexpected results. You can, however, use the information below to read PolyCAD objects into your programs or change other object descriptions into a form usable by PolyCAD.

In the current version of PolyCAD only one object per file is allowed.

An object description begins with the text **Start**, followed by lines describing vertices, polygons and colour table entries. The description ends with the text **End**.

The vertex description begins with the text **v**, followed by an integer label and integer x, y and z co-ordinates.

v *int_vlabel int25_x int25_y int25_z* [**vn** *int_xn int_yn int_zn*]

Here *int25* denotes an integer which has a value $-1024 < int25 < 1024$ and is an integer multiple of 25. This is required if PolyCAD will be used to edit the object. Object descriptions derived from other formats may require scaling. Vertices can appear in any order.

The vertex normal vector information begins with the text **vn** followed by the x, y and z components of the normal vector. The vector has a length of 1024 so that

$$(int\_xn^2 + int\_yn^2 + int\_zn^2)^{1/2} = 1024,$$
where ^ denotes raised to the power.

Note that the square brackets [ ] enclose information which is optional. Do not put these brackets in the object file. If you do not provide vertex normal data then PolyCAD will compute the normals when the object is loaded. If you are using PolyCAD to read in object descriptions derived from other formats you should usually not include optional data.

The polygon data begins with the text **p** followed by an integer label, the integer fill colour index, the number of vertices in the polygon and an appropriate number of vertex labels which indicate the vertices from which the polygon is constructed. The order of the vertex labels is very important, as described below.

p *int_plabel* *int_cindex* *int_nvert* *int_vlabel1* *int_vlabel2 ... [pn int_xn int_yn int_zn int_back]*

Here $11 =< int\_cindex =< 235$ with the actual colour determined by the colour table entries (see below) and $3 =< int\_nvert =< 6$ for the current version of PolyCAD. There must follow *int_nvert* vertex labels (of the type *int_vlabel*, see above) which must be distinct. If you are using PolyCAD to view objects derived from other formats it is essential (and your responsibility) that the vertex labels are ordered correctly. PolyCAD uses a **left-handed** co-ordinate system; increasing X to the right, increasing Y up the screen and increasing Z into the screen. Within this co-ordinate system polygon vertex labels should be ordered **clockwise** when viewed on the screen. If objects derived from other formats appear to display incorrectly in PolyCAD view mode you should try reversing the order of the vertex labels. In addition the defined polygons must be **convex** and **planar**. The polygons can appear in any order.

The polygon normal data is optional and begins with the text **pn** followed by the x, y and z components of the polygon normal vector. Like the vertex normal this has a length of 1024 (see above). The last quantity, *int_back*, is used to indicate if the polygon has a corresponding back face defined and takes the values: 0 = no back face; -1 = back face present. Once again if PolyCAD is used to read in object descriptions

derived from other formats you should not normally include the optional data.

All the colour table information is optional. If colour entries are absent then PolyCAD will create a default palette. The palette can then be tailored to suit your needs using the Palette Panel available in the registered version of PolyCAD. Changing or creating colour table entries by hand can cause unexpected results and is not recommended.

The colour table entries begin with the text **c** followed by the start of the colour index range, an even integer value of the Hue, a floating point value of Saturation followed by floating point values for the upper and lower levels of Lightness. **Note:** The current version of PolyCAD has 15 shades per base colour.

  *[**c** int_locindex, int2_hue, float_sat, float_lumhi, float_lumlo]*

The value of *int_locindex* must be 11+15*J where 0 =< J =< 14. In addition 0 <= *int2_hue* =< 360 and must be even. All floating point numbers range from 0 to 1.0.

If you wish to import PolyCAD objects into your programs and use polygon fill colours defined in the file format you may need to convert the (HLS) colour table to the one used by your programs.

Registration and Licensing

Registration
If you find PolyCAD useful or interesting then why not register your software for a small fee of £15 (UK Pounds Sterling). This will provide you with a unique Personal Identification Number (PIN) enabling the extended functionality of PolyCAD. Your PIN will be valid for future updates of PolyCAD available for downloading. We can accept UK Cheques or International Money Orders.

Please send your name, address and, if you have one, your e-mail address along with cheque or money order made payable to:

N.J. Dubal

at 59 Hepleswell
Two Mile Ash
Milton Keynes
MK8   8LU
United Kingdom.

e-mail: **mrd@maths.soton.ac.uk**

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Changes, Bugs and FAQ

Changes:
1. First version of PolyCAD 1.0 released on the 15th December 1995.

2. PolyCAD v1.0 is the most recent version (15/12/95).

Known bugs currently under investigation:
1. Certain combinations of polygons produce an error when calculating the vertex normals. (See the FAQ below).

2. After an object has been heavily edited the BSP tree may not be constructed correctly when using the BSP hidden option. (See the FAQ below).

Frequently Asked Questions:

1. What are convex and concave polygons?

2. Why, when drawing a polygon, on clicking a new vertex the polygon disappears?

3. How can I draw polygons which don't lie in the X-Y, X-Z or Y-Z planes?

4. In design mode while drawing a polygon I placed a vertex in the wrong position, what can I do?

5. In editing mode why can't I pick a particular vertex?

6. I completed the polygon in a design view where the polygon is seen edge-on, does this matter?

7. I constructed a non-planar polygon but the triangulation is not what I expected. What can I do?

8. I placed one polygon directly on top of another, but with polygon fill on it disappears. Why is this?

9. Which hidden surface method is best for my object?

10. When I entered view mode the message **Vertex Normal Magnitude Error** occurred. What does this mean?

11. In view mode the BSP hidden surface method produces strange results. What should I do to fix this?

12. I have registered PolyCAD, but when I type in my registration details I get **Invalid serial number for registration I.D.** Why is this?

Please send additional FAQs and bug reports to:

mrd@maths.soton.ac.uk

or to the address shown in <u>Registration and Licensing.</u>

Menu Commands : File

New Object

Open Object

Save Object

Save Object As

Exit

Menu Commands : Mode

Design   **(D)**

Edit   **(E)**

View   **(V)**

Menu Commands : Options

Views

Grid

Fine Grid

Polygons

Palette

Normals

Menu Commands : Design

Front View   **(F1)**

Back View   **(F4)**

Top View   **(F2)**

Bottom View   **(F5)**

Left View   **(F3)**

Right View   **(F6)**

Back Face

Menu Commands : Edit

Pick Vertex

Delete Polygon   **(Del)**

Change Colour   **(Esc)**

Add Back Face

Reverse Face

Menu Commands : View

Lines

Hidden
    None
    Depth Sort
    BSP

Perspective

Stepping

Background

Shading
    None
    Lambert
    Gouraud
    Phong

Rotation
    Plus X   **(F1)**
    Minus X   **(F2)**
    Plus Y   **(F3)**
    Minus Y   **(F4)**
    Plus Z   **(F5)**
    Minus Z   **(F6)**

View Panel

File : New Object

This file command allows you to create a new object. Any objects currently in memory will be cleared, however, if an object has been modified you will be asked if you wish to <u>save</u> the object before clearing. <u>Design mode</u> is automatically selected.

See Also

   <u>Open Object</u>, <u>Save Object</u> & <u>Exit</u>

File : Open Object

This file option allows you load an existing object into memory ready for editing or viewing. The system will display any .POL files located in the default directory. When a valid file has been chosen the object will be loaded. If, however, an object has been modified prior to choosing this option you will be asked if you wish to <u>save</u> the object before loading.

You may specify the full path name of the file or alternately, select the appropriate directory and key the file name.

See Also
   <u>New Object</u>, <u>Save Object</u> & <u>Exit</u>

File : Save Object

The file **Save** option will write the object currently in memory to disk. The system will use the existing file name or request you to enter one if the object is untitled. If a file with the same name already exists the system will rename that file with the extension .PO~, providing you with a backup should it be required.
Note: *Only one backup per file name.*

The **Save Object As** option allows you to change the current file name of the object before saving. After loading and modifying an object you can use this option to save the new object with a different file name.

Note: *Only users of the registered version will be able to save objects with over 256 polygons or vertices.*

See Also
   New Object, Open Object & Exit

File : Exit

Use this option to exit <u>PolyCAD.</u> If there is an object in memory which has not been saved the system will offer you the option to do so.

See Also
    <u>New Object</u>, <u>Open Object</u> & <u>Save Object</u>

Mode : Design

When you select this mode, you may create a new object or add to an existing one. This is the default mode for PolyCAD.

See Also

    Design Views, Views & Back Face

Mode : Edit

When this mode has been chosen you may edit the object currently in memory. You can select polygons and change their attributes or delete them.

See Also
    Pick Vertex, Delete Polygon, Change Colour, Add Back Face & Reverse Face

Mode : View

View mode allows you to visualise your object in 3-D. You can rotate, scale and translate your object as well as controlling ambient lighting, direction and shading. Rotation of the object can be achieved either by the keyboard or mouse. The keyboard controls are F1,F2 for X-axis rotation, F3,F4 for Y-axis and F5,F6 for Z-axis rotation. Mouse operation will involve a little trial and error to achieve the desired motion, however once mastered it provides the most flexible method of rotation.

See Also
    Lines, Hidden, Perspective, Stepping, Background, Shading, Rotation & View Panel

Options : Views

Selecting the Views option produces three additional windows showing the X, Y, & Z axis views of the object in the main window. These three windows provide a useful guide to the position of the design/edit cursor. Selecting the option a second time will close the windows. This option may be toggled.

***See Also***

    Grid, Polygons, Palette & Normals.

Options : Grid

Using the **Grid** option while in <u>design mode</u> helps you to align <u>vertices</u>. Whether the grid is visible or not all vertices will snap to the nearest grid point. For smaller objects or more detailed sections you may wish to select the **Fine Grid** option, which permits a finer resolution. This option may be <u>toggled</u>.

See Also

<u>Views</u>, <u>Polygons</u>, <u>Palette</u> & <u>Normals</u>.

Colour and Shade

The base colour and shade are selected by clicking on the appropriate squares below the design area.
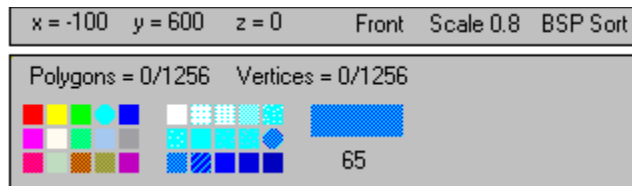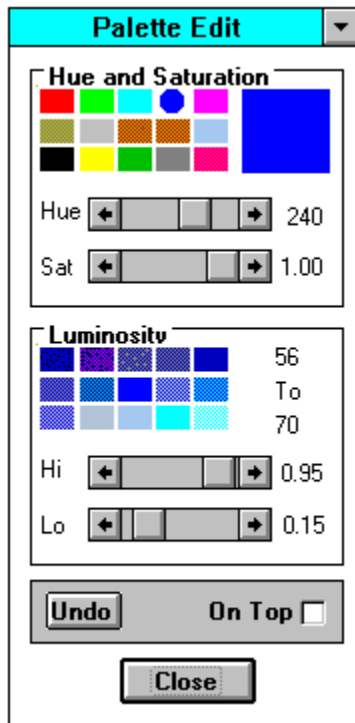
Options : Polygons

When constructing an object you would normally be in <u>wireframe</u> mode, however to give a more realistic rendering of your object you may select this option. Your object will be displayed as a series of solid coloured polygons. This option may be <u>toggled</u>.

See Also

<u>Views</u>, <u>Grid</u>, <u>Palette</u> & <u>Normals</u>.

Options : Palette

This option is available only with the registered version of PolyCAD. Using the **Palette Control Panel**, you can set the 15 base colours and the degree of shading for each one interactively. A Hue - Lightness - Saturation (HLS) colour model is used.

See Also

Views, Grid, Polygons & Normals.

Options : Normals

Selecting this option causes PolyCAD. to compute the normal vectors at each vertex of the object. These normals are necessary for the Gouraud and Phong shading methods. Normally this calculation is done automatically when view mode is entered if the object has changed. If the normals are up-to-date a check mark is placed against this option.

See Also

Views, Grid, Polygons & Palette.

Design : Design Views

When in design mode you may select from six possible view points. These are Front (F1), Back (F4), Top (F2), Bottom (F5), Left (F3) and Right (F6). Typically when constructing a 3-D object you will use all the views available. The default is Front View.

See Also
  Back Face

Design : Back Face

Sometimes when designing an object you may require a polygon which can be seen from opposite view points. In other words you require a **back face**. If this is the case you should select this option before constructing the <u>polygon</u>. This option may be <u>toggled</u>.

See Also
   <u>Design Views</u>

Edit : Pick Vertex

When editing objects you need to define the polygon you wish to edit. To do this you must select the polygon uniquely by clicking on one or more <u>vertices</u>. When the polygon has been selected, it will be outlined in black. You may now delete, change the colour, add a back face if one is not already present or reverse the polygon. Note: If the polygon you have selected has a <u>back face</u>, a message reminding you of this will be displayed.

If you wish to deselect the polygon or any vertices already chosen, click on the pick vertex option. The same effect can be achieved by double clicking on the edit window.

See Also
   <u>Delete Polygon</u>, <u>Change Colour</u>, <u>Add Back Face</u> & <u>Reverse Face</u>

Edit : Delete Polygon

Selected polygons may be deleted using this option or by simply pressing the **Del** key. If the polygon you wish to delete has a back face you will be asked if this should also be deleted.

See Also

   Pick Vertex, Change Colour, Add Back Face & Reverse Face

Edit : Change Colour

When in Edit mode, you may change the colour of the selected polygon. Choose the required <u>colour</u> from the <u>status panel</u> and then click on this option. The polygon will now contain the new colour. If you are satisfied with the colour double click on the edit window to confirm your choice of colour.

If, instead, you press the **Esc** key then the polygon will be deselected and reset to its original colour

See Also

<u>Pick Vertex</u>, <u>Delete Polygon</u>, <u>Add Back Face</u> & <u>Reverse Face</u>

Edit : Add Back Face

On occasion you may find you need to add a underline back face. Select the appropriate polygon and choose this option. The back face will be generated with the same colour as the selected polygon.

See Also

Pick Vertex, Delete Polygon, Change Colour & Reverse Face

Edit : Reverse Face

From time to time you may define a polygon which faces in the wrong direction. Instead of deleting and redefining the polygon correctly, you may use this option to reverse the face. Select the polygon and click on this option, the polygon will now face in the opposite direction.

See Also
  Pick Vertex, Delete Polygon, Change Colour & Add Back Face

View : Lines

When in view mode you may wish to remove the lines which are normally visible in other modes. Using this option provides a more realistic representation of your object. This option may be underlined toggled.

See Also
  Hidden, Perspective, Stepping, Background, Shading, Rotation & View Panel

View : Hidden

In view mode PolyCAD renders an object polygon by polygon. Three methods of processing are provided:

None: The polygons which make up the object are rendered in a simple Z-ordering from back to front. This may be fine from some view points, but as the object is rotated errors may appear. Note: This simple method is adequate for **convex** objects

Depth Sort: Sorting the polygons within an object by order of depth with plane comparisons and then displaying them, resolves many of the problems found in the first method. Most simple objects, (and even some complex ones), are displayed correctly, yet there are still situations with which it cannot cope, e.g. cyclic overlap and penetrating polygons are two such cases.

BSP Sort: The BSP sort method of rendering polygons solves almost all of the problems found with the previous two. This includes cyclic overlap and penetrating polygons. This is achieved by splitting appropriate polygons into two or more segments and constructing a binary tree which determines the correct ordering of each polygon and/or segment.

Note: PolyCAD does not perform hidden line removal. If you wish to see all the construction lines of your object select Lines on and Polygons off with Hidden set to None.

See Also
 Lines, Perspective, Stepping, Background, Shading, Rotation & View Panel

View : Perspective

When **perspective** projection is chosen portions of the object which are further away appear smaller. This gives the viewer a depth cue and the object appears more natural. If perspective mode is not chosen **parallel** projection is performed instead. This method simply discards the **Z** co-ordinate when displaying on the 2-D screen.

See Also

 Lines, Hidden, Stepping, Background, Shading, Rotation & View Panel

View : Stepping

Selecting this option allows you to step through the display of your object. Each time you click the mouse button one polygon will be displayed. When completed **Done** will be displayed in the status panel. You should use this option when looking for errors in your object.

See Also
  <u>Lines</u>, <u>Hidden</u>, <u>Perspective</u>, <u>Background</u>, <u>Shading</u>, <u>Rotation</u> & <u>View Panel</u>

View : Background

This options provides a black background upon which to display your object. It gives better contrast for lighter coloured objects. This option may be <u>toggled</u> between a white and black background.

See Also
  <u>Lines</u>, <u>Hidden</u>, <u>Perspective</u>, <u>Stepping</u>, <u>Shading</u>, <u>Rotation</u> & <u>View Panel</u>

View : Shading

PolyCAD provides four methods of shading an object. These are **None**, **Lambert**, **Gouraud** & **Phong**.

None: The polygons which make up the object are rendered in their selected colour. No attempt is made to shade the object. As a result the object can look rather flat.

Lambert: This method of shading provides a very good visualisation of your object in 3-D. It is particularly good for blocky objects and has little effect on rendering speed.

Gouraud: Using Gouraud shading removes the blocky appearance associated with Lambert shading. Shading from one polygon to another is more subtle and therefore more realistic. Objects which required the appearance of curved surfaces are rendered more successfully using this method. Rendering speed is slightly reduced, but real-time rotation is still possible.

Phong: Objects which require the appearance of a shiny surface are best rendered using this method. Phong shading produces specular reflection which gives the impression of objects with highly polished surfaces. This method of shading is expensive in respect of rendering time, however real-time rotation is possible on smaller objects.

See Also
  Lines, Hidden, Perspective, Stepping, Background, Rotation & View Panel

View : Rotation

Rotation of objects occurs about the <u>origin</u> and move in one of six directions at any given time.
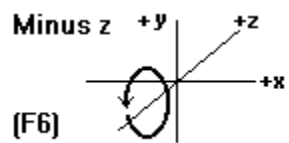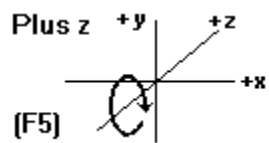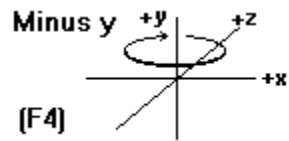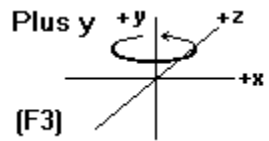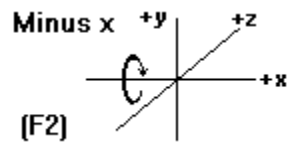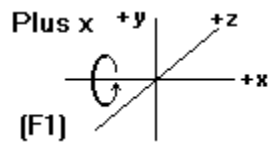

You may use the mouse to rotate objects while in view mode. Click and hold the left mouse button then move the mouse as appropriate. It requires some practice!

See Also
<u>Lines</u>, <u>Hidden</u>, <u>Perspective</u>, <u>Stepping</u>, <u>Background</u>, <u>Shading</u> & <u>View Panel</u>

View : View Panel

Using the **View Panel** you can interactively set the spotlight position and ambient lighting level and fall-off. You can also set the scale and position of the object and control the rotation angle per key press.
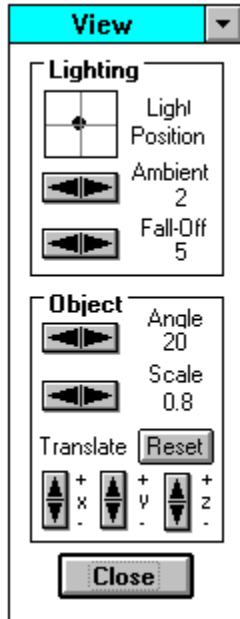
See Also

  Lines, Hidden, Perspective, Stepping, Background, Shading & Rotation

Keyboard: Esc

When in <u>Design mode</u>, pressing the **Esc** key abandons construction of the current polygon.

When in Edit mode, pressing the **Esc** key is equivalent to selecting the menu option <u>Pick Vertex</u>, or double clicking on the Edit window, except if polygon <u>Change Colour</u> has been chosen. In this case pressing **Esc** while the polygon is still selected will reset it to the original fill colour.

Vertices are points in 3-D space described by their X, Y & Z co-ordinates.

Wireframe objects are points joined together by a series of lines, giving the appearance of being constructed from wires.

Toggled options are those which, when switched on, are subsequently switched off and vice-versa.

Cyclic overlap describes the situation for a configuration of polygons which are in front of and behind each other at the same time.

Shareware software is a try before you buy method of evaluating software. If you find the software useful or interesting, you are encouraged to registered for a small fee.

A **Polygon** is a geometric closed shape made from 3 or more straight edges. It is usually filled with a solid colour or pattern.

Loads this **HELP** file!

The value displayed shows the current **X co-ordinate** of the design mode cursor. In view mode it displays the angular rotation of the object about the x-axis.

The value displayed shows the current **Y co-ordinate** of the design mode cursor. In view mode it displays the angular rotation of the object about the y-axis.

The value displayed shows the current **Z co-ordinate** of the design mode cursor. In view mode it displays the angular rotation of the object about the z-axis.

Indicates the current **view point** while in design or edit mode. If in view mode this will indicate the currently selected **shading** method.

Displays the number of **polygons** used and the maximum number available.

Displays the number of **vertices** used and the maximum number available.

This circle indicates the currently selected **base colour**.

This indicates the currently selected **shade**.

This number indicates the **colour index** for the selected colour and shade.

Hue sets the primary colour, **Lightness** sets the brightness and **Saturation** determines the purity of the colour.

Set this option to make the **Palette Control Panel** stay on top of other windows.

Removes the **Palette Control Panel**. Note: You cannot undo palette changes after closing.

Resets the original **HLS** values for the currently selected **base colour**.

Sets the low value of lightness ranging from 0 (dark) to 1 (bright). Note this can be larger or equal to the high lightness value.

Sets the high value of lightness ranging from 0 (dark) to 1 (bright). Note this can be smaller or equal to the low lightness value.

Colour indices for the lowest and highest lightness of the selected **base colour**.

This is the current range of shades for the selected **base colour**

Saturation ranges from 0 (monochrome) to 1 (pure colour).

Hue ranges from 0 (red) through 180 (cyan) to 360 (back to red).

This is the selected **base colour** that will be changed.

When in view mode this displays the currently selected **hidden surface** technique for the object.

The **origin** is the point where the x, y & z axis intersect. (i.e. co-ordinates 0,0,0)

When in view mode this will display the current **scale** of the object. In edit mode information regarding the status of picked vertices is displayed.

By dragging the black dot (i.e. holding down the mouse button and moving the cursor), you can determine the position of the **light source**. This can be viewed in real-time, so you see the changes as they occur. Note: you must have selected an appropriate shading option.

The ambient lighting levels range from 0 to 13. By adjusting this value you determine the strength of the light source. 0 - Darkest, 13- Brightest.

The illumination from a point source decreases as the distance from it and the object increases. The **fall-off** value gives you control over this effect. Values range from 1 to 7.

You can use this control to increase or decrease the **angle** of rotation. Low values produce smooth movement but at the cost of speed, whereas larger values provide faster rotation but slightly jerky movement. Values range from 2 to 90.

Use the **scale** control to increase or decrease the displayed size of the object being viewed. Values range from 0.1 to 2.0.

This control **resets** the object back to its original co-ordinates prior to any translation in the x,y or z planes.

Use this control to move or **translate** the object in the **x direction**. Positive or negative translations may be performed.

Use this control to move or **translate** the object in the **y direction**. Positive or negative translations may be performed.

Use this control to move or **translate** the object in the **z direction**. Positive or negative translations may be performed.

This button **closes** the **view panel**.

Constructing a simple pyramid

When creating a <u>new object</u> or adding to an existing one, you should ensure <u>design mode</u> has been selected. A simple shape such as a pyramid can be constructed by following these steps:

a) Select the <u>front view</u> (F1) and position the cursor at x=**-650** & y=**-650**. Now select the <u>top view</u> (F2) and position the cursor at x=**-650**, y=**-650** & z=**-650** and click. You now have your first point.

b) Move the cursor to x=**650**, y=**-650**, z=**-650** and click again.

c) Next move the cursor to x=**0**, y=**-650**, z=**0**, select the front view (F1) and move to x=**0**, y=**0**, z=**0**. Click again.

d) To complete the first polygon move to x=**-650**, y=**-650**, z=**0**, select the top view (F2) and move to x=**-650**, y=**-650**, z=**-650**. Clicking this time will complete the polygon and colour fill it if appropriate.

e) Now use the right view (F6) in combination with the top view (F2) to click at the following co-ordinates:

   x=**650**, y=**-650**, z=**-650**
   x=**650**, y=**-650**, z=**650**
   x=**0**,   y=**0**,   z=**0**
   x=**650**, y=**-650**, z=**-650**.

f) You should now begin to appreciate the method of setting <u>vertices</u> in 3-D space. To complete the pyramid select back view (F4) in combination with top view (F2) and click at co-ordinates

   x=**650**, y=**-650**, z=**650**
   x=**-650**, y=**-650**, z=**650**
   x=**0**,   y=**0**,   z=**0**
   x=**650**, y=**-650**, z=**650**.

g) Now select combinations of left view (F3) & top view (F2) and click at co-ordinates:

   x=**-650**, y=**-650**, z=**650**
   x=**-650**, y=**-650**, z=**-650**
   x=**0**,   y=**0**,   z=**0**
   x=**-650**, y=**-650**, z=**650**.

h) All that remains is to enter a base for the pyramid. Using front view (F1) and bottom view (F5) click at co-ordinates:

   x=**-650**, y=**-650**, z=**-650**
   x=**-650**, y=**-650**, z=**650**
   x=**650**, y=**-650**, z=**650**
   x=**650**, y=**-650**, z=**-650**
   x=**-650**, y=**-650**, z=**-650**.

The pyramid is now complete, but if you wish to keep it <u>save</u> it now! Remember with more complex objects you should get into the habit of saving regularly, it could save a lot of extra work.

Rotating and viewing your object

Having constructed your pyramid, you now wish to view it. Select <u>view mode</u> and the object is displayed without the vertex points shown. Normally the object will be displayed in <u>wireframe</u> mode, however by selecting <u>polygons</u> you can see the pyramid in solid mode.

Try rotating the pyramid with the <u>function keys</u> (F1-F6), or by using the mouse. Press and hold one of the buttons and move the mouse as appropriate. You may find object rotation using the mouse requires a little practice, however soon you should find this is the most flexible method.

Switch off the <u>lines</u> and you will find that the pyramid becomes rather flat and difficult to visualise from some view points. Now select <u>Lambert</u> shading and the pyramid obtains a greater feeling of depth.

Depending on the colour you originally chose for your pyramid, you may now wish to select a black <u>background</u> to provide a better contrast.

Select the <u>Gouraud</u> shading technique and rotate the pyramid. You will find greater realism is provided and a more pleasing image is obtained. For even better results, select <u>Phong</u> shading, the rotation will be slower but should be acceptable on most systems.

Use the <u>View Panel</u> to obtain special lighting, scaling and rotation effects. Position the pyramid so that the view point has one of the corners face on, and is slightly elevated. Now drag the black dot within the <u>light position control</u> to the bottom left. Begin to move the dot to the right using an arc motion. The effect should appear as a sun rise followed by a sun set and hopefully demonstrate the ability of the light position control.

Experiment with the view panel, you can cause no harm and some interesting effects can be achieved very easily.

Editing and changing attributes

After viewing your pyramid, you may find changes are required to some of the polygons. If you just want to add more polygons select <u>design mode</u>, however should you wish to delete or change existing polygons select <u>edit mode</u>.

When in edit mode you need to select the polygon you wish to work with. This is done by <u>picking enough vertex points</u> to uniquely define the polygon. Sometimes this can be achieved by selecting one vertex, but it often requires two or more.

As practice try the following steps which will show you how to select the front face polygon of the pyramid.

a) Select the <u>front view</u> **(F1)** if it is not already selected.

b) Position the cursor at the top vertex (x=**0**,y=**0**) and then select <u>top view</u> **(F2).**

c) Now position the cursor at the middle vertex (x=**0**,y=**0**,z=**0**) and click. The vertex should be highlighted.

d) Move to the bottom right vertex (x=**650**,z=**-650**), then select <u>front view</u> **(F1)**.

e) Move the cursor to the bottom right again and locate at (x=**650**,y=**-650**,z=**-650**). Click and the second vertex should be highlighted.

f) Position the cursor at the bottom left vertex (x=**-650**,y=**-650**,z=**-650**) and click. This time the entire polygon should be selected.

Having selected a polygon for editing you may now   <u>delete it</u>, <u>change its colour</u>, <u>add a back face</u> or <u>reverse the face</u>.

Note: If you find it impossible to select a particular vertex it is likely that the vertex is defined at a fine grid position. Try turning on the <u>Fine Grid</u> option.

What are convex and concave polygons?

A convex polygon (shown on the left) has all its internal angles less than 180 degrees while a concave polygon (shown on the right) has a least one internal angle greater than 180 degrees.

Why, when drawing a polygon, on clicking a new vertex the polygon disappears?

A maximum of six vertices per polygon are allowed. PolyCAD will eliminate polygons with more vertices. All vertices of a polygon must be unique. While constructing a polygon if you click on a vertex already present, which is not the starting vertex, then the polygon will be rejected.

How can I draw polygons which don't lie in the X-Y, X-Z or Y-Z planes?

You can draw such polygons using a combination of the different design views. The design view can be changed using the keys F1-F6 while a polygon is being drawn. See <u>Constructing a pyramid</u>.

In design mode while drawing a polygon I placed a vertex in the wrong position, what can I do?

At the moment the only option is to press the **Esc** key which deletes the partially constructed polygon.

In editing mode why can't I pick a particular vertex?

The vertex lies at a fine grid position. You should turn on the fine grid option to pick this vertex.

I completed the polygon in a design view where the polygon is seen edge-on, does this matter?

When you complete a polygon PolyCAD makes the side facing you the front face. If you complete the polygon edge-on a warning message is displayed. You should then check that the front face is as you expected. If it is not you can edit it and <u>Reverse Face</u>.

I constructed a non-planar polygon but the triangulation is not what I expected. What can I do?

There are three options. You can edit the polygons to reverse faces etc., or you can delete the polygons produced and enter an equivalent set of planar polygons. A third option to try is to enter the vertices of the non-planar polygon in the opposite order. This can produce a different triangulation.

I placed one polygon directly on top of another, but with polygon fill on it disappears. Why is this?

In <u>design mode</u> a simple depth sort is used which cannot handle polygons placed directly on top of each other. The top polygon is present and is best edited with the <u>polygon</u> fill mode off. In view mode only the <u>BSP hidden</u> surface method will correctly handle this situation for the current version of PolyCAD.

Which hidden surface method is best for my object?

The answer depends on what type of object you have constructed. If your object is convex (i.e. its outline always forms a convex polygon when viewed from any angle) then the simplest Hidden option **None** will work as well as the other two. The option **Depth Sort** works for moderately complicated objects, but it cannot deal with intersecting polygons. For complex objects with intersecting polygons and polygons placed directly on top of each other the **BSP Sort** option works best, though this method can result in a lot of polygon splitting. The **BSP Sort** is the most general and sophisticated hidden surface removal method in the current version of PolyCAD.

When I entered view mode the message Vertex Normal Magnitude Error occurred. What does this mean?

The Gouraud and Phong <u>shading</u> methods require a normal at each vertex. For certain combinations of polygons an error can occur when evaluating this normal (in the current version of PolyCAD). Default values are set for the vertex normal. This may have a slight effect on the shading in Gouraud and Phong, but there is usually no problem.

In view mode the BSP hidden surface method produces strange results. What should I do to fix this?

This is a bug in the current version of PolyCAD. The problem can be solved by saving the object and then reading the object back in. This will rebuild the BSP tree and the object should display correctly.

I have registered PolyCAD, but when I type in my registration details I get Invalid serial number for registration I.D. Why is this?

You should type in your Registration I.D. **EXACTLY** as shown in your registration details. This includes any capital letters and punctuation.