AC3D v3.6 User Manual

AC3D 3.6 User Manual

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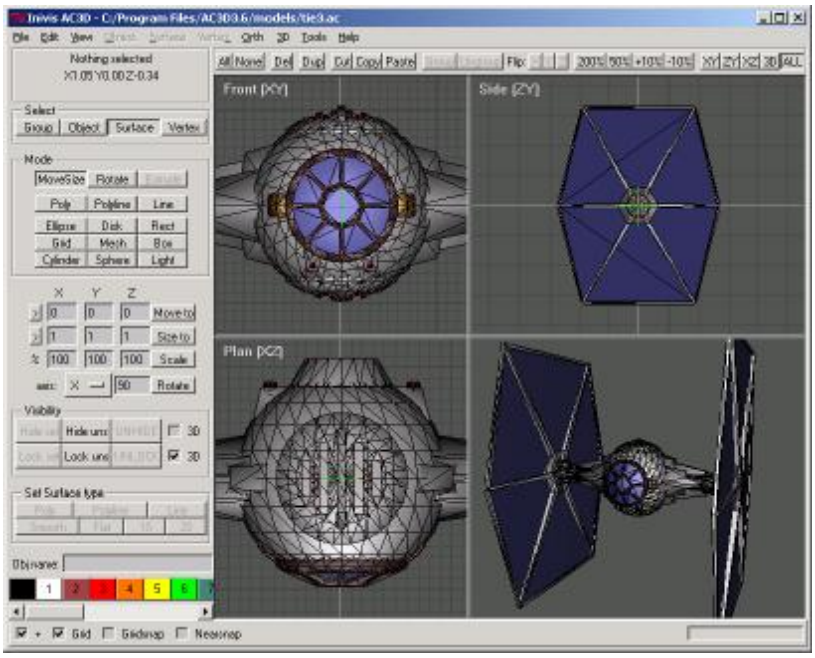
Introduction

Welcome to AC3D

AC3D is designed to make the construction of 3d objects fast and easy to do. It is used to create 3D models for games, rendering ray-traced images, and for scientific and general data visualisation.



AC3D runs on a wide range of standard hardware and is available across a number of popular platforms.

AC3D terminology

Vertex
A vertex is a single point in 3d space. It's specified by three coordinates x, y and z. More than one vertex can occupy the same position in 3d space. A vertex is always owned by a single object, they cannot be shared between objects. A vertex is usually part of a Surface, but need not be.

Surface
A surface in AC3D is a list of vertices. Surfaces are one of three types; polygons, lines or polygon outlines. The type of a surface can be easily changed. A surface normal specifies the direction a surface is facing. Normals are used in lighting calculations. Surface normals are automatically calculated

by AC3D. A surface is facing the viewer if the vertices can be seen in an anti-clockwise direction. If a surface is set to be single sided, it will only be visible from the front. Two sided surfaces will be visible from both sides. It is more efficient to draw single sided surfaces and makes more sense when used as part of an object such as a sphere (where you can't see the other side of the surfaces). Surfaces have a material attribute, which defines the color and quality (for lighting purposes). Each vertex referenced in a surface has an associated texture coordinate. Vertices can be shared between surfaces in the same object.

Object
An AC3D object is a list of vertices, and surfaces that use these vertices. It also has other attributes such as a name and texture.

Group
A group is a special object that has no surfaces or vertices but has other objects as children. Groups are created by selecting two or more objects and selecting 'Group' from the edit menu, or toolbar.

Material
A material defines the color of a surface and also the attributes that define the way it will react to light e.g. shininess.

Texture
Graphical images can be mapped onto the surfaces of an object. The images are usually from graphics files such as gif, jpg, bmp etc.

Texture coordinates
When the vertex of a surface is drawn, a texture coordinate specifies the position of a texture to map to that point. A texture coordinate is a two dimensional (u,v) value.

Bounding box
When you make a selection of objects or vertices, a green box outlines it. You can drag, resize or rotate this box to adjust the contents

Windows/Views

AC3D has a control panel, on the left, plus 4 other windows - three 2D orthographic views and a 3D view. There's also the menu and toolbar at the top and an information bar along the bottom.

Control Panel

This is where the main controls over the selection and draw modes are located. It also contains the surface-type controls, the palette of materials and the object name field.

The top of the control panel shows information about the current selection. When the mouse is being used to interact with models, this area will also display current positions, distances moved and other related information.

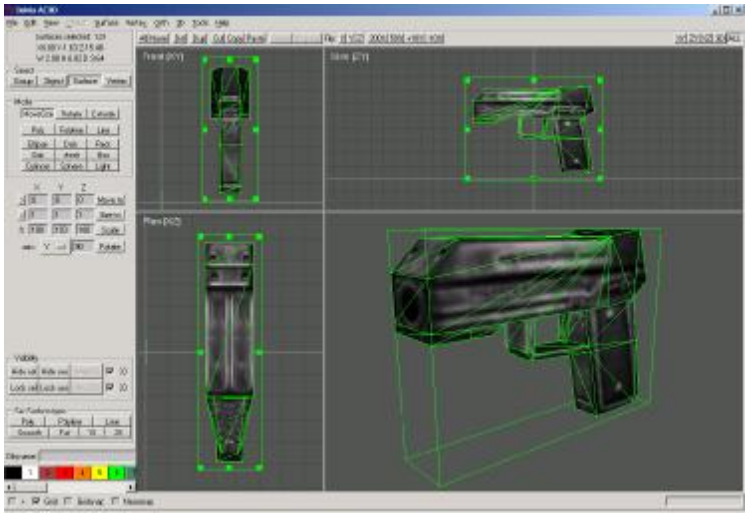
Toolbar

This contains buttons for some of the most commonly used functions.

All – select everything.
None – clear the selection.
Del – delete the selected objects/surfaces or vertices.
Dup – duplicate the selection.
Cut, Copy, Paste – uses AC3D's internal clipboard.
Group, Ungroup – put selected objects into a group/remove the group object
Flip XYZ – flip the section about this axis
200%/50%/+10%/-10% - scale the selection.
XY/ZY/XZ/3D/ALL – Maximise a single view or view ALL together

Orthographic views

The orthographic views consist of three 2 dimensional windows. These windows allow selection and model manipulation (moving and resizing). Each orthographic view shows a two dimensional view of the 3d world (front, side, plan). Although it's useful sometimes to work in a single view, seeing all the windows at once can be very helpful when positioning objects and laying out scenes.



The dividers between the 4 view windows can be dragged to resize the views. Individual views are maximized by clicking on the view buttons at the top right of the main window (alternately, the F1-F5 keys can be pressed to switch between the different view configurations).

The main window size/position and other settings are saved when exit AC3D.

The items on the 'Orth' menu control how the windows are drawn and what components are visible.

The grids

In the orthographic windows, there are two grids - the draw grid and the snap grid. Both can be set from 'File->settings' and can be toggled by pressing the switches at the bottom of the control panel.

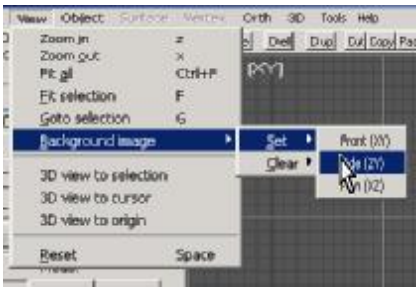
The draw grid displays visual guide lines in the orthographic windows.

The snap grid (if on) will snap moving/resizing/creating mouse movements to nearest grid points. The Snap grid is shown by thin grid lines, the draw grid uses thicker lines.

Both grids don't need to be set the same but they can be.

Using Background Images

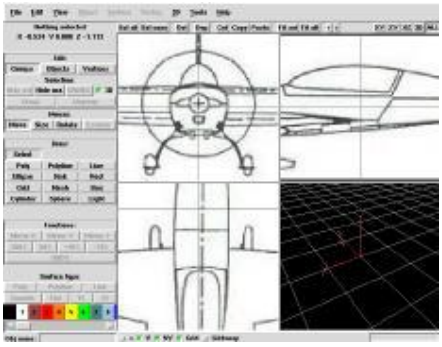
Each of the orthographic (2D) windows can display a background image. This can be very useful for tracing shapes or laying out objects in relation to some scanned image



e.g. a map. Background images are set and unset from the View menu. All the image formats that are supported by AC3D's texture loaders can be used.

The view menu contains items to Load and clear background images.

Background images will scale and move with the views. By default, the image will be centred on the origin. The scale and position of the background image is by adjusted using alt and the cursor keys. Alt and the cursor keys, reposition the image, whilst Alt+Shift plus cursor up/down scale the image.



Details of background images are not saved with models or when AC3D exits.

The 3D view

The 3D view displays the current model in three dimensions and changes instantly when any modifications are made to the current model. The 3D window is primarily for viewing your models but also allows selection of objects, surfaces and vertices (depending on the current Select-mode) by holding down the control key and clicking/dragging.

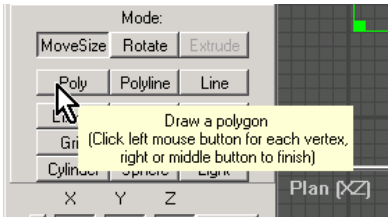
Two navigation modes are available in this window – 'spin' and 'walk'. These can be switched in the 3D menu or by pressing the '1' or '2' keys whilst the pointer is in the 3D window.

A 3d grid is available - toggle with 'g'. The grid is lies on the XZ plane (floor).

Press 'w' to toggle between wireframe and filled drawing, 't' toggles textures. 'l' toggles the fixed light. See the 3D menu for more viewing options.

Getting help

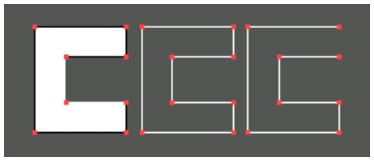
User interface components in AC3D have 'balloon help'. Small 'tooltip' windows will popup when the mouse pointer rests over a button or field label.



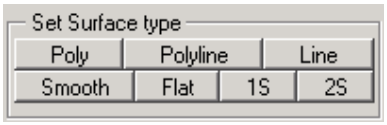
When browsing through the menu items, the function on each item is described in the message text at the bottom of the AC3D window.

Creating AC3D objects

AC3D Surfaces

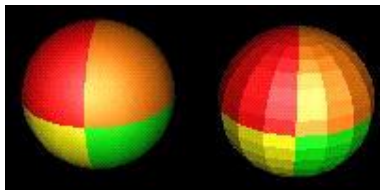


Objects in AC3D consist of a list of vertices and a number of surfaces that reference those vertices. A surface may be one of three types; Polygon, Polyline or Line. A polygon is a filled area, a Polyline is a wire-frame outline of the polygon (a loop that joins the start vertex to the end), a line has a specific start and end.



Surface type is changed by pressing a button on the control panel. The Surface-type buttons are located at the bottom of the control panel (Poly, Polyline, Line):

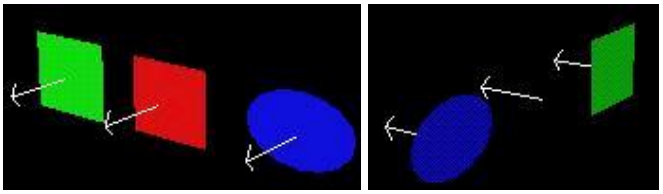
This panel also contains controls to set surfaces to be smooth 'SM' or flat 'FL'. This determines the way that a polygon is drawn (it has no effect on lines or polylines):



If a surface is flat-shaded, the colour across the surface will be constant. If it is shaded then the colour will be 'graded' depending on lighting conditions.

Vertices can be shared between surfaces (i.e. one or more surfaces use the same vertex). If these surface types are set to 'smooth', the effect is of one continuous 'smooth' surface. The vertices MUST be shared for two surfaces to be smoothed together. This method of shading allows smooth looking objects to be created from relatively simple shapes.

The '1S' and '2S' buttons select how many sides a surface has (one-sided or two-sided). If a surface is single sided, it will only be visible from one side. The following pictures aims to demonstrate this:



In this simple model, there are three objects - a green rectangle, a red rectangle and a blue ellipse (made by creating an ellipse object and setting the surface type to be POLY). The red rectangle has been set to be single-sided '1S'. This means that it is visible from the 'front' but not from the back (the second image

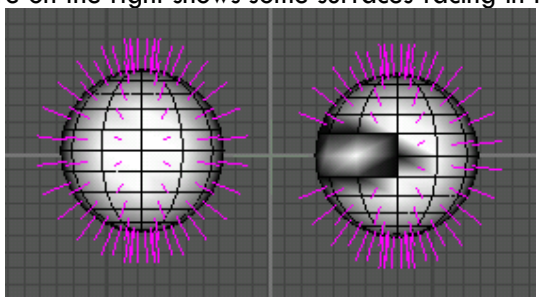
shows the whole model rotated). Objects such as spheres and cubes, which do not have any interior surfaces visible, benefit from a speed optimization when being drawn with the surfaces single-sided.

Surface normals

The direction a surface is facing is determined by its 'Normal' (indicated by arrows in the above diagram). This is a 3D graphics term for a line at right angles to the surface that indicates a direction.). Normals are used to calculate surface colors and shading when the objects in AC3D are drawn. For smooth shading, vertex normals are automatically calculated by averaging normals of all connected surfaces.

Normals can be visualised in both the orthographic and 3d views ('Normals' on the 'orth' and '3d'menus). This preview is useful for solving problems where, for example, some surfaces in an object are the wrong way around (this can cause surfaces to appear missing if they are one-sided, or the smoothing can appear uneven. Viewing the normals is also useful for use with the extrude function and can help determine the extrude settings that ensure that new surfaces face in the correct direction.

This picture shows two spheres. The sphere on the left shows correct normals (i.e. all facing outwards). The sphere on the right shows some surfaces facing in the wrong direction. Notice how the shading is not consistent.



AC3D automatically calculates the normals (both surface and vertex).

To flip the direction of a surface, use Surface->Flip normal. (This actually reverses the order of the vertices in the surface so that the automatically generated normal faces the opposite way).

Creating new objects

The AC3D control panel contains a number of 2D and 3D object shapes that can be created:

New objects are created by selecting one of these buttons and clicking/dragging in one of the orth. windows.

Polys/polylines/lines

To create a poly/polyline/line, click to position each point and either double-click or press the middle or right mouse button to end. The surface type can be altered later from the control panel if you need a different type.

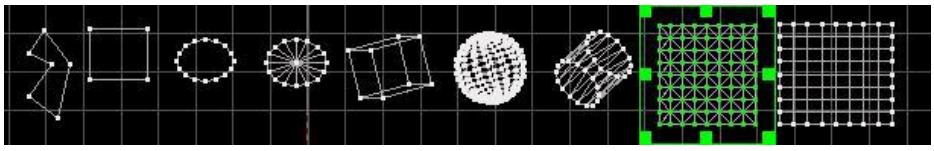
These objects consist of a list of vertices and a single surface. The surfaces from more than one of these objects can be collected together into a single object by using the Object->Merge function.

Polygons should be 3 or more points. Concave polygons are handled by AC3D. They can be converted to triangles by using the Surface->triangulate function.

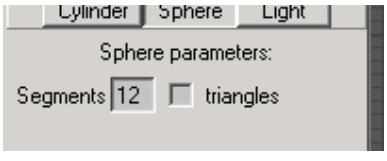
It is possible to draw a line or poly in different windows - creating a non-planar object. This makes sense with lines but is not correct for a polygon which should have all it's points on the same plane. Invalid polygons i.e. polygons that have less than three vertices or have crossing edges are displayed in a cyan color.

To draw shapes that have vertices in the same position as an existing shape, use the 'nearsnap' function. The switch at the bottom of the AC3D window is used to control this. When this is on, the next point drawn will 'snap' to the nearest existing vertex (when there is a vertex within a certain range).

Spheres, boxes etc.



Creating a 3D object by dragging the mouse in a window specifies two of the dimensions for the new object - the third dimension is an average of the original two. The location of the object in the third dimension is specified by the 3D cursor. The 3D cursor is shown in the orthographics views by a cross. This is repositioned by holding down the Alt key and dragging the mouse. Most people rarely use this because it is very easy to create an object and position it later.



Some object types allow parameters to be set before creating the object. E.g. spheres and Meshes can be made from triangles or quads. Controls for any available parameters will appear in the control panel underneath the mode box.

When created, AC3D Objects are automatically named. The object name box is at the bottom of the control panel and allows these names to be set.

Object names can only be edited/set in Group or Object select mode. Object names need not be unique and can be the same across multiple objects. This can be useful for selecting or finding particular objects with the Edit->select-by-name function (e.g. to select all objects named 'chair'). Object names are used in some of the file formats exported by AC3D.

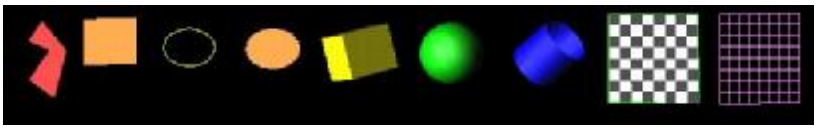
If AC3D is being used to generate VRML or Dive files, URLs and other text can be associated with objects. This text is used in a number of the export file formats that AC3D generates. The names, text and urls are saved in the .ac AC3D files. Text attached to each object is entered into the field on the Tools->Object Data window. Object names can also be set in the same dialog.

Creating other objects

It is very easy to create other objects from these shapes. E.g. to make a torus shape ('donut'), create an ellipse and select the Object->revolve menu.

A cone can be made in a number of ways. Create a cylinder; select one end (in vertex mode) and select Vertex->snap-together. A cone made this way will have the texture coordinates set correctly. For a simpler cone (fewer vertices), no texture map), optimize the vertices with Object->Optimize-vertices. This means that the centre-point of the cone will be a single vertex which is shared with all the sides. Some other ways of making cones are - make a 'disk' and pull the centre point up; revolve a line around an axis. To add a base to the cone, select the bottom vertices and select the menu item: 'Vertex->Create surface/object'.

'Extrude' is used to add extra parts to objects or to give 2d shapes depth. Objects can be cut into pieces and specific surfaces deleted.



Lights

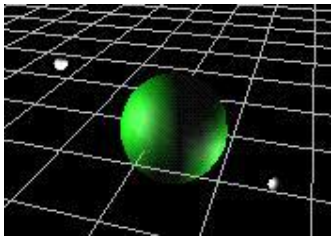
Lights have no associated geometry and represent a 'point light'. Lights are represented by this symbol:

This symbol is not shown in the 3D window but the effects of the light on other objects in the scene will be noticeable.

Lights are fixed brightness white lights. Lights are selected and repositioned in Group or Object select mode.

Lights are generated in POV files and RIB files. The generated files can be edited to alter the lighting attributes.

This image shows a green sphere with two lights (indicated by white spheres) - the main headlight is off. (The headlight in the 3D window is toggled on and off with the 'l' key, or from the '3D' menu). If the headlight is on when POV or RIB files are generated, a light will be added to information in the file.



Text

Tools->Add-Text is a function that creates text from a special AC3D file. An AC3D font file contains a set of objects that are treated in a similar way to a text font. The font file can be viewed by simply loading it in to AC3D. Objects are named to be letters in the alphabet (and other symbols too). Add-Text takes a string (e.g. your name) and duplicates these objects, laying them out next to each other. The text is created at the origin (0, 0, 0) and will usually be facing so that it's viewable in the XY (side) window. This text can be selected and moved, resized, or rotated just like other AC3D objects. The Extrude function can be used to make this text three-dimensional.

Making your own fonts

A file for use with Tools->Add-Text is a normal AC3D file with named objects. - Objects have their centres (origins) 'minimized' (set using the Object->Minimum centre function). To view object-centres, ensure that the '+' button is on (at the bottom of the control panel). This point is used when lining up text objects. The

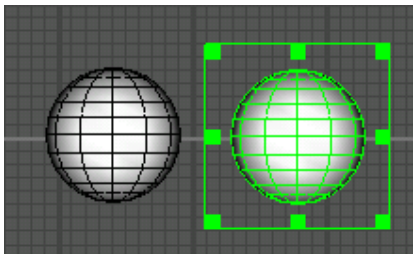
point is taken as the start of the 'character' and the width of the object is measured so that the next character can be placed the correct distance along the line, without overlapping. The font file should be designed to be viewed from the front in the XY window, since these coordinates are used for positioning the font objects.

The Add text function can be useful for storing a library of objects e.g. furniture. Each object can only be indexed by a single character.

To create accurate 3D text objects from TrueType fonts (as used by Windows etc), use Font3D to generate DXF files and import them into AC3D. Font 3D is free to download from http://www.checkpoint.net/font3d/

Registered users benefit from a special Font3D plugin.

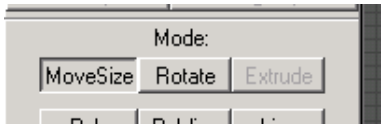
Selecting, resizing and moving



In AC3D the manipulation of 3D objects works in a very similar way to a 2D drawing program. I.e. the selection is shown highlighted and 'handles' can be moved to reshape the section.

The majority of selection and manipulation is done through the orthographic windows although selection is possible via the 3D view.

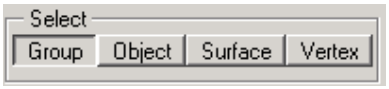
Selected components (surface, vertices) are shown in a different colour and are surrounded by a 'bounding box' (usually green).



Selection is possible in mode/size, rotate and extrude modes. The default mode is move/size.

Note that the extrude button is disabled in this picture – it's enabled only in surface select mode.

Selecting



The Select-mode defines the granularity of selection i.e. it determines if selections will affect objects, groups or vertices. To select in AC3D, either click the left mouse button or use the left mouse button to drag a box over an area. When something is selected, the Bounding-Box that appears can be dragged or resized directly affecting the points/surfaces/objects.

In Vertex mode, vertices are selected by a single click on a single vertex or by dragging a box over a number of vertices. In Surface-mode, a surface is selected by a click or dragging a box over an area. In Object-mode, selecting any part of an object causes the whole object to be selected. In Group-mode, a group of objects can be selected by highlighting any part of a single object that belongs to a group.

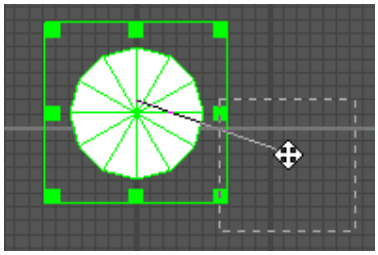
There is an important difference between a click-select and a drag select. Click selects are used for selecting single entities e.g. one object, one surface, one vertex. A click select will select the nearest entity underneath the pointer. A drag-select will select everything within the drawn box that lies underneath the

region. Click-select is useful, for example, when selecting a single surface of a sphere (where a drag select will always select more than one surface).

Selections are preserved between changes of select modes. Changing from vertex to surface select-mode means that any surfaces that have all vertices selected will remain selected in surface-mode.

Moving

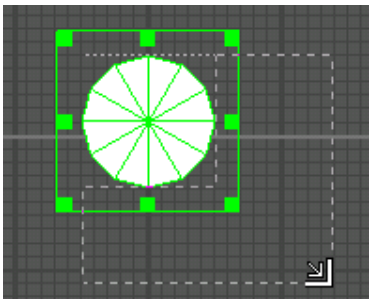
The green bounding box is dragged with the left mouse button to reposition the selection. Holding the control key down whilst dragging, constrains movement to up/down or left/right only.



Resizing

Drag the 'handles' in the corners of the bounding box using the left mouse-button, to resize the selection. On the edge handles, hold the control key down whilst moving the mouse to resize opposite edges.

Note that it is possible to resize a selection down to zero width. This is useful for lining up vertices.

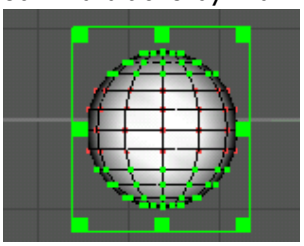


Extending/Negating the selection

Holding down the shift key whilst selecting with the left mouse button, extends the selection (adds new entities) and pressing shift whilst selecting with 2nd (or 3rd) mouse button to negate (subtract) items from the current selection.

Extend and negate selection work in all select modes.

This picture shows the top and bottom of a sphere selected. This is done by first selecting the top vertices with a drag. Holding down the shift key and dragging across the bottom of the sphere.



Clearing the selection

Clicking the outside the area of the bounding box will cause everything to become unselected

The selection can also be cleared by pressing the 'None' button in the toolbar or from the menu Edit->select-nothing.

Selecting in the 3D window

This works in the same way as selecting/extending and negating in the orth windows, but requires the control key to be held down.

Hiding objects

Hiding allows objects to be temporarily removed from the views. The current selection, or objects that are not selected, can be hidden from view. The 'unhide' button ensures that all objects are visible. The '3d' toggle determines if the hidden objects are visible in the 3d window. Hiding is useful when access is needed to work on obscured objects.

Locking objects

This is useful for temporarily disabling objects that are obscuring others. When objects are locked, it's not possible to select them.

Locking also helps with the speed performance when editing large models. It works in a similar way hiding, only that locked objects are drawn in grey wireframe. Wireframe surfaces take less time to draw compared to filled surfaces.

Note that if objects are hidden (or locked) and the model is saved/exported, hidden/locked objects are included in the file.

Navigation and viewing

Moving and zooming the orthographic views

Dragging the mouse when holding down the middle button ‘pans’ the window. The right mouse-button zooms (magnifies and minifies). Alternatively, holding down the control key and using the right mouse button will pan the view.

The views in the orthographic windows can also be repositioned with the cursor keys. Pressing shift with the cursors keys moves in larger steps. To zoom in and out, use control and the cursor keys (or 'z' to zoom-in, 'x' to zoom out).

The window zoom can be set to be the same for all 2D windows from the settings dialog (File->edit settings menu), otherwise windows will have independent zoon settings.

Navigation in the 3D window

There are two viewing modes accessible by pressing '1' and '2' in the 3d window (or by selecting the menu items in the '3d' menu):

Spin mode

In 'spin' mode, holding down the left mouse button and dragging the mouse rotates the view. Holding down the right mouse button and dragging the mouse vertically zooms (scales) the view. Middle mouse button dragging will ‘pan’ the view. Alternatively, holding down the control key and using the right mouse button will also pan the view.

The cursor keys can also be used to control the spin (control plus up/down zoom in/out).

Walk mode

In ‘walk’ mode, the cursor keys work in a similar way to 'Doom/Quake'. The '2' key switches into this mode ('1' switches back to spin mode). Cursor up/down moves forwards/backwards, cursor keys left/right turn. Pressing control with the cursor keys up/down tilts the view position and alt moves (pans) left, right, up, down.

Walking can also be controlled with the mouse - the left button turns and moves forward and backward, the right button controls up/down/left/right movement.

Resetting views

Press the 'space' key to center that windows about the origin and reset the zoom levels.

Viewing the selection

Press 'f' to fit the current selection into the current window. 'F' fits the selection to all windows. Control-F fits the whole model into all views. Use 'g' to 'goto' the current selection - the window will centre about the centre of the selection. 'G' centres all windows. These options are also in the View menu.

Three functions available from the View menu allow you to centre the 3D view about the selection, the cursor (that is positioned with ALT-click in the 2D windows), and reset to view the origin.

Model manipulation

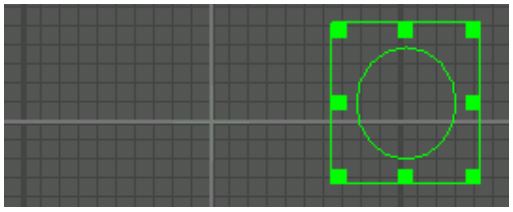
Operations on objects

These operations are on the 'Object' menu and act upon one or more selected objects.

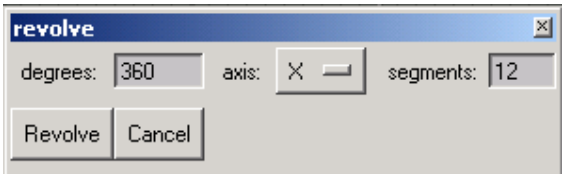
Revolving

Revolving makes copies of the selected objects, rotating each copy, then creating surfaces between the copies. It's recommended that this function be used to revolve 2D outlines of shapes rather than filled-polygon objects. Any revolved line objects are automatically removed after the revolution. The axis to perform the revolution about can be altered.

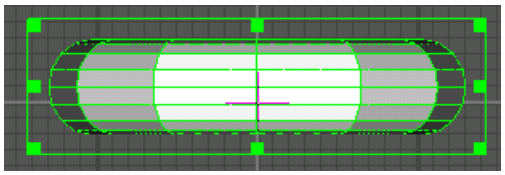
To create a torus - make a circle in the Front window:



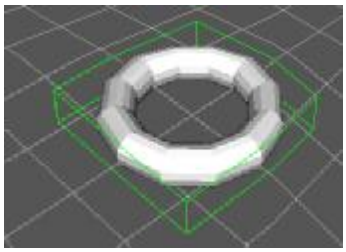
Select 'Object->Revolve…'

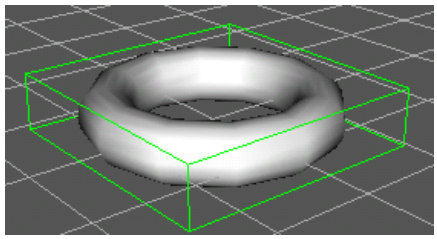


Set the axis to Y and click Revolve. You should see something like this:

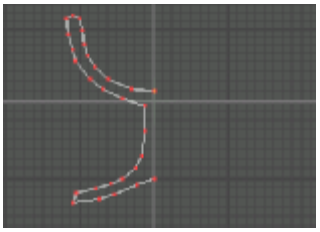


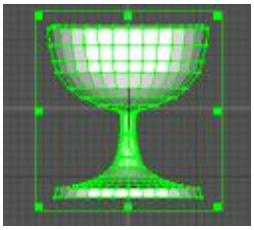
Select the 'smooth' surface type (near the bottom of the control panel) to make it appear rounded





The degrees of revolution can also be altered 1-360 degrees:





If there are points that need to be in the centre of the final revolved object - (e.g. the start and end points of the cup profile above) then these points must lie exactly on the axis. Drawing the line with 'gridsnap' can ensure this. Alternatively, snapping the points to the grid (Vertex->snap to grid) or by using the control panel Move-to function to ensure that two of the values are zero. If these points are not exactly on the axis, a small hole or possibly overlapping surfaces will be created. If this happens, the 'Vertex->snap together' function and optimize vertices can be used to remove duplicate points.

Optimize Vertices

This function removes duplicate vertices from each selected object. For vertices to be removed, an object must own the vertices and they much match the same position exactly. The function will share one vertex between each connected point. This means that vertex normals can be calculated if smooth shading is required. This function also removes duplicate vertex references from the surface - something that might cause a bad polygon. If vertices do not match the same position, Vertex->snap-together or Vertex->snap-together-by-distance can be used to move them to the same point.

Optimize Surfaces

This function removes any duplicate surfaces and any polygons that consist of 1 or 2 vertices (these may exist if vertices have been deleted from an object). AC3D highlights invalid polygons by displaying them as cyan lines.

Re-centre

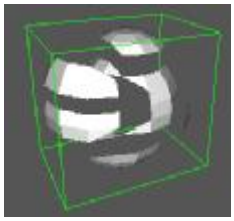
Object centres define the local origin of AC3D objects. Object centres can be seen by switching on the '+' button at the bottom of the control panel. This function re-centres this origin at the objects centre of gravity. This can be useful for specifying where the pivot points or local-origin of an object are.

Minimum-centre

This function sets the object's origin to the minimum xyz of the object. It is used to create AC3D fonts for the Tools->Add-Text function.

Fragment

Fragment creates one object per surface of the original object so that each object contains only one surface and the necessary vertices. This image shows a sphere that has been fragmented. The new objects have been moved apart. Notice that the surfaces are no longer 'smoothed' together - this is because each surface is now a separate object and vertices cannot be shared across objects.



Merge

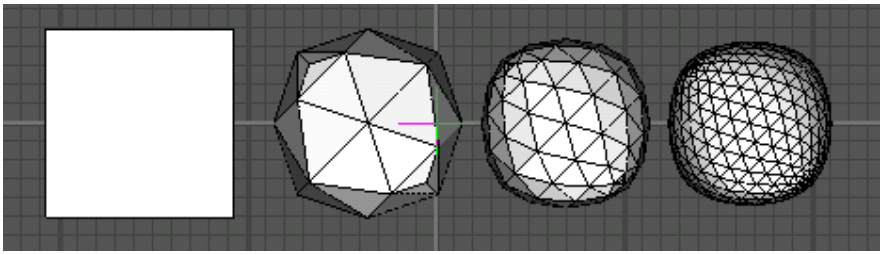
This function places all of the surfaces from the selected objects into one single object. This does not optimize the vertices so that they are shared. (select 'optimise vertices after merging to create a more efficient object and/or get smooth shading across adjacent surfaces)

Explode

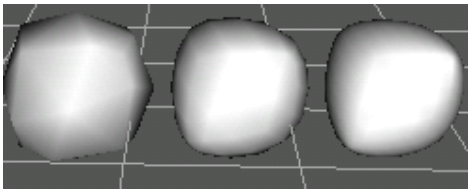
This is similar to fragment, but each new object is moved forward (in the direction the surface is facing) by a specified amount. This picture shows an exploded cube.

Subdivide surfaces

This function is used to ‘smooth’ the edges of an object. This picture shows four cubes. The first is a standard box; the others have had surface subdivision applied one two and three times.



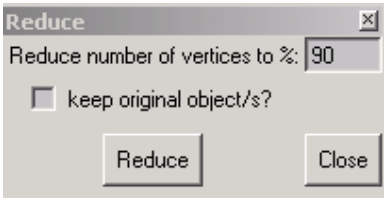
The same objects with their surface set to 'Smooth' (SM button on control panel):



Note that this function always creates triangles. Each subdivision quadruples the number of triangles in an object.

Reduce

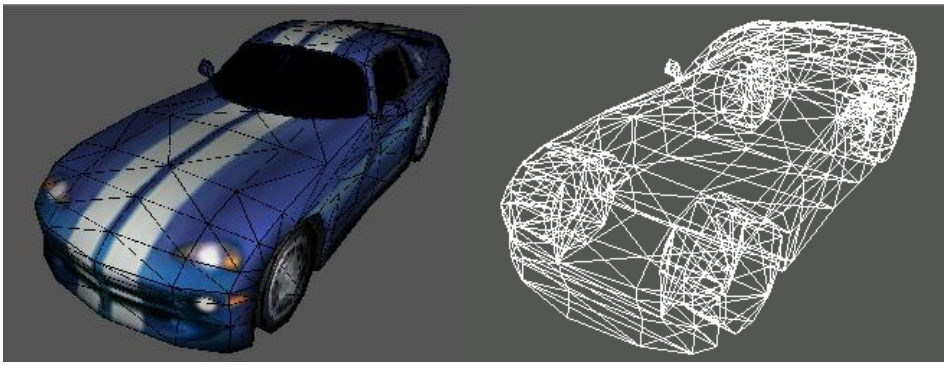
This function reduces the number of vertices (and polygons) whilst trying to retain as much of an objects original shape as possible. This is useful for saving on storage space and for speeding up the rendering of complicated objects. This function can be used to create different objects that will be shown at different distances (LOD – level of detail). E.g. a car object should be viewed close up with all polygons but from a distance, a more simple shape is adequate and can save drawing time.



A target percentage specifies the proportion of vertices that are to remain. E.g. If an object has 100 vertices and 80% is entered, the final object will contain 80 vertices.

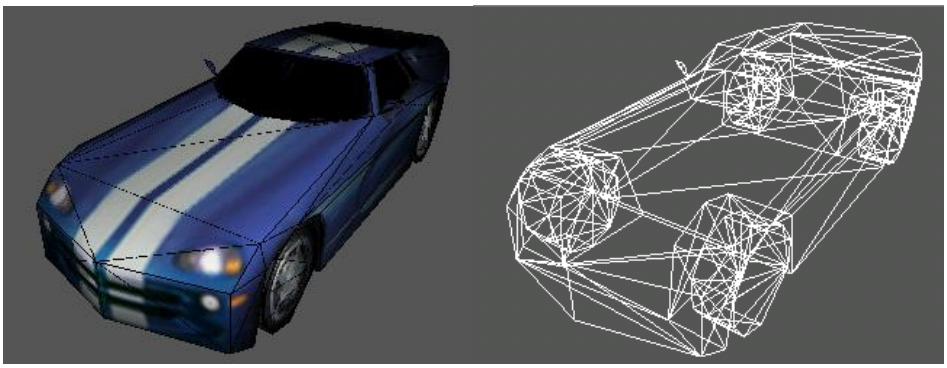
The original object can remain in the model, or it can be replaced with the new object. If the original object is kept, the new object will be created in the same position and will be selected.

An example:



732 surfaces, 376 vertices

Reduced by to 40% gives:



276 surfaces, 150 vertices – A saving of 456 polygons.

The reduce window remains visible so that different reductions can be tried (use Edit->Undo to revert to the previous state).

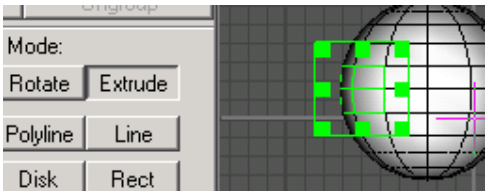
Operations on surfaces

Extruding

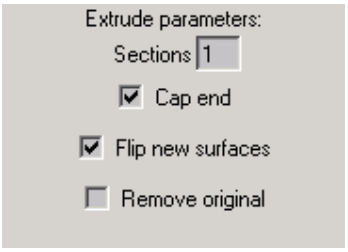
Extruding works only in surface select-mode. Pressing the extrude button on the control panel when there are one or more surfaces selected, enables the function. The actual extrude is done after the selection is dragged.

Extruding is a very powerful function that can be used for a number of tasks. It works by making new surfaces at the edges of the current selection. The original selection can be removed and/or copied to the end of the new surfaces.

Selecting one of more surfaces and selecting the extrude button on the control panel, brings up the extrude parameters:

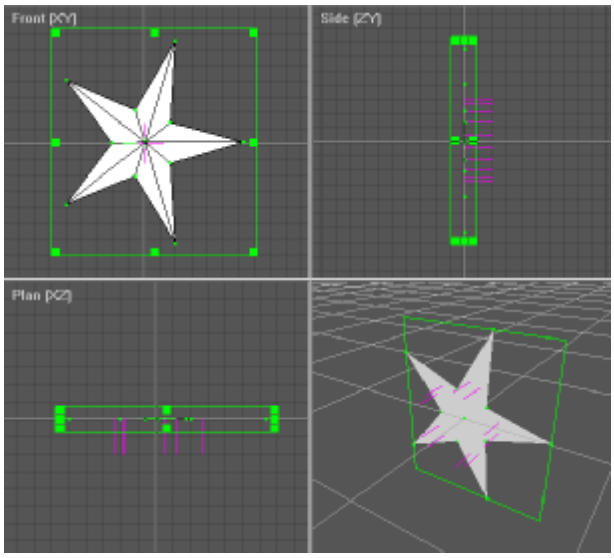


Here the number of sections to produce is specified. The end of new object can be capped with a copy of the original selection. New surfaces can have their normals reversed. Removal of the original surfaces is also an option.

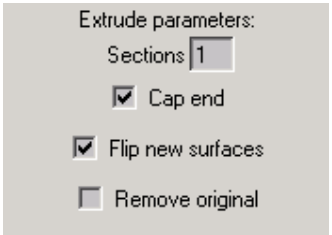


After setting these parameters, bounding box is dragged in the desired direction. (if the control key is held down movements of the mouse are constrained to either horizontal or vertical.)

The extrude function is best demonstrated with some examples. (This star is made by creating a 10-sided disk, selecting alternate vertices and shrinking the selection, using the –10% toolbar button a few times).

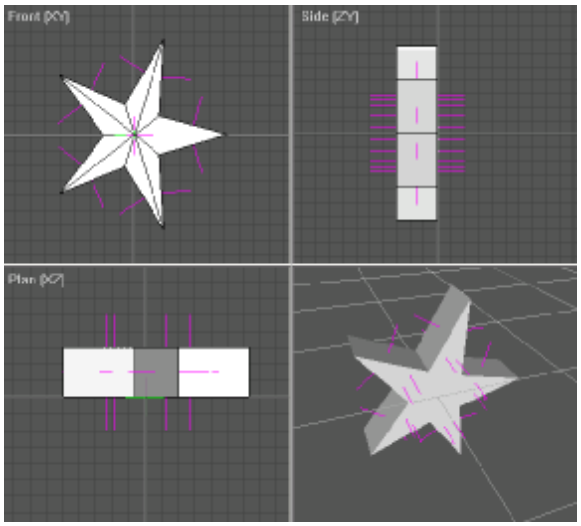


The magenta lines shown here represent the normals. Normals can be displayed by switching on 'Show normals' from the Orth and

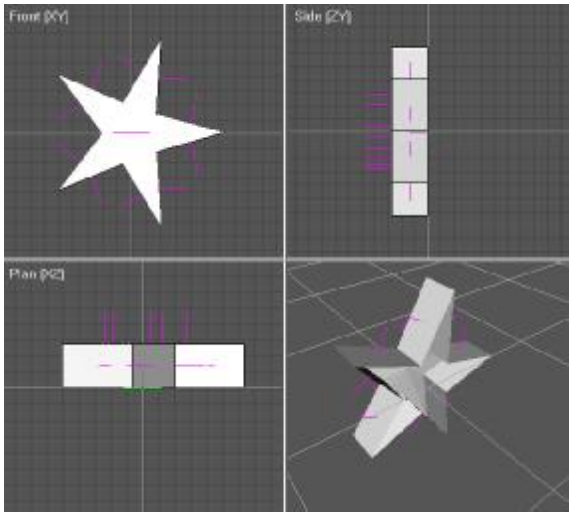


3D menus. Displaying the normals is used here to help determine the direction to extrude the object. In the extrusion, if the selection is dragged in the same direction as the normals, the resulting shape will hide the front of the original surfaces. This is good if you are, for example, extending one side of a box, but in this case we want the original surfaces to be on the outside of the final shape. This means that we want to drag the surfaces in the opposite direction that the normals face. Because we are doing this, we need to 'flip new surfaces' so that all the new surfaces face outwards.

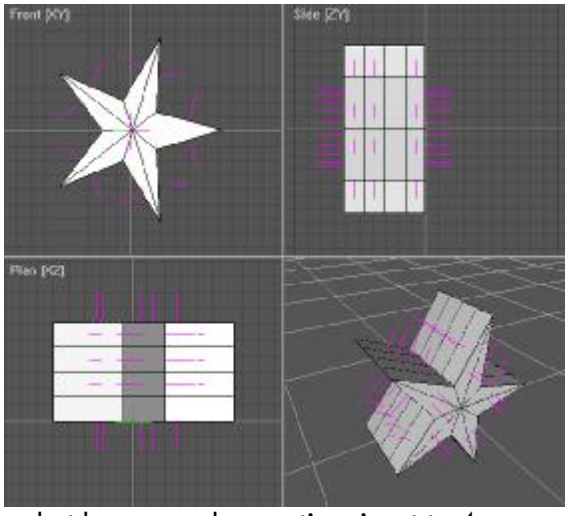
This is what happens when we drag the selection up in the plan window.



If we ticked 'remove original' here then the star that we are dragging will be deleted:



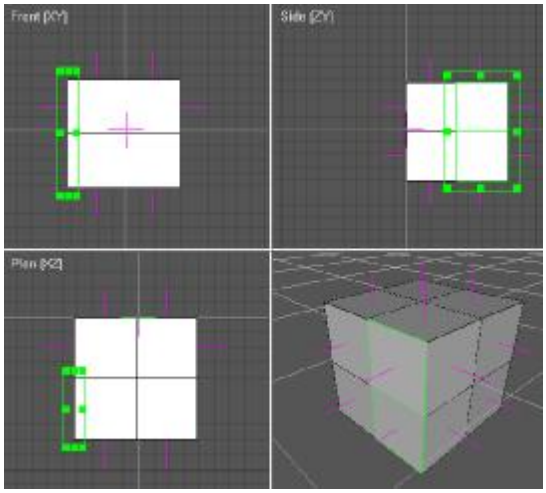
Here you can see that the original surfaces have been removed to leave a start shaped box (without a lid). If we'd un-ticked 'cap end' then we'd be able to see right through the star shape.



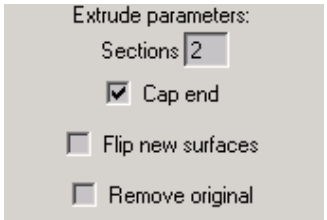
This picture shows what happens when sections is set to 4.

If you need to extend an existing set of surfaces, you may not want to keep the existing surfaces inside the new object.

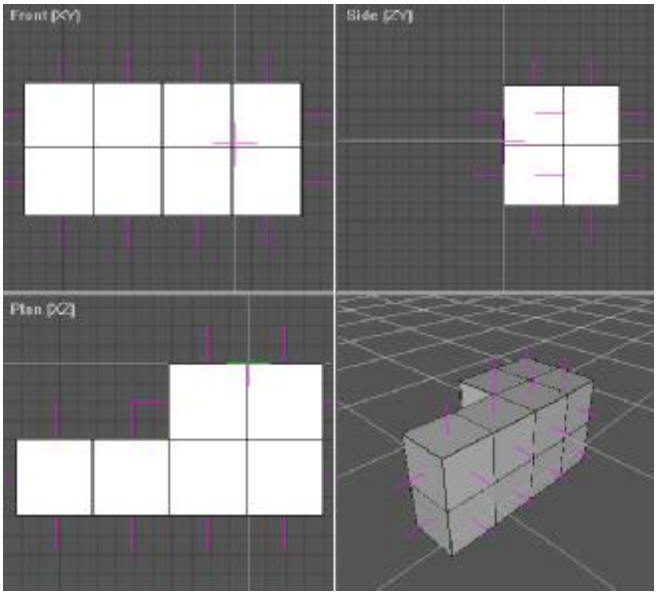
Here is a cube that has had a single 'Surface->divide'. Two of the surfaces are selected.



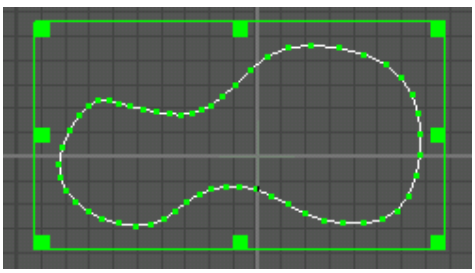
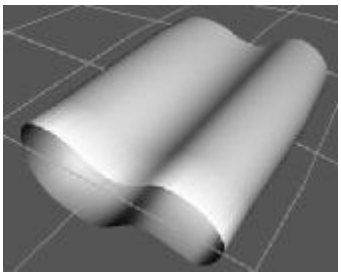
We can extend these surfaces without keeping the original surfaces (since they will not be visible because they are inside the shape. We use these settings:



To perform the extrusion, we drag the bounding box to the left (in either the front or plan window), holding down the Control-key as we drag to ensure that the new surfaces are square to the original. This gives:



When extruding lines, you will probably want to ensure that remove original is ticked and cap end is un-ticked. This ensures that no lines remain in the new surfaces.

It's useful to switch on the display of normals when extruding so check that the resultant surfaces are facing in the correct direction. If they are not, use surface->flip normals.

Flip normal

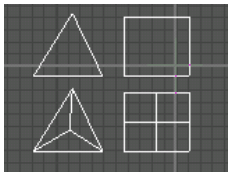
This effectively reverses the list of the vertices in each selected surface. This reverses the way that a poly 'faces'. A polygon is defined as 'facing' if the vertices appear anti-clockwise to the viewer. If a polygon is set to be one-sided (by pressing the '1S' button on the control panel) then it will only be viewable from one direction - the direction it is facing. You can switch on the display of normals in the orth and 3D windows – this can help determine if any surfaces are facing in undesired directions.

Change vertex order

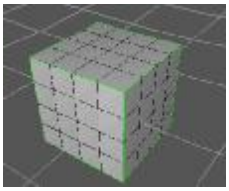
This changes the order that the surface vertices are drawn, by moving the first vertex to the end of the vertex list. This can be used to change where the break in a line is. It can also be used to fix bad polygon, which has the first three vertices in a non anti-clockwise order - causing the normal (used for lighting) to be incorrectly calculated. If a polygon appears all black, this function may need executing (possibly repeatedly) until it appears correctly.

Divide

Divide works on triangles and quads. It makes one triangle into three surfaces (new vertex at centre) and splits a quad into four smaller quads.

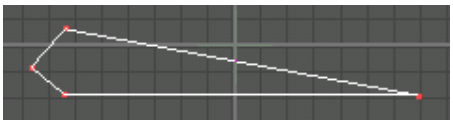


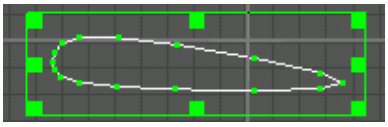
e.g. divide run twice on a box:



Spline

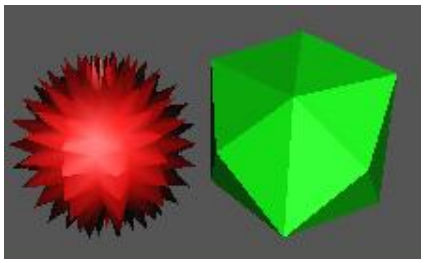
This is sseful for smoothing out a 'line' object and for rounding off polygons. New points are interpolated between existing points.





Spike

This creates a 'spike' in place of each quad or triangle selected. The 'spike factor' in the dialog that pops up - this defines the distance that the apex of the spike will be away from the original surface.



Make hole

This function creates a hole in each selected surface.

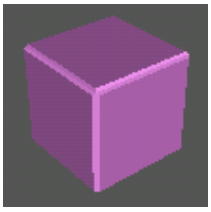
This image shows 4 objects that have had holes made in them - An Ellipse (set to poly surface-type), a sphere, a cube and a disk. Notice how the insides of the sphere and cube are not visible through the holes- this is because the default surfaces for these objects are single-sided and face outwards. To see the insides though the holes, these surfaces need to be made two-sided by pressing '2S' on the control panel.

Some concave polygons may have overlapping surfaces after making holes.

The size of the hole is specified as a percentage and can be adjusted in File->settings.

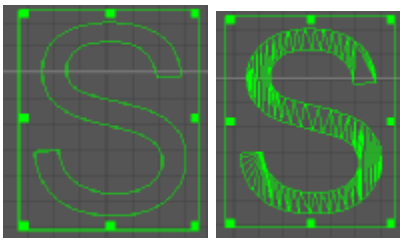
Bevel

Bevel works on each selected surface and creates another surface, which is smaller than the original, moved away slightly and joined by more new surfaces around the edge. The original surface is discarded. The distance that the new surface is moved and indented is specified in File->settings (Bevel size). Bevelling a concave polygon can result in new points being positioned incorrectly and these may need to be repositioned.



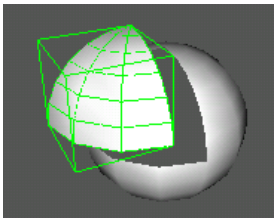
Triangulate

This spits non-triangles (i.e. polygons with more than 3 sides) into more surfaces, each new surface being a triangle. This operation can fail if it is given a 'bad' polygon - i.e. one that has overlapping edges or duplicate vertices.



Cut away object

This function takes all of the selected surfaces and vertices and puts them into a new object. This can be useful for extracting parts of objects. e.g. splitting a sphere into two.



Remap texture coors

see texturing section.

Remove surface only

This deletes any whole surfaces selected. The vertices will remain.

Operations on Vertices

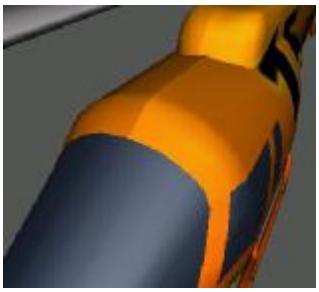
The functions on the Vertex menu are available when the Surface or Vertex select mode is on and one or more vertices are selected.

Snap-together

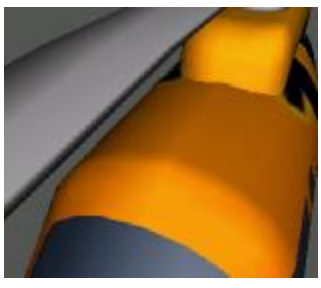
This sets all selected vertices to the same location. The vertices can be in separate objects or the same object. The point that they are snapped to is the average of all selected points.

Snap-together-by-distance

This function moves vertices together that lie within the specified distance. This is useful for example, to join two halves of an object together.



e.g. This picture shows a close-up of an object where two halves have been positioned together. Notice that there is a visible seam along the top. This is because the two halves are separate objects. Once the two halves have been merged together into a single object (Object->merge), the vertices need to be shared in order for this seam to



disappear. If Object->optimize does not remove duplicate vertices then it means that the vertices are in very slightly different positions. The solution is to select the vertices along the join and Vertex->snap-together-by-distance. The Object->optimize will remove the duplicate vertices and allow the surface to appear smooth.

Snap-to-grid

Moves each selected vertex to the nearest grid position. This may or may not be the visible grid. The snap grid is defined by 'snap grid' in settings and may be different to the 'draw grid' (which is the visible grid).

Snap-objects-by-vertices

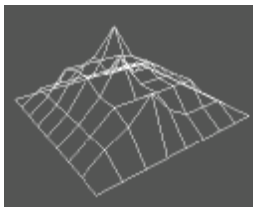
This is for aligning two objects. One vertex in each of two separate objects should be selected before executing this function. The objects will be moved together, so that the two selected vertices are in the same location.

Unshare

This creates new vertices so that each surface will access a unique vertex in the same object. New vertices will be created in the same location as the originals.

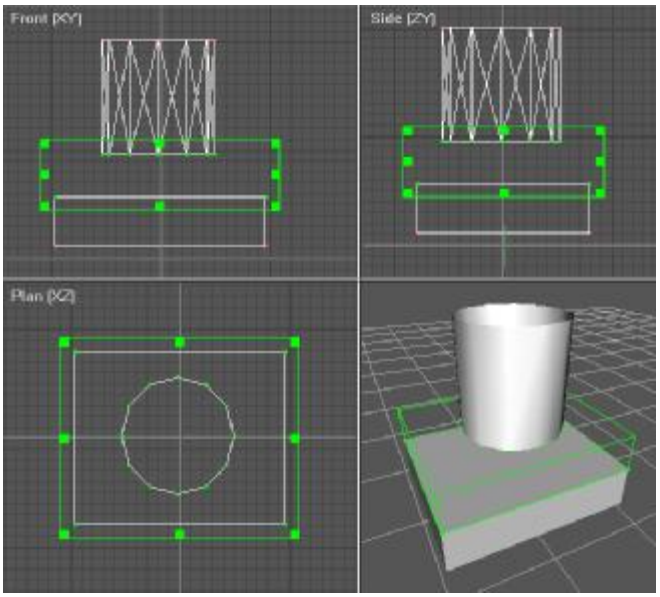
Insert Vertex

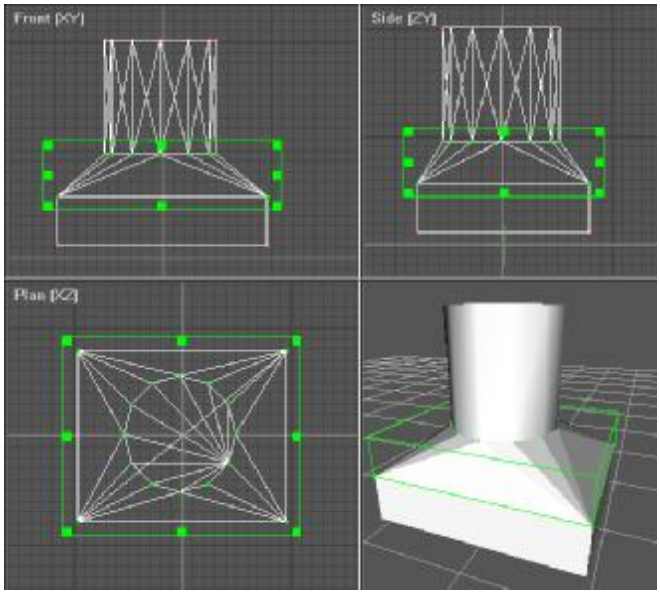
This function inserts a new vertex between each selected pair of vertices. Insert-vertex is useful for adding extra points into a line. One example is to create a grid object (which is made from lines) in a power of 2 dimensions e.g. 8. Press 'Insert vertex' 3 times (2^3=8). You should now have a grid where you can lift each point and create a 3d graph.



Create convex surface/object

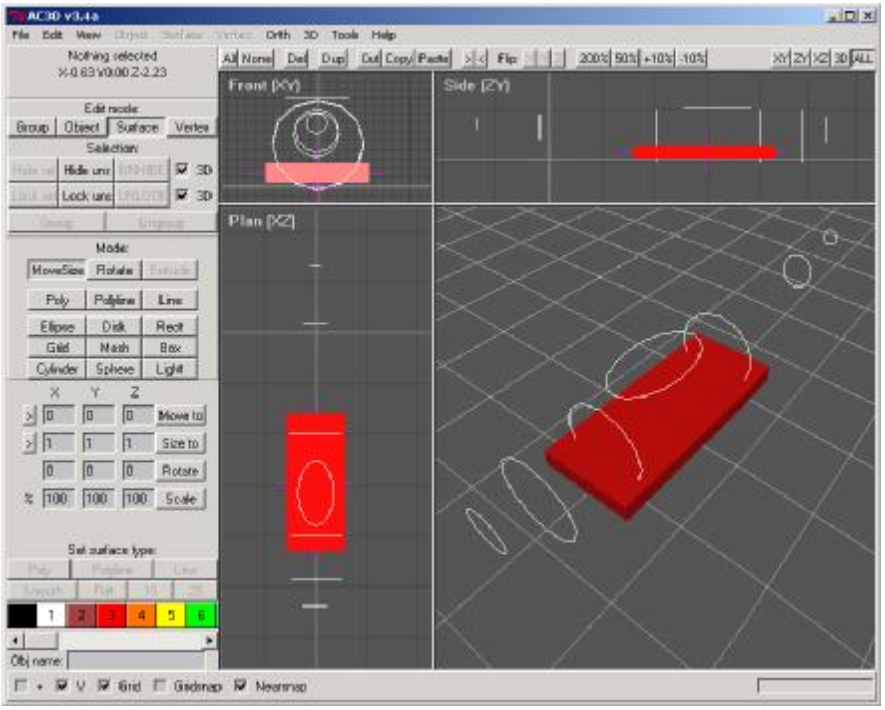
This function uses a technique called 'convex hull' to create a new object that surrounds the vertices that are selected. This is very useful for joining complex objects together or for simplifying the creation of some complex shapes.





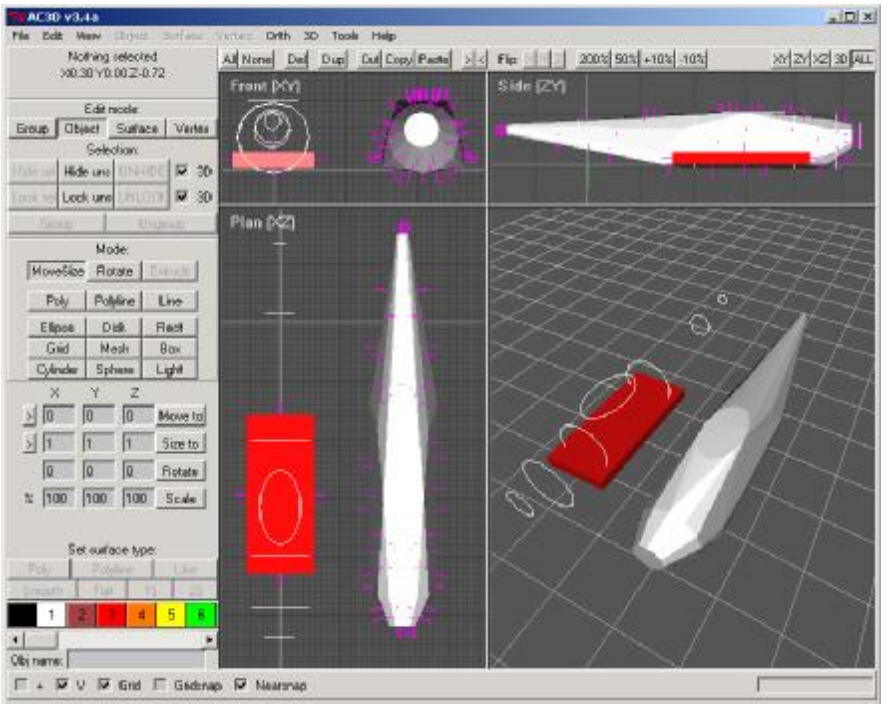
These two pictures show the function being used to join a cylinder to a cube. The new object will always be flat shaded but it can be set it to smooth by pressing the "sm" button on the control panel. Note that because this function makes a new object, the vertices are not shared with the old objects. If the whole shape needs to be smooth then the objects must be merged together with(object->merge) and then have the duplicate vertices removed with (object->optimize-vertices)

A second example uses a number of simple objects, which are 'shrink-wrapped' by this function. In this case we are creating the fuselage of an aircraft. The objects are ellipses and a single red box. Any AC3D objects can be used this way, either lines or polygons.



To get a more accurate outline, these shapes could have be made by placing background images of a real aircraft onto the views and building the shapes on top of those images.

After Surface->Create surface-object menu function has been selected:



This picture shows the fuselage object created from the simple shapes. It's been dragged to the side of the original objects, which still remain in the scene.

It's important to note that the hull created is 'convex'. This means that if there had been an object that was totally 'inside' the encompassing hull, the new hull object would not have any vertices created at the points on that object.

This function will also create 2 dimensional convex hulls, as long as all of the selected vertices lie on the same plane. If they are not, a 3d object will be created.

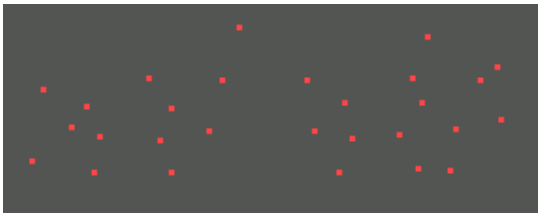
Create ordered surface

This function creates a surface using the individual vertices that are selected. The vertices should be selected in the correct order and in an anticlockwise direction. This function works by creating a new surface and adding vertices in the order they were selected. If vertices are not selected in exactly the correct order, a bad surface (crossing edges or non-planar) may be created.

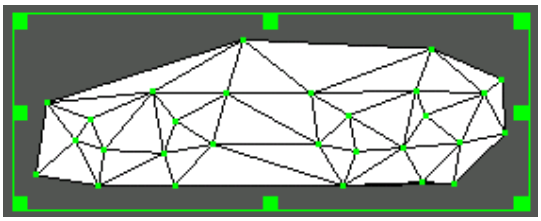
Create 2D mesh

This function uses a technique called 'Delaunay triangulation' to calculate triangles between a set of points. When this function is selected, a plane is specified. This treats the points as 2D so that a mesh can be laid out over the points.

e.g. here are a number of vertices in front window.

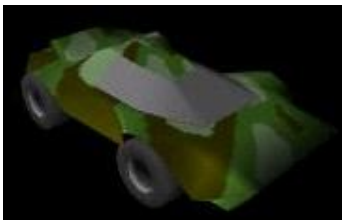


After Vertex->create 2D Mesh->Front is applied:



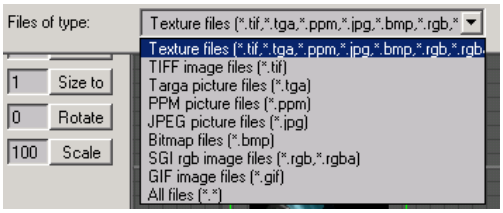
To make vertices specifically for this function, create a line, placing each point at the desired location. Select the line and Surface->remove-surface-only. This removes the surface and leaves the vertices. Note that this function works convexly.

Texturing



Each AC3D object can have one texture. A texture is set from the object->texture menu.

Setting a texture



Each AC3D object can have one texture applied to its surfaces. After selecting an object (or objects), use the menu Object->texture->load-texture to set a texture.

AC3D loads a number of different picture file formats as textures. These include .gif, jpeg etc. More image file formats are available as plugins. To view which formats AC3D can load, see the load texture dialog.

Note that some export formats (or rather the programs that load the files) do not support all the texture file types that AC3D supports. You should ensure that you are using the correct format texture for the correct export file type e.g. .jpg or gif for VRML.

Changing the mapping

Texture coordinates determine how a texture is mapped onto the surfaces of an object. All AC3D objects have default texture coordinates applied to them when they are created. For example a cube has mapping set so that one instance of the texture will appear on each face.

Some file formats do not contain texture coordinates and some AC3D operations may cause these coordinates to become disturbed, in these cases, it it necessary to remap the texture coordinates.

Remapping the texture coordinates

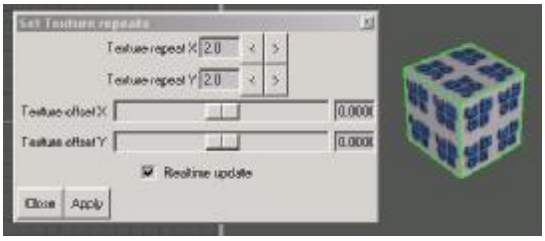
Surface->remap-texture-coors->(front, side, plan) maps the selected surfaces by axis. It finds the bounding rectangle of the selection and uses this for the edge of the texture mapping. Spherical mapping 'wraps' the image around a ball and shrinks it onto the selection. For more powerful texture mapping control, use AC3D's Texture Coordinate Editor.

Changing the texture repeat and offsets

The texture repeat and texture offset for an object can be modified in Object->Texture->set texture repeat/offset. The texture repeat indicates the number of times the texture is to be fitted in to that dimension.

E.g. a cube with texture repeats set to 1, 1 (the default):

Object->texture->set-texture-repeats/offsets and repeats set to 2, 2:



The texture offset determines how far across the texture, the mapping should start.

Texture repeat set to 1,1 and Texture offsets set to 0.5,0.5:

If more than one texture is required on a single object (e.g. a different image on each side of a cube), the object should be split up into parts (e.g. use Surface->cut away object) and different texture mapped on to each of the sub-objects.

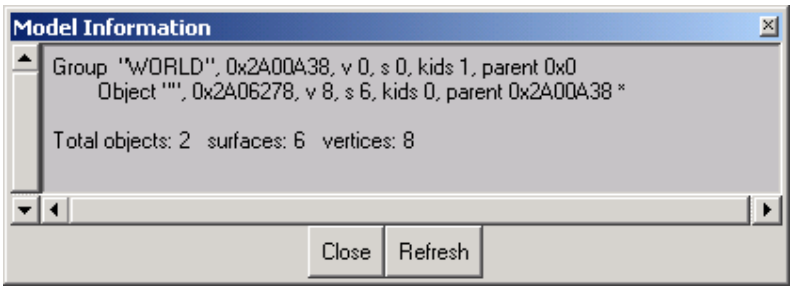
Alternatively, it is more efficient to create a single texture image (i.e. a single picture file containing all the required images) and use AC3D's Texture Coordinate Editor to map parts of the object.

Tools

This section describes AC3D's integrated tools. Other tools are available as plugins. Tools are accessed from the Tools menu.

Model Information

This displays information about the current model.



This shows the information for a single cube. Note that the total number of objects shown is actually two. This is because the 'World' object is included in this count. The internal world object is the top-level container object. This window can remain visible but if any changes occur to the current AC3D model, the 'refresh' button need to be pressed in order to update the displayed information.

Render

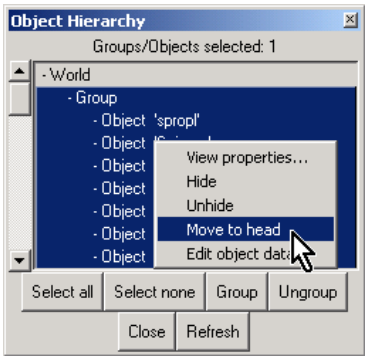
This menu item starts up an external renderer or other linked program. See the rendering section for more information on how this is configured.

Object hierarchy

This window shows the structure of the current model but also allows control over the structure of the hierarchy.

Clicking on one of the items in the list can select or unselect objects. This selection is sensitive to the current select mode being used e.g. in Group select mode, it is only possible to select top-level groups. To select individual objects, switch to Object select mode (using the main AC3D control panel).

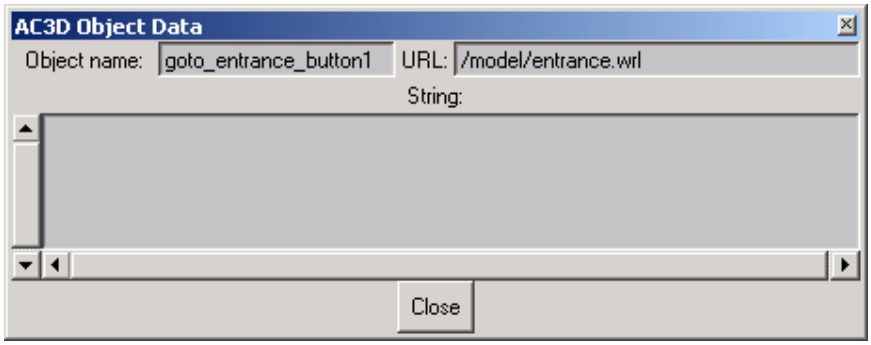
As well as controlling selection and grouping of objects, a right click on an object item will reveal a popup menu:



This allows control over hiding, a more detailed properties viewer, editing object data and the option of moving an object to the head of the children list.

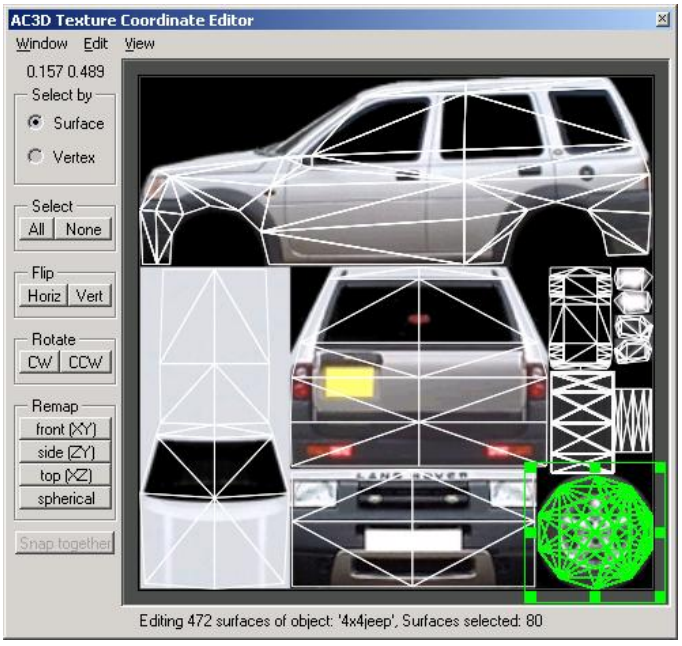
Edit Object Data

Every AC3D object can have a url (web link address) and text data attached to it. This is a string of text. This data is saved in the AC3D file, along with the object geometry information.



This interface shows that the current object is named 'goto_entrance_button1' and the object has a URL attached. Some export data formats supported by AC3D use this URL and object data. e.g. objects in VRML files will have a link generated around them if a URL is present, and Povray objects can include object data text at the end of each object description (allowing custom povray commands to be added).

The Texture Coordinate Editor



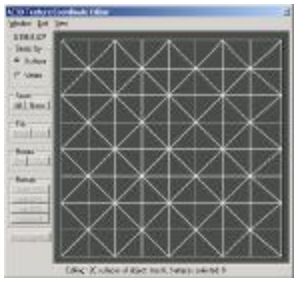
AC3D's integrated Texture Coordinate Editor (TCE) allows full control over the texture coordinates that are applied to all surfaces in AC3D objects.

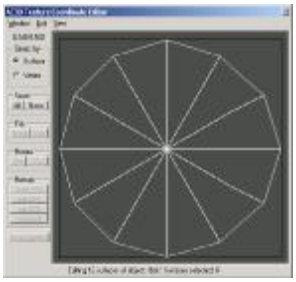
To start the TCE select: Tools->Texture-Coordinate-Editor.

To edit the texture coordinates of an object, select a single object, or surfaces from a single object should be first selected (in the main AC3D windows). The TCE runs in conjunction with the main AC3D program so you can switch between

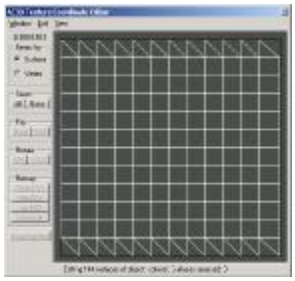
the windows, selecting the surfaces and objects you wish to edit. Note that if a group object is selected (which has textured children) then nothing will appear in the TCE. In this case, switch to Object select-mode and select a single object.

The surfaces selected in AC3D will appear in the TCE according to their texture coordinates. All AC3D primitive objects (those created from the control panel) have default texture coordinates e.g.


Mesh


Disk


Cylinder


Sphere

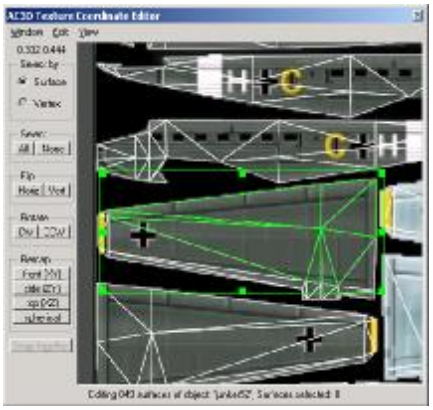
It's important to realise that the pictures here represent the coordinates that are attached to each vertex reference in each surface, and have no relation to the layout of the actual object vertices.

Note that the pictures above show the texture mapping for objects that have no textures applied. If there is a texture, it will be shown in the window.

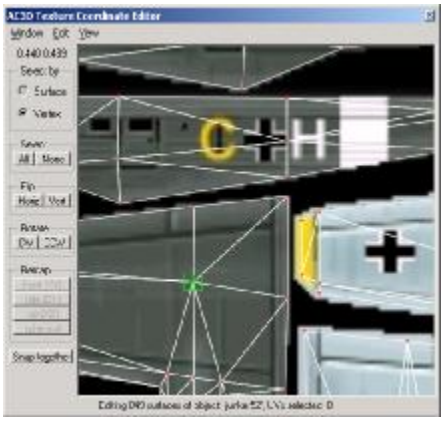
Selecting and manipulating

When surfaces are selected in AC3D and the TCE is visible, the texture coordinates of those surfaces are all visualized. The TCE allows editing of all or a subset of the texture coordinates.

The TCE has two modes of selection, Surface and Vertex. In Surface select mode, the texture coordinates are selected, moved and size by manipulating individual surfaces. Vertex select mode allows individual texture coordinates to be manipulated.

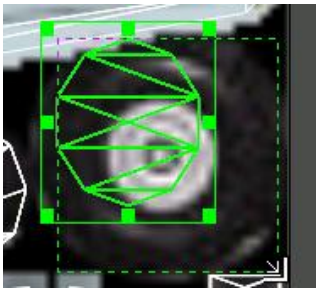


Surface select mode

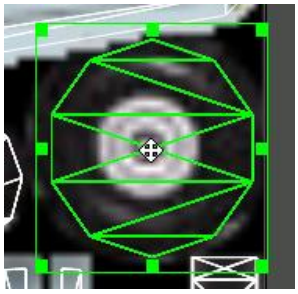


Vertex select mode

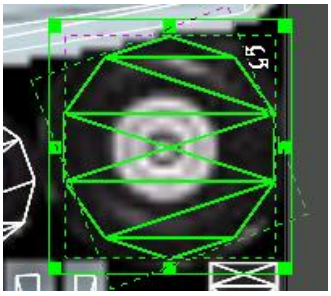
Manipulation in the TCE is similar to the main AC3D 2D views. After a selection is made, the green bounding box can be moved; the handles can be dragged to resize the selection and the selection can be extended and negated (shift-left mouse, shift right mouse). The selection can also be rotated using the mouse. When the mouse pointer is over the edge of the bounding box, the pointer changes to indicate that if the left mouse button is dragged the selection will be rotated.



Resizing

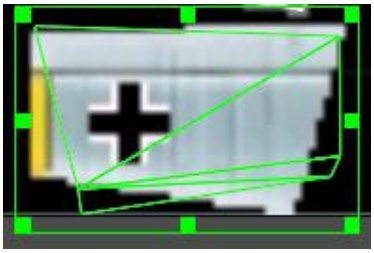


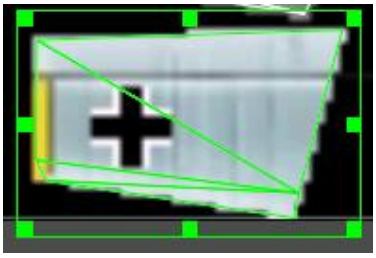
Moving



Rotating

The Flip buttons mirror the selection either horizontally or vertically.

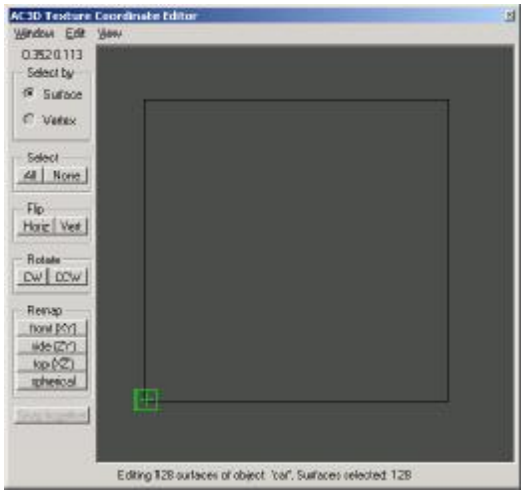




e.g. flipped horizontally

Remapping the selection

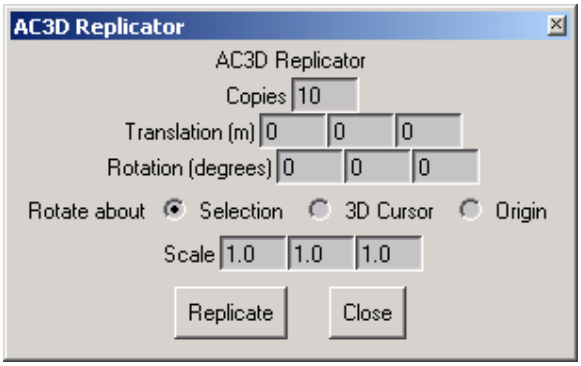
The 'remap' buttons on the TCE perform the same function as the Surface->remap-texture-coors menu items in AC3D. The 'Front', 'Side', 'Top' buttons 'project' the texture onto the surfaces in the specified axis. The bounding size of the selected surfaces determines the boundaries of the mapping. The 'Spherical' button cause the texture coordinates to be 'wrapped' around selected surfaces.



It is possible that after starting the TCE and selecting an object, the window appears blank. It's likely that the object has zero value texture coordinates e.g. each surface-vertex reference has 0.0, 0.0 as a coordinate. In a case like this, a 'Select all' in the TCE would reveal that all of the coordinates are set to 0, 0.

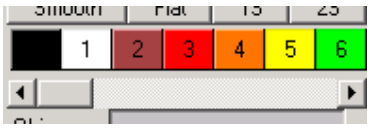
In this case, you will need to make sensible coordinates for your model, probably in groups. Do this by selecting a number of surfaces (from within AC3D) and using the remap buttons to assign a mapping to the texture coordinates. You can then reposition and size the surfaces in the TCE and map them onto a texture.

Replicator



The replicator allows multiple copies of the selection to be created. Each copy can be moved, rotated and scaled.

Materials and the palette



The scrolling window of buttons near the bottom of the control panel represents the colours/materials available. The default colour for an object is palette entry 1 (usually white)

The colored buttons are pressed to change the material on the currently selected objects/surfaces. Setting the material of surfaces works in all selection modes but for a surface to change color in Vertex mode it must have all vertices selected.

Note that the colour on the palette button represents only the diffuse RGB values for that material.

New palette buttons are appended to the list when a file (containing extra materials is loaded.

When surfaces have a texture as well as a material, that material can affect the way the texture appears. To make a texture to appear as the original coloured image then the surface color should be white.

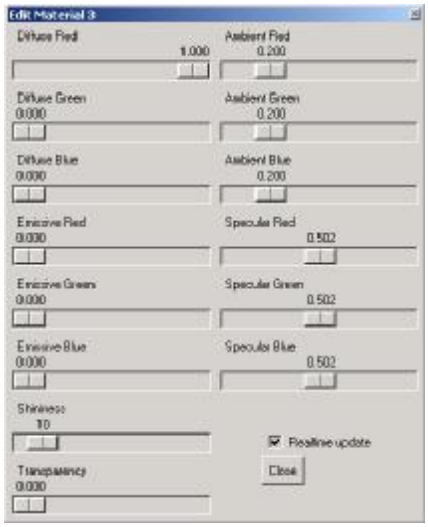
To find the material index of an existing polygon, select that surface and the message at the bottom of the AC3D window will display the material number.

Editing Palette entries

Pressing the right mouse button on a palette button pops-up a menu. The options are to edit a colour or add a new one (a copy of the selected material will be added to the end of the list).

If the 'realtime update' option is selected, the AC3D view windows to be redrawn every time a change to the edited material is altered.

Transparency is supported in the palette but for purposes of speed, the surfaces are not sorted when they are rendered into the views.



Loading and saving files

An AC3D file (usually named <something>.ac) is a text file describing the geometry of a model. AC3D files retain all available information about a model built with AC3D e.g. textures, surface settings, materials, object data etc. Other file formats exported by AC3D may not retain all of this information. Models should always be saved in this format to ensure that no detail is lost.

Developers can view a description of the file format on the AC3D home page.

AC3D files are loaded by selecting File->Open. This will replace the current model. To load models in addition to the current model, use File->Merge.

A list of the most recently opened files appears on the File menu. Selecting one of these causes it to be loaded.

Importing other formats

See the File->Import menu for a list of file types that AC3D cam import.

Full versions of AC3D come with a number of extra Import/Export plugins that handle more file formats.

The following formats may be useful for importing your own model data.

Triangle files

The format of triangle file is: each line contains 9 floating point numbers and one hex value e.g.: 0.0 0.0 0.0 1.0 0.0 0.0 1.0 1.0 0.0 0xffffff represents 3 vertices of a triangle. hex value is 0xRRGGBB col - in this case white duplicate vertices are aggregated when loaded.

Vector files

This is another simple format for importing 2D vector data. Each line should consist of a number of vertices followed by the same number x/y coordinate pairs e.g.

3 0.5 0.5 2.5 2.5 10 5
This represents a line with 3 vertices (0.5, 0.5)(2.5, 2.5)(10, 5)

Exporting files

AC3D can generate output files for many different formats. Support for extra file formats are added by installing AC3D plugins. See File->export for a list of the output files supported. Not all are mentioned here.

VRML 1

Object URLs (set from the object data dialog) are used so that objects will be selectable in the appropriate browser. The output of normals and textures can be switched on/off in the File->settings window.

VRML 2

Output of normals and textures is switchable via Settings.

DIVE

Dive files will handle textures. The Dive generation will include the dive data (if you have input any) this is usually TCL code. If an object has a URL then the object will be a dive gateway. See www.sics.se/dive for more info about the Dive VR system.

MASSIVE

Massive is a distributed VR tele-conferencing system written by Chris Greenhalgh at Nottingham University in the UK. It runs on SGI and Sun platforms. For more details, see: http://www.crg.cs.nott.ac.uk/~csm/massive.html

RENDERMAN

These files are used in a raytracer. See http://www.bmrt.org for a good rendering tool (BMRT) and other pointers to Renderman related stuff. The eye viewpoint is defined by your view position in the 3D window (approx). Note that lines will not be output. Any polygons that need triangulating (breaking up into triangles) will be triangulated.

POVRAY

Povray is a very popular raytracer see www.povray.org for more info. The eye viewpoint is defined by your view position in the 3D window. (In Spin mode the viewpoint will be approximate, for a more accurate viewpoint position, switch to walk-mode in the 3d window). The colour palette is output at the top of the file (each entry has the same number as the AC3D material). The properties can be altered easily to provide different surface types and textures (you might need to add some #includes to get external definitions). The light is output at the end of the file. The lights position is the same as the viewers. The POV-Ray output is based on triangles - lines will be ignored and polygons with > 3 vertices will be triangulated automatically.

Tools->edit object data can be use to attach information to objects which is then generated in the povray file. You need to tick the setting (File->settings) for 'Use object data in POV files'. You will probably want to enter a POVray include command in to the settings 'POV header' e.g. #include "glass.inc".

See the Rendering section for an example.

Triangle files

see loading triangle files for a description of this format. This format is very simple and is easy to parse.

Rendering

The "Render" button in the tools menu can be configured to automatically launch your favourite renderer. The command executed when the button is pressed is entered in the settings.

The command is actually a TCL string. TCL commands are separated by ';'. by default, AC3D is configured to generate a POV file, then execute povray. An example command for POV is:

```
ac3d write_POV ac3dpovfile.pov ; ac3d execute {"C:\Program Files\POV-Ray for Windows v3.5\bin\pvengine.exe"  /RENDER ac3dpovfile.pov }
```

you may need to edit this command and set the correct location of the povray program.

and for BMRT:

```
ac3d write_rib /tmp/ac3dribfile.rib ; ac3d execute { rendrib -d /tmp/ac3dribfile.rib &}
```

The first part sends a message to AC3D to write a POV file. The second part sends a message to AC3D to execute the povray program. This will only work if povray is somewhere on the default search path - you might need to specify a full pathname to the binary program. The execute command must be surrounded by {} NOT quotes (").

Under WINDOWS it's slightly different:
ac3d write_POV ac3dpovfile.pov ; ac3d execute {"C:\Program Files\POV-Ray for Windows\bin\pvengine.exe" /RENDER ac3dpovfile.pov }

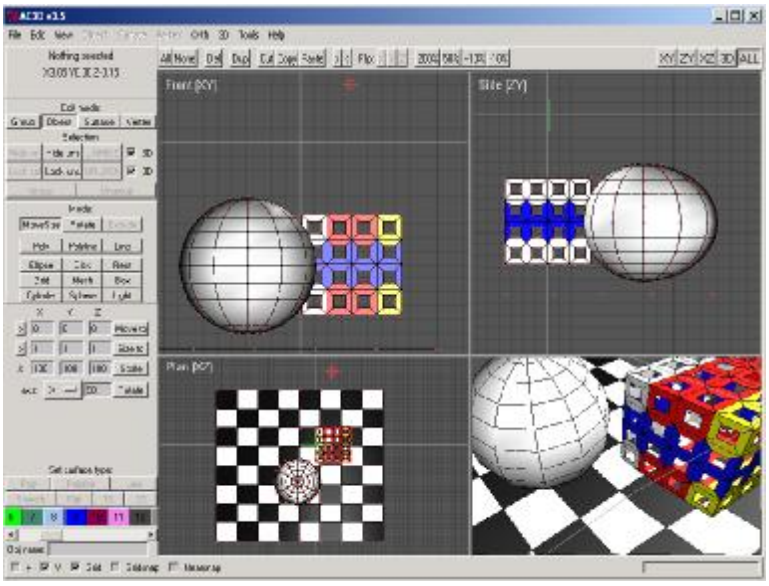
For other renderers - the other AC3D write_ commands are:

```
write_dive
write_vrml
write_massive
write_rib
write_POV
```

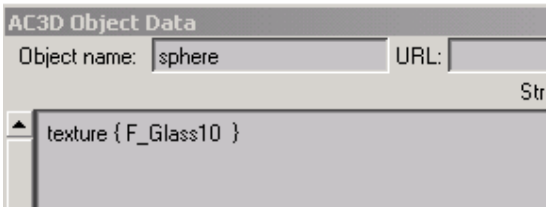
A POVray example

Povray is a very popular raytracer-see www povray.org.

This example shows a very simple model consisting of a mesh, a sphere and a cube that's been divided a couple of times (with Surface->divide) then had a Surface->make-hole. There's also an extra light.



The sphere has had a pov texture specified using the Tools->edit object data (the appearance of the object in AC3D will be unaffected by this):



The settings in file->settings were:

And the render command (also in File->settings) was:

ac3d write_POV ac3dpovfile.pov ; ac3d execute {"C:\Program Files\POV-Ray for Windows v3.5\bin\pvengine.exe" +W300 +H300 +A /RENDER ac3dpovfile.pov }

Selecting Tools->render gives:

The Povray exporter supports bitmap-textured objects. You should ensure that the format of the texture picture files you use are compatible with POV-ray.

Appendix

Performance tips

Rendering more polygons takes more time. As a larger number and more detailed objects are edited, the rendering will take longer. Here are some tips to help edit larger models more effectively.

Switch to wireframe viewing. This is much faster to render.

Use object hiding and locking. This reduces the graphics load.

Edit in only one maximised view. This prevents all views from being updated every time you make a change.

If surfaces can only be viewed from one side, set them to single-sided. This is slightly faster to draw.

Switch on move-wireframe in both the orth and 3d menus. This temporarily sets the drawing to wireframe when being panned or zoomed using the mouse – much faster.

Use Object->reduce to reduce the number of vertices/polygons in an object.

Keypresses

Key shortcuts for menu items are shown on the menus. Other keys can be used:

In orthographic (2D) windows:	
Key	Function
Cursor-keys	move view
Shift-Cursor	move view faster
Control-up	zoom in
Control-down	zoom out
Shift-Control-up	zoom in with larger step
Shift-Control-down	zoom out with larger step
Alt-Cursor	move background image
Alt-shift-cursor up/down	Scale background image

Backspace/Delete	delete current selection
Space	home windows to origin and reset zoom in each window
t	Toggle textures
o	set select mode to OBJECT
v	set select mode to VERTEX
s	Set select mode to SURFACE
m	set drag mode to MOVE
R	Set drag mode to ROTATE
e	set drag mode to EXTRUDE
f	fit selection to window
F/control-f	fit selection to all views (Control f fits everything to all views)
G	centre window at centre of selection
H	hide selected objects
z	zoom in
x	zoom out

Some of the keys for the 3D window have equiv. menu item in the 3D menu.

In the 3D view:	
Key	Function
W	Wireframe/filled toggle
T	toggle textures
L	toggle headlight
G	toggle 3d grid
f	fit to window
Space	Reset view to origin at the default scale

Cursor-keys - spin model in 'spin-mode', control viewpoint in a similar way to 'quake' in walk mode e.g. left, right, forward back, alt-up/down move up/down, control-up/down tilt.

Preferences/settings

The settings in File->settings are saved automatically when you exit AC3D.

This automatic saving can be switched off (you must save the settings with this off for the change to be remembered). Some settings such as the background colours of the windows can be adjusted in the settings file but beware – changing values that you don't know about could cause AC3D to behave unexpectedly or crash.

Under Unix, the settings are saved to $HOME/.ac3dprefs. Under Windows, they are saved to the users home directory as ac3dprefs.txt.