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LASETUP version 7.0

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What is it?

LASETUP is a geometry creator and editor. It lets you make geometric objects and examine them interactively for validation.

Where can I find it?

You can find a version that runs on SGI hardware at ~jxf/lasetup on either of the X Division LANs or on the Los Alamos Common File System at /jdfcom/lasetup −− a PostScript file of this document named lasetupdoc.ps can be found in the same places. On the Web, go to www.t12.lanl.gov/~lagrit. When you run LASETUP, the version number appears on the window title bar.

Does it run on other platforms? How about across the network?

LASETUP uses the X Window System, the MOTIF widget set, and OpenGL for rendering images. It is written in C. Versions have been made for Solaris Ultra systems and for the HP systems that have OpenGL, but I don't routinely do this. If you need a version for one of these or any other system that has the libraries listed above, let me know.

To run it across the network, your workstation must have the GLX extension to X. You can check this by running xdpyinfo and checking near the top of the output under "number of extensions". LASETUP has been successfully run from an SGI box to a Windows NT system with Hummingbird Exceed software.

What file types does LASETUP work with?

It can read and write files for the LaGrit grid generator. It can also read AVS geometry files consisting of triangles and/or quads, and stereolithography (STL) files. Many CAD systems can create STL files.

How can I create objects with LASETUP?

The first step in geometry creation is to define some surfaces. Then you can use Boolean operations on the surfaces to make regions.

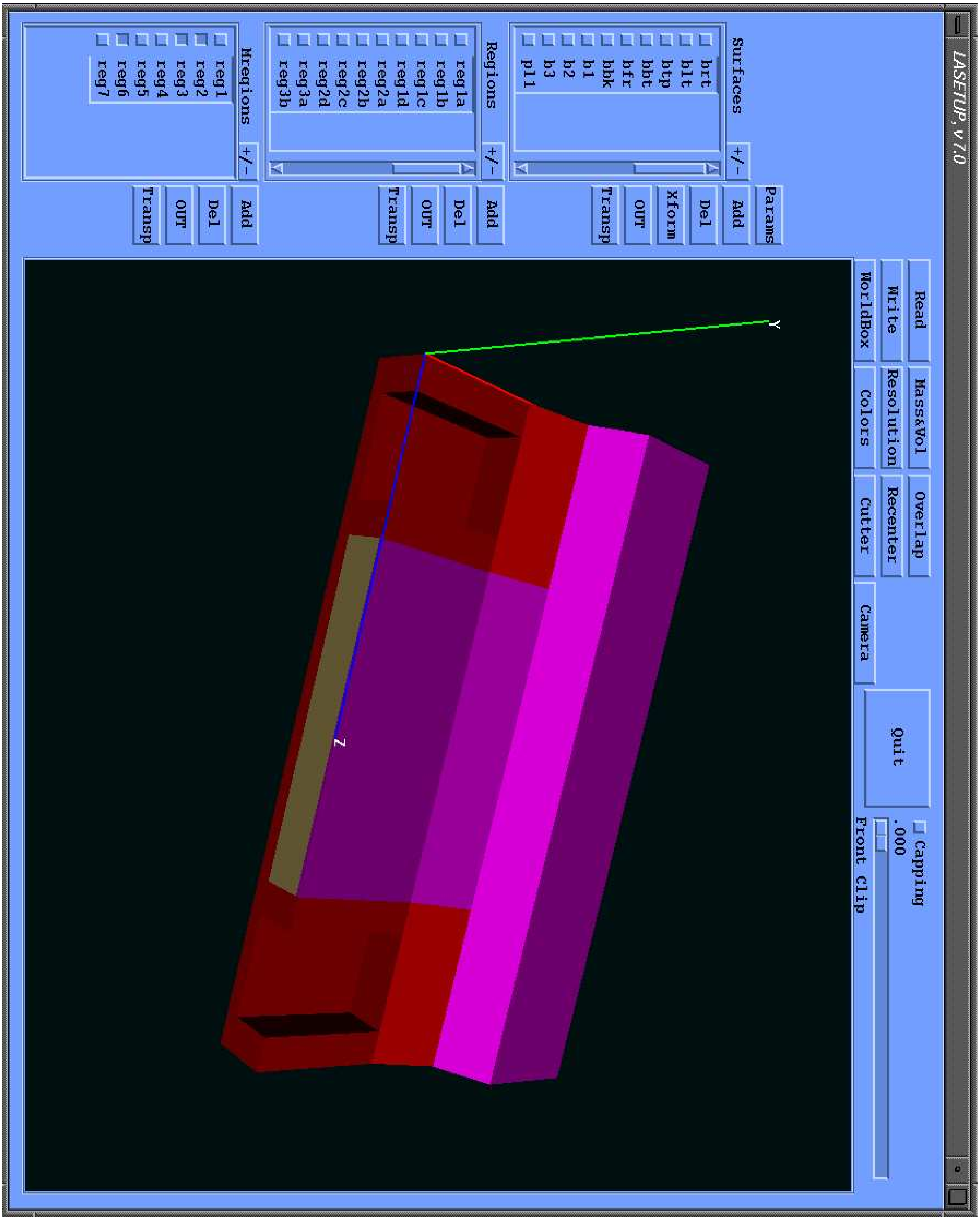
What kinds of surfaces can I make?

You can make the following surfaces with LASETUP:

plane normal to the x axis −− specify the x value
plane normal to the y axis −− specify the y value
plane normal to the z axis −− specify the z value
plane passing through three points −− specify the three points
plane in spherical coordinates −− specify three values of r, theta, and phi, and the origin
box −− specify xmin, ymin, zmin and xmax, ymax, zmax
closed cylinder −− specify radius and two points on the axis that define the end caps
sphere −− specify center and radius
cone −− specify radius and coordinate of base on axis and apex coordinate
ellipsoid −− specify center, vectors defining major and minor axes, and three radii
parallelopiped −− specify coordinate of base and three vectors
torus −− specify center, normal direction, and major and minor radii
any closed surface presented in an AVS or STL file
tabular surface of revolution

What happens when I run LASETUP?

Here's the LASETUP main window.

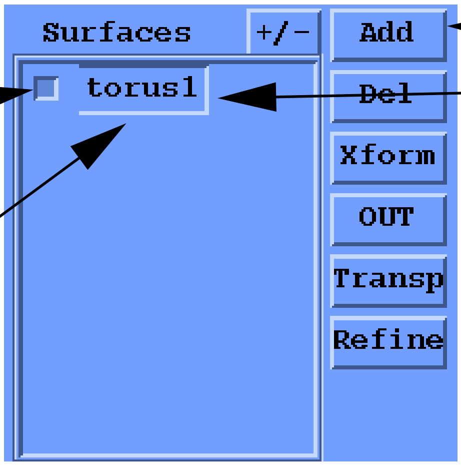


How can I use LASETUP to make surfaces?

On the left side of the LASETUP main window, you will see the "Surfaces" grouping, shown below. If you click on "Add", the "Add Surface" panel will appear. Then you can click on the desired surface type and fill in the blanks.

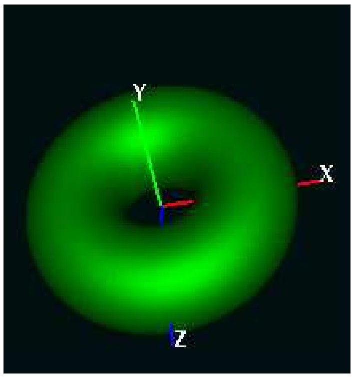
visibility button

When you add a surface, its name shows up here.

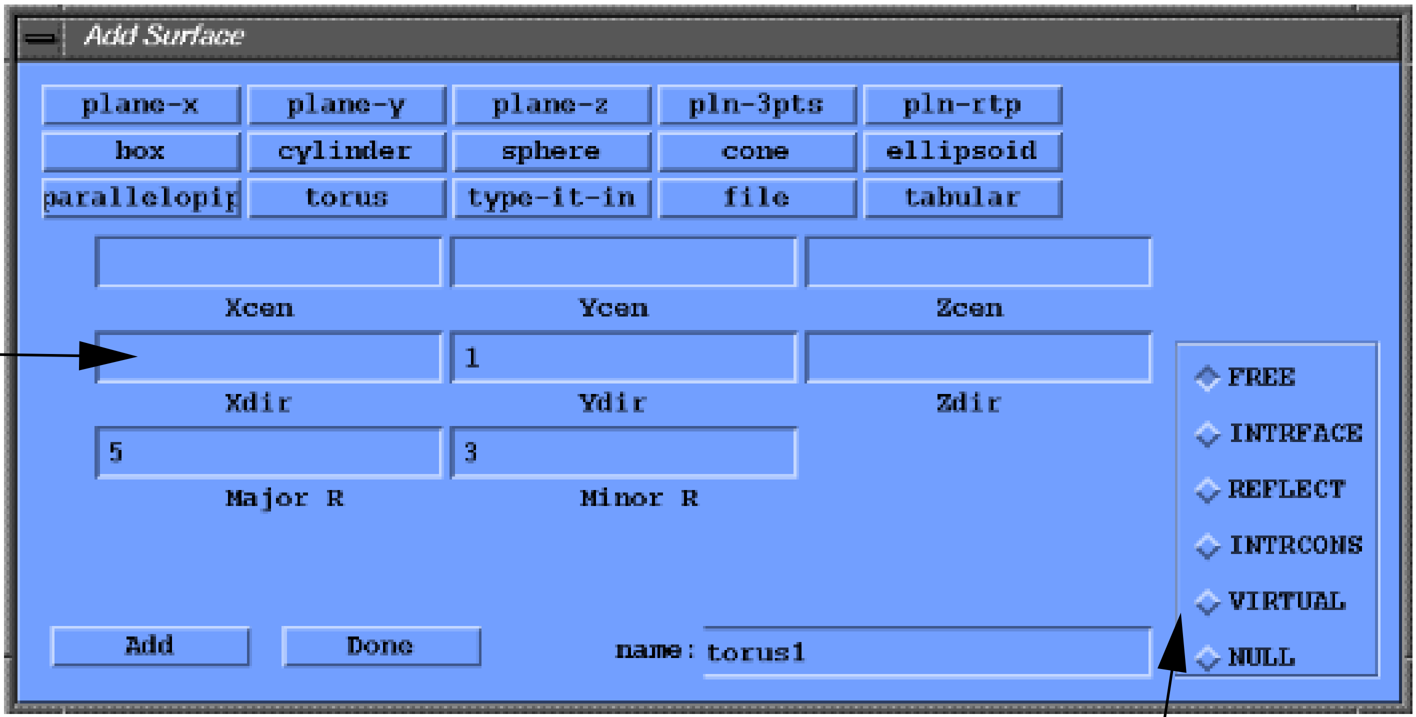


Click here to get

Click on name to select



Defining a torus:



No need to type in 0 values or to insert decimals.

Boundary type -- OSO stuff.

Once you have made a surface, you can view it in the drawing area window. You can turn it on and off by clicking with the left mouse button on the visibility button. You can select it by clicking on its name with the left button. If the "Add Surface" panel is visible, selecting a surface will cause its values to be placed in the "Add Surface" panel so that you can modify them to change the surface or create a new one if you change the name.

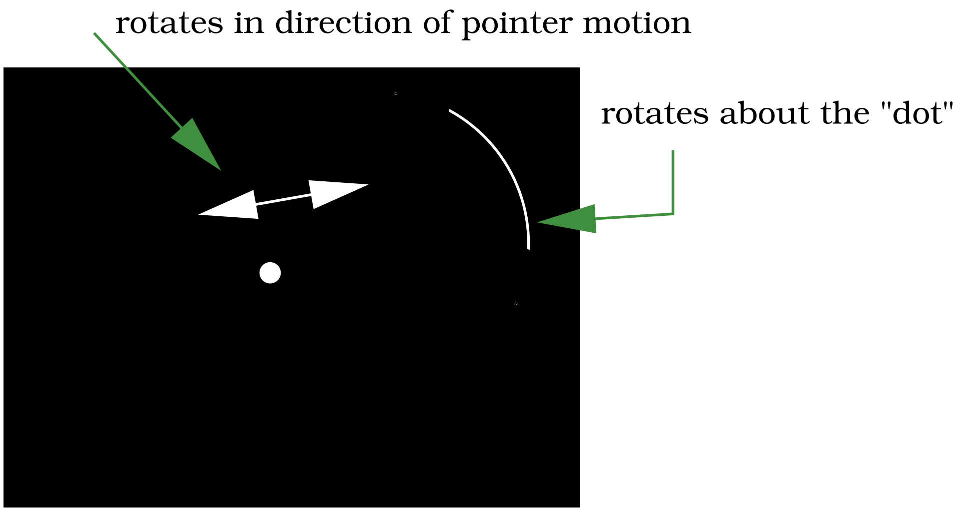
How to translate, rotate, and scale existing surfaces is described near the end of this document.

Why would I want to select something that I have already made?

As mentioned, if the "Add Surfaces" menu is up, clicking on the name of a surface will fill the form with its name and values, so that you may change them. In general, if any menu is up that requires a name, you may type it in the text field provided or if it is already a surface, region, or mregion name -- more about these later -- just click once on the name with the left button and LASETUP will do the right thing, duplicating the name in the text field. All mouse operations use the left button, except for object manipulation in the drawing areas.

How do I manipulate objects in the drawing area?

The left mouse button is for rotation, middle is for translation (panning) and right is for scaling (zoom). Holding down the left button while the pointer is in the drawing area and moving the mouse will cause the object to be rotated -- hopefully intuitively -- in the direction that the pointer moves. If the pointer is near the edge of the window, moving the pointer tangentially will cause the object to be rotated about an imaginary axis that comes directly out of the screen.



Left mouse button operations for rotation

Holding down the middle button moves the object in the direction of pointer motion in the plane of the screen.

Holding down the right button and moving the pointer up and/or to the right magnifies the image. Moving down and/or to the left makes it smaller. If you move the pointer along the other diagonal (e.g. up and to the left), LASETUP will try to zoom and unzoom at the same time and nothing much will happen.

How else can I control the visual appearance of objects?

Clicking on the "Camera" button will bring up a panel that lets you select shading models and projection mode, draw edges, and align with axes. You can also turn off axis drawing.

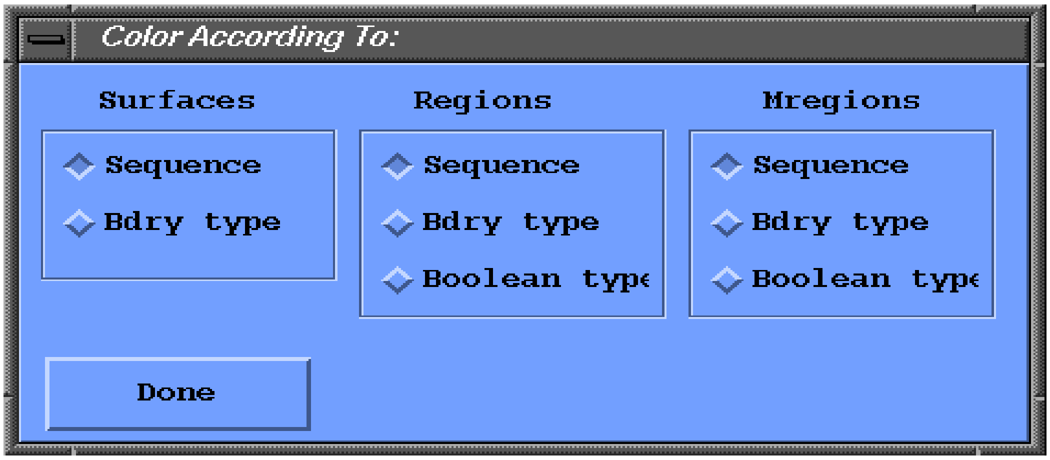
What else do I need to know about object manipulation?

The center of rotation is determined by LASETUP to be the centroid of all the objects that are displayed. When you create a new object, this will usually change and LASETUP will recompute a new center of rotation. If you make an object invisible, however, by clicking on its visibility button, LASETUP will not recompute a center of rotation. This makes it easy to toggle things on and off without having the picture jump around. If you wish to recenter things, you may at any time click on the "Recenter" button.

What are some other drawing-related options?

The Front Clipping slider and Capping button are in the upper right corner. You may use the slider to slice into whatever is being drawn. Objects will appear to be hollow inside, with the inside of their surfaces rendered in a unique color, kind of brownish gray. If you want to make the objects appear to be solid inside, click on the Capping button.

Clicking on "Resolution" will bring up the Tiling Resolution panel. This lets you select a relative fineness with which surfaces will be triangulated. Larger numbers cause surfaces to be tiled with more triangles. It is not retroactive. Any previously created surfaces will have to be remade in order to have their resolution changed. For the most part, surface resolution is a graphics thing and has no effect on subsequent grid generation. The exceptions are AVS and STL surfaces, which are written out as triangles. Also, currently, tori are written as tabular surfaces of revolution due to the fact that LaGrit has no torus primitive. So these will be affected by resolution selection.



The "Colors" button lets you select how objects will be colored: By the sequence in which they were created; by boundary type as determined on the "Surface Add" form when surfaces were created; or, for regions and mregions, by the type of Boolean operations used in creating them. These options are useful for matching boundaries as required by LaGrit.

How do I read and write files?

For LaGrit files, click the "Read" or "Write" button and select or type in a file name. If you are trying to read a file and already have some stuff created, LASETUP will ask you whether to keep or remove existing entities. When you read a LaGrit file, LASETUP remembers everything in the file, but deals only with the geometry part. If later you write it back out, it will write out everything, including any new or modified geometry, as well as all of the nongeometry things that were in the original file. When LASETUP reads a file, it makes the surfaces right away but doesn't actually make regions and mregions until you try to see them.

To write AVS or STL files, click on the "Out" button for surfaces, regions, or mregions. You can read files of these types using the "Add Surface" panel and clicking on "File". When reading an AVS or STL file, you must specify a Mesh Object (MO) name because LaGrit requires it. It is a good idea not to make the MO name the same as the surface name, which you also have to specify.

Tabular surfaces of revolution can either be embedded in a LaGrit input file or can be read in under "Add Surfaces" by clicking on the "tabular" button. These files must be in a special form like this:

```
 $tabular_data
   rz =
    0.000000      -1.000000
    1.000000       0.000000
    1.200000       1.000000
    1.000000       2.000000
    0.000000       3.000000
 $end
```

Currently the only way to write a tabular surface file is by writing a LaGrit file, which will have any tabular surfaces embedded in it.

Can I use parameter names in place of numerical values when creating surfaces?

Clicking on the "Params" button will bring up the "Set/Alter Parameters" pane that lets you associate names with values. You enter names and their numerical values into a list, after which you can use the name in place of the value when defining a surface. LASETUP puts a leading dollar sign on parameter names if you don't. This is done so that parameter names won't get confused with command or object names. If you alter the value of an existing name, you will have to go back and recreate the surface and any regions or mregions that depend on the surface. To recreate the surface, just bring it up in "Add Surface" and click on "Add". We will cover recreating regions and mregions later. There is a maximum of 500 parameters.

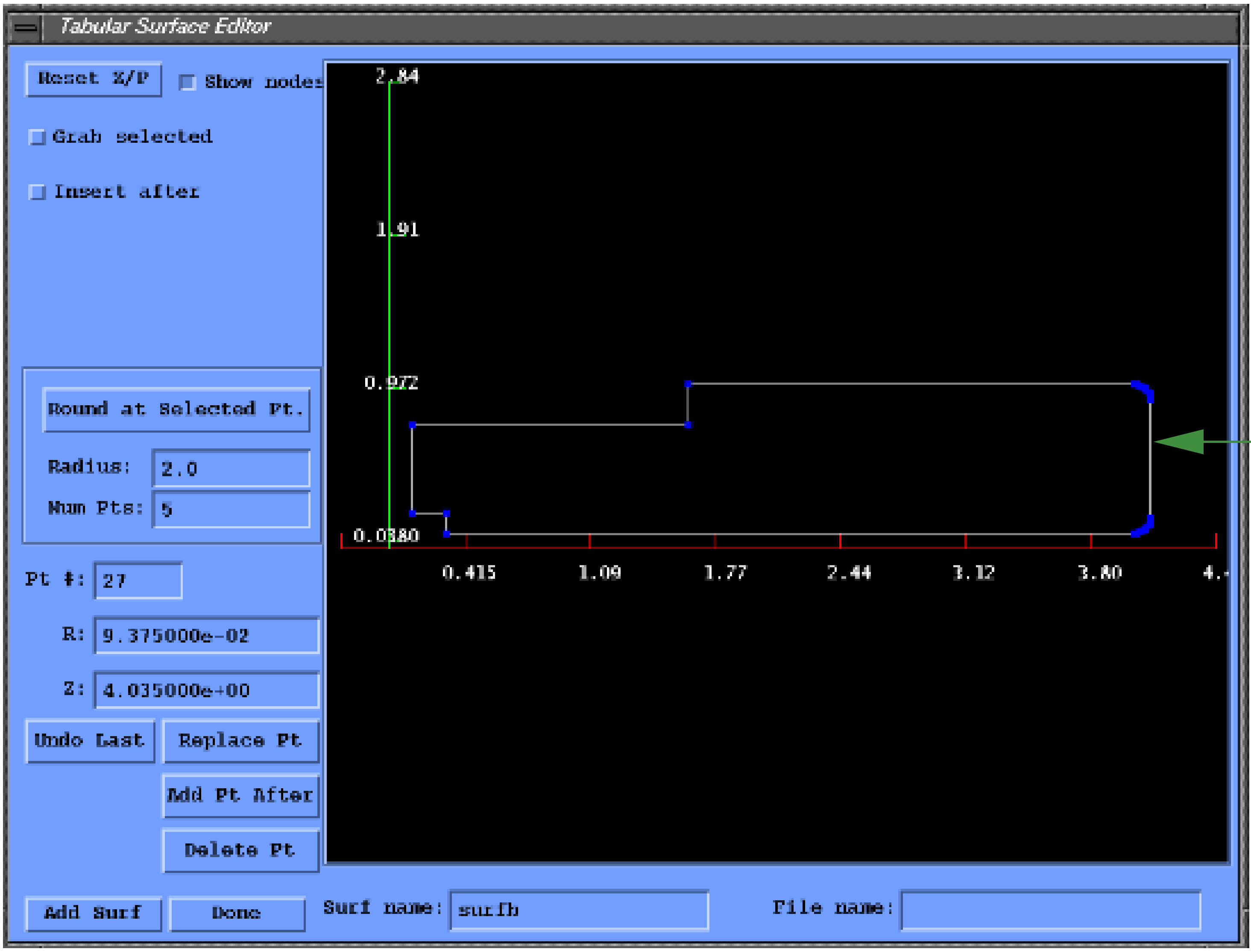
How can I create and alter tabular surfaces?

On the "Add Surface" pane, click "Tabular" and then click "Edit". This will bring up the Tabular Surface Editor panel. Another way to bring up this panel, if you have an existing tabular surface, is to click on the surface's name, while the "Add Surface" panel is up. This automatically puts you in the tabular surface editor with the selected surface displayed.

Although tabular surfaces generally are oriented in three−dimensional space, they are defined in terms of (r,z) pairs where z is the distance along a baseline and r is the perpendicular offset from the line. r must always be non−negative. Regardless of their true orientation, tabular surfaces are always displayed in rz coordinates in the editor.

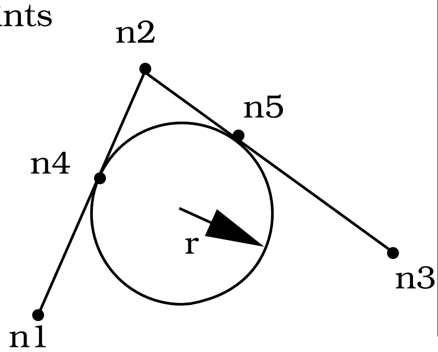
After creating or modifying a tabular surface in the editor, you must click on "Add Surf" in the editor panel in order to save or replace the edited surface. Newly created surfaces will appear oriented on the Z axis. You may orient them more generally using the "Xform" button, to be described later.

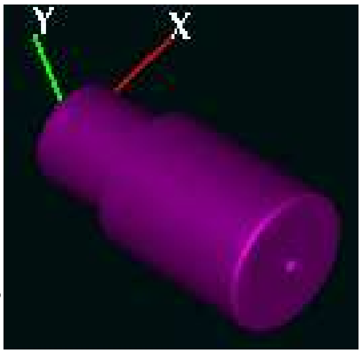
The middle and right mouse buttons when the pointer is in the Tabular Surface Editor drawing area perform pan and zoom, in a manner similar to their functioning in the main window drawing area. Since the Tabular Surface Editor drawing area is 2D, there is no rotation function. The left mouse button is used instead for selection.



The nodes of the surface are shown in blue unless the "Show Nodes" button is deselected. You can select a node with the left mouse button. LASETUP will find the node that is closest to the pointer and will update the point number, R, and Z textfields with the node's values. You can then edit the text fields and replace the node, add a node after it, or delete it. You can also interactively move the node around by selecting the "Grab selected" button. Or you can interactively insert points with point-and-click by selecting the "Insert after" button. "Undo Last" lets you undo the effects of a mistake, but it only goes back one level. You can put in a rounded edge by selecting a node and clicking on "Round at Selected Pt.". First select a radius and number of points to insert if the default values are not desired. This feature offers a nice way to make cylinders with rounded edges.

Rounding works by finding the tangent points n4 and n5, for the circle of radius r, then replacing n2 with the desired number of points along the arc (n4,n5). If r is large enough that n4 or n5 lies outside the two line segments, a failure message will be printed and the tabular surface will not be changed.





This is what it looks like in 3D.

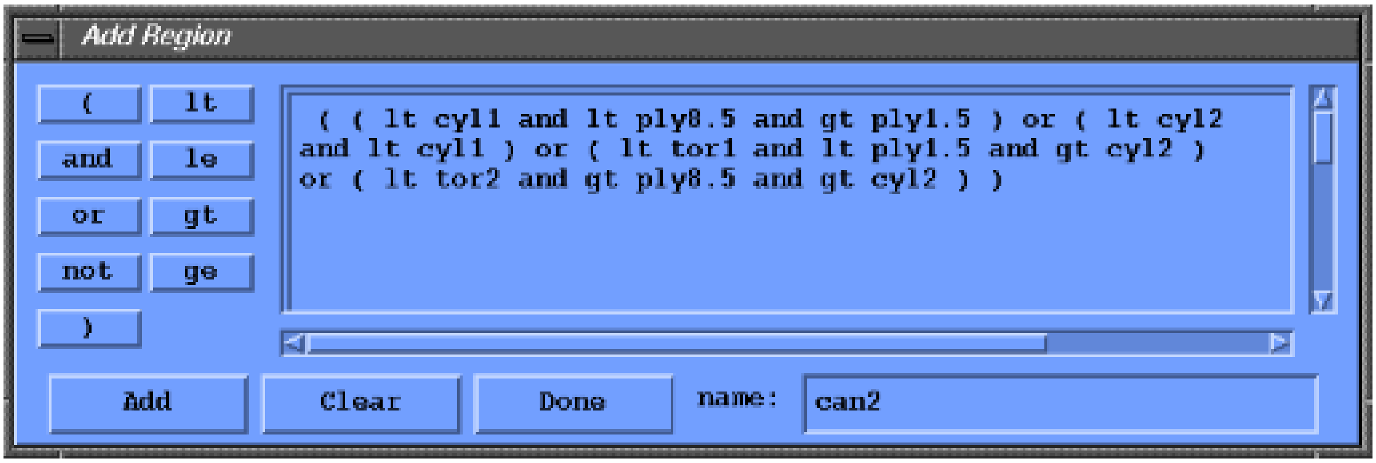
How can I combine surfaces, perhaps with other objects, to make new objects?

LaGrit has two types of object: regions, which are used for gridding, and mregions, which define material objects. They are similar but may be subtly different, depending on the type of grid that you will be making. An interface between two adjacent surfaces will show up in one region and in no mregions. The only place a surface boundary shows up in mregions is on an external boundary.

Other than these rules required by LaGrit, regions and mregions are similar in their construction. Either can be made from combinations of existing surfaces and regions. This is done by constructing description strings using surface and/or region names and Boolean operators. For example, the intersection of two surfaces might be described by:

lt surf1 and le surf2

You use the "Add Region" panel to make or modify regions. This panel comes up when you click the "Add" button in the Region grouping. Here's a fairly complicated example:



You can do all of this with point–and–click or you can type it in or use some combination. Here's what the operators mean:

lt –– inside
le –– inside and on
gt –– outside
ge –– outside and on
and –– Boolean intersection
or –– Boolean union
not –– Boolean negation, used only before region names. To negate surfaces, use "and gt" or "and ge".

For planes, "inside" and "outside" are determined by the unit normal, which points to the outside. You can visually identify the inside by its unique color.

If you click on a surface name or a region name from the surface or region list while the "Add Region" panel is up, the name will be placed in the text string of the "Add Region" panel.

IMPORTANT NOTE: To bring up the definition of an existing region, have the "Add Region" panel visible and DOUBLE CLICK on the region name in the region group list. You can then modify the description and/or rename it.

These observations also apply to mregions.

What does LASETUP do when I make a region?

The first thing LASETUP does is write out a LaGrit file, called ".bkup@", just in case it terminates abnormally in what follows. Next it does some checking of your description string for reasonable names, syntax, and values. If if finds a problem, it will let you know what the problem is and where it is located, and will not proceed further.

If there are no problems with the description string, LASETUP then parses it and builds a Reverse Polish Notation stack of operators and operands. It pulls operands in pairs off the stack and performs the intended operation, one pair of operands at a time. The result may go back on the stack. When the stack has emptied, the desired resulting object is the final operand.

LASETUP does the pairwise Boolean operations by intersecting every triangle in object A with every triangle in Object B. After all of the edges of intersection have been found, any intersected triangles are retriangulated so that each resulting triangle in Object A is either inside or outside of Object B, or is coincident with its surface, and vice versa. A new object is then composed by taking the appropriate triangles from each of the parent objects. For efficiency, LASETUP uses K-D (binary) trees for finding which triangles might overlap, hash tables for list insertion, and O(n logn) or better algorithms for retriangulation. Typically LASETUP can combine 10 or so object pairs per second, but this depends on the resolution of the original surfaces and the number of triangles in intermediate children. A very complicated region might take 30 seconds to make, but this is rare.

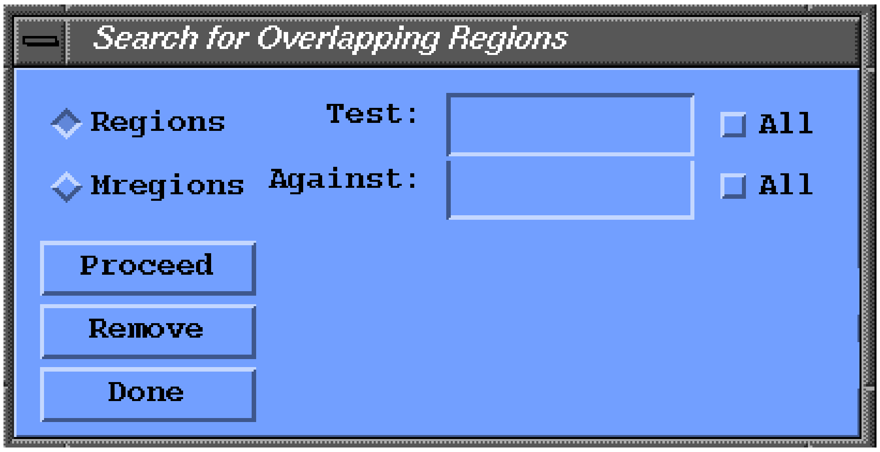
Once made, the objects can be manipulated in real time at several frames per second.

Please note that approximations due to this triangulation process have no bearing on the quality of the grid made by LaGrit, since it is the *descriptions* of surfaces and regions that are passed to LaGrit, not the triangles -- except for STL and AVS files, and tori as mentioned earlier.

As mentioned earlier, when you read a LaGrit file with regions or mregions, LASETUP won't actually construct those objects until you try to look at them or at an object that depends on one of them. Since it takes some time to make a region, to make them all at file-reading time would slow this operation perhaps unnecessarily.

Can I test regions to see if they overlap other regions?

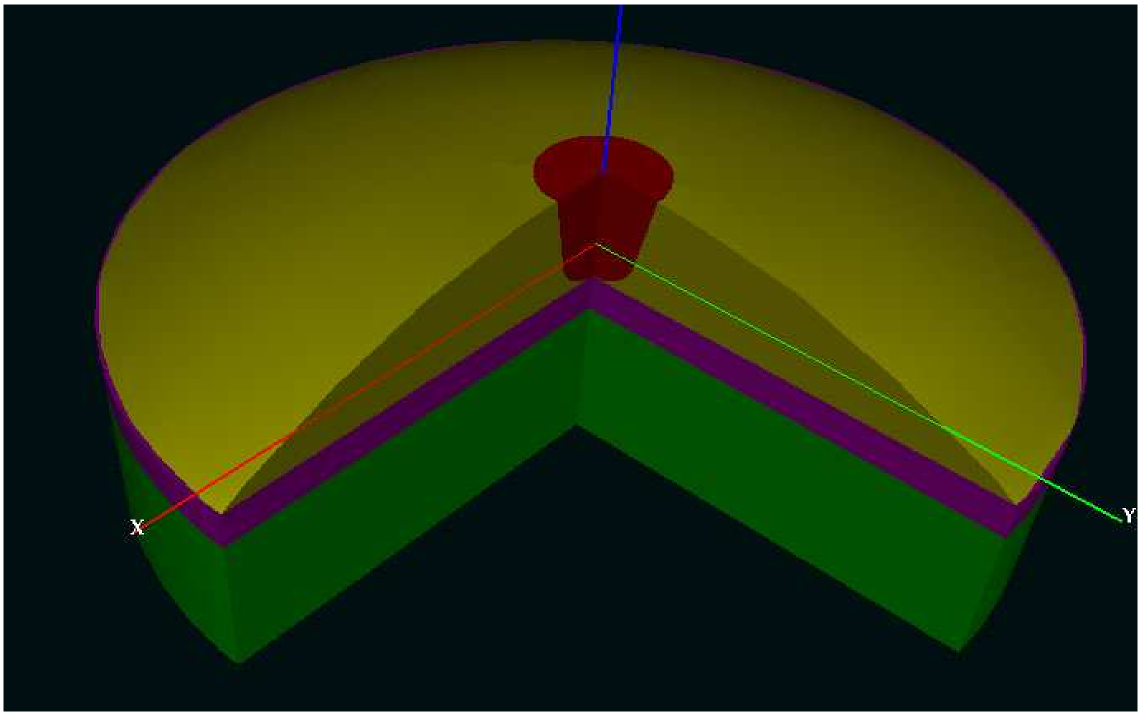
Click on the "Overlap" button to bring up the "Search for Overlapping Regions" panel. This will let you test individual regions against others, single regions against all, or all against all. If overlaps are found, messages will appear in the window that you ran LASETUP from, listing the number of triangles found to be overlapping. Also, if you just test one region against another, the overlapping triangles will be drawn in white in the drawing area.



Because of the faceted approximation used in triangulating ideal surfaces in LASETUP, you may occasionally get overlaps where in truth none exist in the idealized intersections. You can usually tell when this happens because there will be very few triangles, and they will be very thin and will not form a closed object. In some cases you might not be able to see these triangles because they are so thin.

What's the "Cutter" button for?

You can use any surface that you have created as a cutter body for subsequent region or mregion creation. This is for visualization only and is useful for such things as removing a slice from a set of objects so that you can see inside.



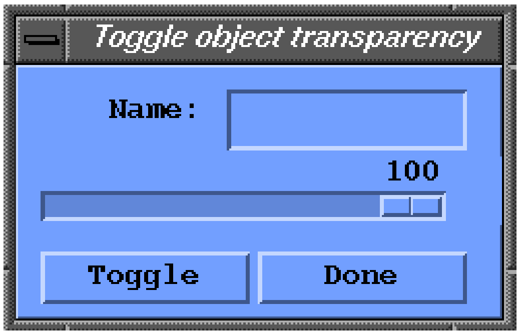
Using a box as a cutter body for visualizing the inside of an assembly.

How about "Mass & Volume"?

This brings up a panel that lets you enter the name of any surface, region, or mregion, and optionally a density. It computes the volume and optionally the mass of the triangulated approximation to the object. Accuracy depends on the resolution with which the surfaces were made. For the default resolution, the first three figures are probably accurate. This is just intended to be used as a reality check, not for accurately determining volumes and masses.

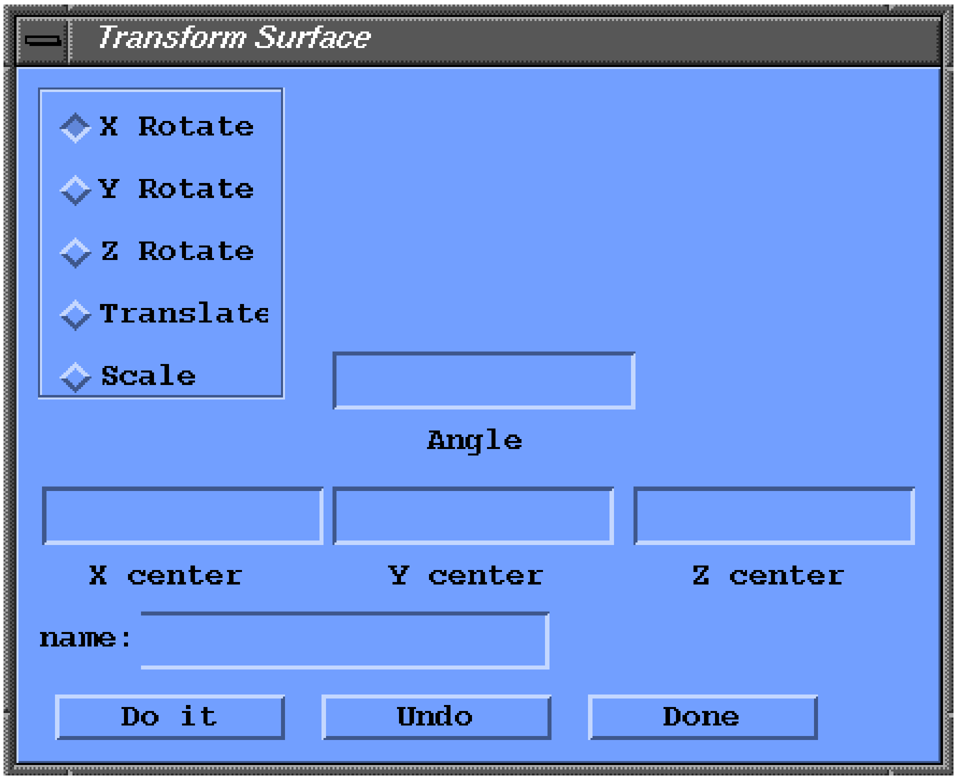
Can I make objects transparent?

Use the appropriate "Transp" button for this. It brings up a panel that lets you select opacity with a slider and toggle it on or off. You have to click on "Toggle" to get it to work.



How about translation, rotation, and scaling of an existing surface?

In the Surface group, click on "Xform" to get the Transform Surface panel. You can use it to rotate about any of the three major axes, or to translate or scale a surface. There is an "Undo" button for getting you back to where you were in case you made a mistake. "Undo" can take you back up to 20 levels.



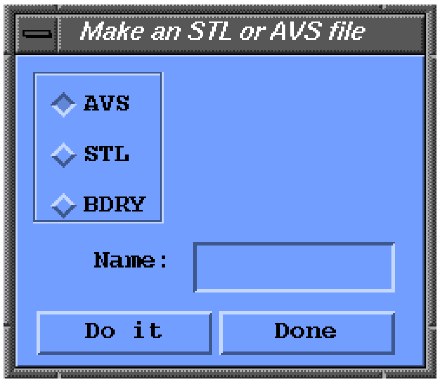
Del, Out, Transp: Why are there three sets of buttons?

These buttons bring up panels that operate on surfaces, regions, or mregions. Since a surface and a region, for instance, can have the same name, LASETUP would have trouble figuring out which one you meant if there were only one button. So there is a button for each of these groups.

What do they do?

"Del" lets you delete an object. If this object is used in something else, for instance a surface that defines part of a region, LASETUP will remind you of that and ask if you really want to delete it. You can delete it, but the dependent object will then be broken.

"OUT" lets you write an AVS, STL, or BDRY file. A BDRY file is an AVS file containing the line segments that make up the intersection edges of the object.



What about the "+/−" buttons?

These let you toggle visibility of all surfaces, regions, or mregions. You may have to click twice to get it to work the first time. For regions and mregions, only those that have already been made will be toggled. Remember that regions and mregions are not automatically made when you read in a file. They are made the first time that you click on their visibility button.

Worldbox?

LASETUP defines a box that holds all of its objects. The size of this box may change as you add surfaces. You can look at the worldbox dimensions and change them by clicking on "WorldBox". You will probably never need to do this. The main effect is that when LASETUP makes a plane it is extended out to the edges of the worldbox. If the worldbox changes, LASETUP will recreate all of the planes.