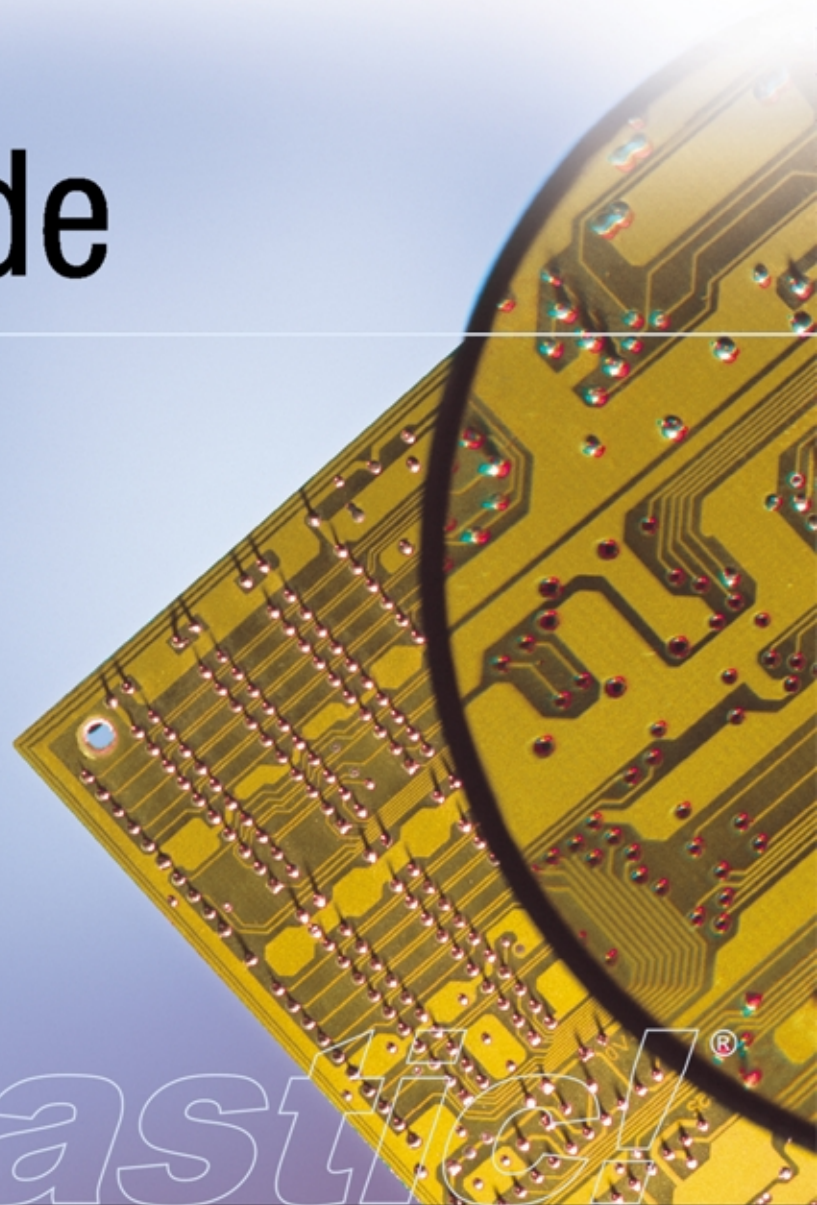


# ***CAMtastic! 2000***

DESIGNERS' EDITION



## User's Guide



**CAMtastic!**

Designing for Manufacture

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## Introduction

CAD files come in dozens of different formats, and simply reading the file, not to mention analyzing and modifying it, has formed a major hurdle for professionals as electronic design automation has taken over their fields. CAMtastic! provides a single environment for viewing, inspecting, and editing CAD files from any major source.

Although its extensive capabilities will appeal to advanced users with intricate needs, the CAMtastic! 2000 Designers' Edition environment remains uncomplicated. The heavy tools are available but concealed, keeping your experience with CAMtastic! 2000 Designers' Edition as straightforward as your individual projects will allow.

For example, the details concerning DXF/DWG imports can be extremely complicated, but in CAMtastic! 2000 Designers' Edition you can simply indicate what *kind* of project you're viewing: PCB, Chemical Milling, Fab Drawing, Silkscreen Panel, etc., and the software will wade through the details automatically. This automatic detection, however, may be bypassed, allowing advanced users to make adjustments according to their specific needs.

### CAMtastic!® 2000 Designers' Edition Features

This section highlights some of the powerful features available in CAMtastic! 2000 Designers' Edition.

- **Comprehensive Import/Export Capability.** CAMtastic! 2000 Designers' Edition will load and auto-detect Gerber (RS274-D, RS274X, or Fire9000) formats, AutoCAD's DXF/DWG files, HPGL/HPGL2, Excellon Drill, Mill, or Rout files. Its DXF/DWG importer supports all AutoCAD objects, including LWPolylines, 3d-Faces, M-Lines, Polyline Splines, Hatches and Mtext. Additional formats are continually added to the program, available for free download from the webpage.
- **Powerful Aperture Control.** Nearly a thousand Dcodes are available for aperture definitions, and an aperture list is created each time a file is imported into CAMtastic! 2000 Designers' Edition. Aperture files for standard and custom parts can be saved and reopened for reuse, minimizing time spent defining commonly used apertures in the Dcode list. CAMtastic! 2000 Designers' Edition supports filled polygons and voids, circular interpolation (true arcs), composites, and transcoding.

- **Easy Access Workspace Bar.** A panel may be continuously viewed in CAMtastic!® 2000 Designers' Edition showing layers, query returns, DRC reports and Netlist information. It also offers quick access to tables, program preferences and report generation, such as PCB summaries for quotation purposes. This bar may be redocked on any side or left floating in the workspace.
- **Viewing and Inspection Tools.** CAMtastic!® 2000 Designers' Edition's viewing tools go far beyond zooming and panning through imported designs. With minimal input, CAMtastic!® 2000 Designers' Edition can generate netlists and DRCs from Gerber data. Objects may be queried individually or in groups, yielding Dcode, shape, size, type, length, location, and net information. Measuring distances between points is made easier and more accurate with over 10 different snap grid methods to choose from. Layers may be compared for their differences, and a translucent view option lets you see behind overlapping apertures.
- **Drawing Tools.** Any aperture may be flashed (placed singly) or used as the "pen" to draw lines, polygons, text (including TrueType fonts), or arcs. Users may choose to have their arcs displayed as segments with varying resolution, helping speed up screen redraws without losing the true arc data in the file. Different methods of drawing are available depending on users' needs and preferences, and snap grids can help place draws and flashes with precision.
- **Editing Tools.** Flashes may be modified; lines may be extended, broken, or joined; and corners may be changed, chamfered or bevelled. Selections may be copied, erased, moved, mirrored, scaled, or replaced by custom apertures. Layers may be renamed, copied, aligned, resized, or deleted. Efficient selection tools allow you to detect specific targets for any edits you wish to make.
- **Advanced Tools.** Wizards help you read custom aperture files, import special DXF/DWG files, and panelize layers on film. Silkscreen and paste mask layers may be generated from signal layers with spread and reduce functions. Identical groups of objects may be converted to single flashes for compatibility with less robust programs. You can fill closed boundaries, generate outlines the board, and create fabrication drawings. Teardrops may be added between pads and traces, while isolated pads may be detected and removed. Composite layers allow you to create non-standard shapes.
- **Manufacturing Tools.** Boards may be panelized, and loop codes may be embedded to avoid inflating the file to an unmanageable size. Venting, Copper Pours, and Silkscreen Trimming are available. Over ten strategies may be applied as you create mill or routing paths. The Tool Table can hold up to 99 different drill bits for board manufacture, with fields for cutter compensation, infeed rate, spindle speed, depth offset, plus any special comments you want to make about any individual tool. Pad pairs may be converted to Homebase Pads for Stencil Manufacturing, and Epoxy Bars may be added automatically.
- **PCB Report.** A board may be analyzed and data extracted for PCB sales quotations. A detailed report may include the following information: Critical Dimensions (minimum trace width and gap spacing), Overall PCB Dimensions (size, area, perimeter length and number of cutouts), Surface Mount Pads (minimum pad and pitch, total number), and Drill information—even detecting blind and buried vias. It can also calculate areas for gold body and immersion boards.



## Guide Overview

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While this manual may be read straight through, it is designed mainly for reference.

- **Chapter 2** guides you through the installation and setup of the software on your personal computer, indicating system requirements and recommendations.
- **Chapter 3** introduces the workspace environment, including toolbars and panels. You will be shown how to manage CAMtastic!® 2000 Designers' Edition sessions, from simple tasks of opening and closing files, to complex imports. In addition, overarching principles, such as selection, layer management, and aperture design, are explained in this chapter.
- **Chapter 4** delineates the viewing and inspection tools. Different display options allow you to see your images in outline mode, filled, or even with transparent objects. Dcodes may be highlighted together, and the Origin, Film Box, and Extent Box are reference tools that will help you keep your image in perspective. Queries and Measurements show layer-specific data, while netlists and DRC checks may apply to the entire board. A series of reports are available for export, allowing you to carefully document your work.
- **Chapter 5** guides you through the drawing and editing tools. This chapter is the heart of the manual, describing in detail each of the building tools and the process by which it is applied. The tools are divided into Drawing, Basic Editing, and Advanced Editing categories, then arranged alphabetically within each section for easy reference.
- **Chapter 6** contains reference information on the CAMtastic!® 2000 Designers' Edition wizards and the program preferences.
- **Appendix A** shows each of the standard toolbars, with references to the portions of the manual in which the different buttons are explained.
- **Appendix B** provides a list of shortcut keys for program features and functions.

Once you have the software running, you will find that in CAMtastic!® 2000 Designers' Edition (like most software packages), you can roam by various roads. Menu bars can be browsed with mouse clicks or by holding down **Alt** as you press underlined letters. Dialogs may be manipulated with the keyboard, using the **Tab** or **Shift+Tab** keys to hop from one option to the next, with the Space Bar or Enter key activating the button or field. Toolbar buttons offer access to individual features with a single click, many of which also have shortcut keys assigned to them. While the existing shortcut keys are listed in the appendix, the emphasis throughout the manual will be on menu sequences and toolbar buttons. This is due, in part, to the fixed nature of the menu lists and the toolbar button icons; the shortcut keys may be modified to your own liking.

Bold fonts and double arrows ( » ) will guide you through menus. For example, **Edit » Undo** means that you should choose Edit from the main menu, then Undo. If any function has a toolbar button assigned to it, a picture of that button will appear beside the description.

Online help is available, of course, in the Help menu, where you may browse through the index of entries or run a search for specific words. Tips and pointers are also available, and may be set to display each time the program is opened (**Help » Tip of the Day**). When individual features, such as dialogs are displayed, pressing **F1** may give additional information about a highlighted button or

field. Finally the CAMtastic!<sup>®</sup> website offers FAQs and user-forums for interactive assistance:  
<http://www.camtastic.com>.

# Installation and Setup

Installing CAMtastic!® 2000 Designers' Edition may be as simple as inserting the CD and accepting the prescribed field contents. Before dashing through the installation, however, certain measures should be taken. You should be aware in advance of any limitations your PC system may impose upon this software. You should read and understand the License Agreement before accepting it—please call for customer support if you have any concerns about this agreement.

## System Requirements

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Make sure that your PC and its software conform to the following requirements and recommendations:

### Recommended System

- Windows NT 4/2000 Professional
- PC with Pentium III Processor
- 128MB RAM
- 200MB Hard Disk Space
- Desktop area 1024x768 pixels
- 32-bit Color Palette
- CD-ROM Drive
- Mouse or compatible pointing device

### Minimum System

- Windows 95/98/2000/Me
- PC with Pentium 166MHz
- 32MB RAM

- 40MB Hard Disk Space
- Desktop area 800x600 pixels
- 256 Color Palette
- CD-ROM Drive
- Mouse or compatible pointing device

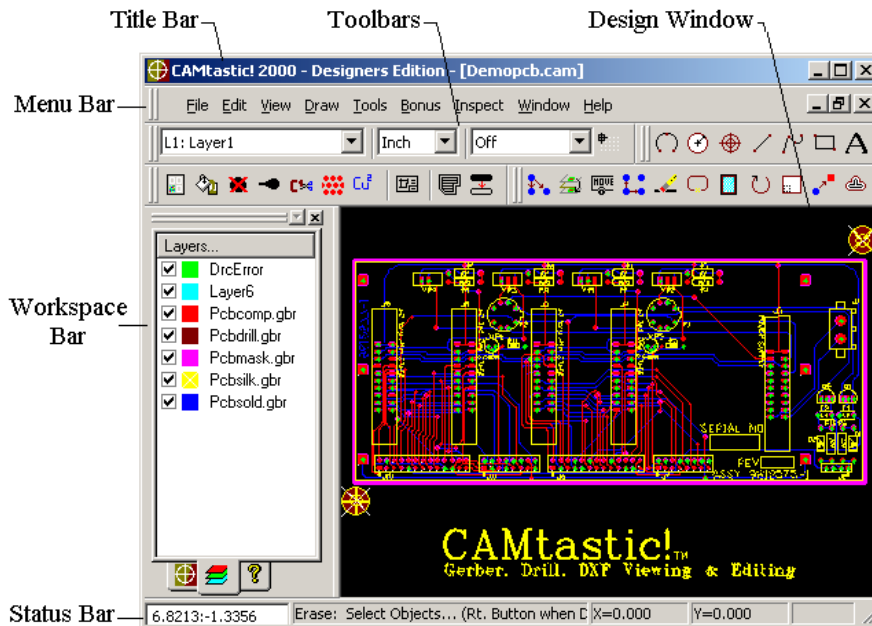
## **Installation**

Insert the CAMtastic!® 2000 Designers' Edition Designer's Edition CD-ROM in your computer, and wait for the installation window to appear. If nothing happens, you may browse through Explorer to the CD-ROM drive, and double-click on **Setup.exe**. You will be shown the End User License Agreement, which you must accept if you wish to proceed with the installation. If you do accept it, you will be shown the destination folder for CAMtastic!® 2000 Designers' Edition; by default, this is C:\Program Files\CAMtastic 2000 DE. You may browse to any other storage location for this installation. You should then choose the Typical installation option to install CAMtastic!® 2000 Designers' Edition Designer's Edition in its entirety. Finally, you may choose the folder name which will appear in the Programs list in the Start menu.

## Basics

To help you get started working with CAMtastic!® 2000 Designers' Edition, some basic concepts ought to be discussed first. This chapter will discuss the different components of the workspace, the way to manage individual CAM sessions, and the concepts that are common to all projects you may undertake with this software.

### Workspace Management

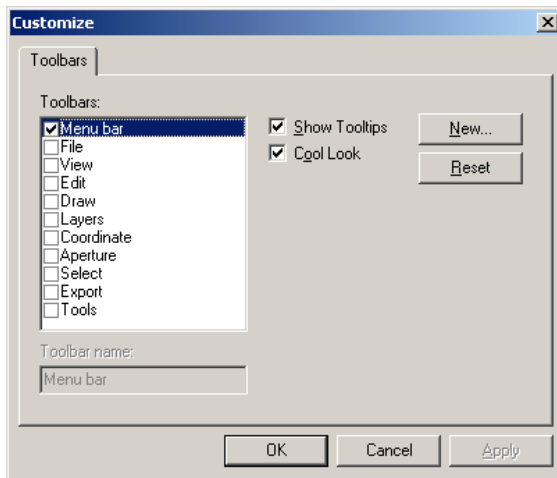


CAMtastic!® 2000 Designers' Edition has updated its environment to simplify the design and verification processes for its users. This section will provide an introduction to the workspace, along with an explanation of basic viewing and selection tools.

## Accessing Tools & Features

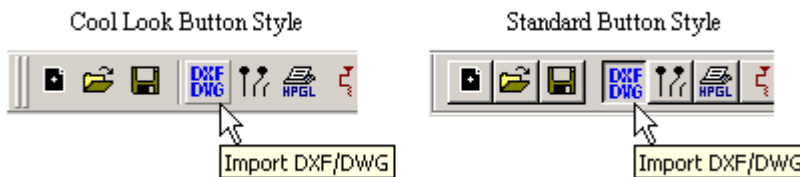
### Toolbars

CAMtastic!® 2000 Designers' Edition offers eleven toolbars, all of which (except for the Menu Bar) can be turned off or redocked anywhere on the screen. The toolbars contain over 70 different buttons and four pull-down menus. You will see pictures of the buttons as their functions are described throughout this manual; you may also refer to a brief summary of toolbar features in the Appendix.



By selecting **View » Toolbars** from the main menu, you indicate all toolbars you wish to display. In addition, you can change the existing toolbars, create new ones, delete buttons, and reset the defaults when unwanted changes have been made.

Select **Show Tooltips** to have the button name appear when the cursor is hovered over the button. Select **Cool Look** to contemporize the layout of the toolbars and their individual buttons. The figure below shows both button styles, with the tooltips selected.



To create a new toolbar, select **New**, and enter a name for your new toolbar. Choosing **OK** will add this new name to the list of toolbars. Upon closing the *Toolbar* dialog, you will notice a new floating toolbar on your screen, currently empty. You can drag new buttons onto this toolbar by following the instructions below.

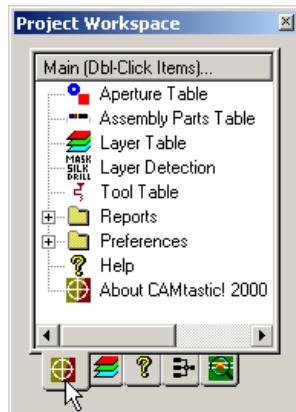
If the *Customize Toolbar* dialog is open, you may modify an existing toolbar by dragging any toolbar button from one toolbar to another. Dragging the button elsewhere (anywhere that is not a toolbar) will delete the button. If the *Customize Toolbar* dialog is not open, you will need to hold down **Alt** as you drag the button to a new location. If unwanted changes have been made to one of the standard toolbars, the original settings may be restored by highlighting the toolbar, and selecting **Reset**.

The **Reset** button turns into a **Delete** button when highlighting a custom-made toolbar.

## Workspace Bar

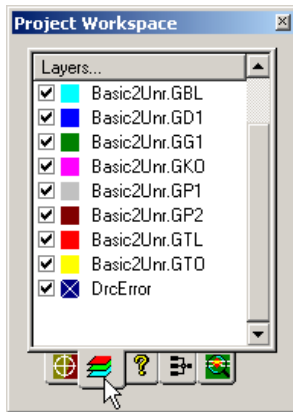
The Workspace Bar is a user-friendly control that displays all the information and tools that are required during the current session. This bar can be resized and docked anywhere. Five views are available in the Workspace Bar: Main, Layer, Info, DRC/DFM Check, and Netlists.

The **Main View** tab displays data tables, reports, and preferences, including general settings that will apply to any session you create or open. It also contains links to online help and an information page about the current version of CAMtastic!® 2000 Designers' Edition.

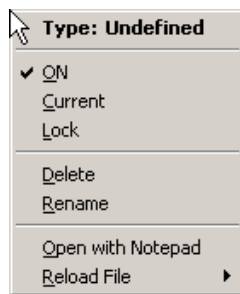


Any item can be opened with a double click. Each of the available options shown in this view tab of the Workspace Bar is described individually in this manual; refer to the index to locate specific instructions about these tables, reports, and preferences.

The **Layers View** tab displays all layers in the active session. Select any layer you wish to display in the Design Window. A layer's color can be changed by clicking on the color box beside its name. Double-clicking any layer name will make it the current layer—upon which an X will appear over the colored box next to that layer. In the figure shown here, all layers are enabled, but only one of the colored boxes (the final one) is marked with an X, indicating it as the current layer.



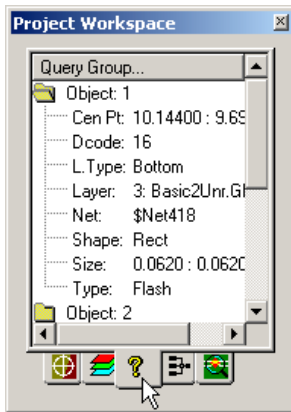
Right-clicking on any layer name displayed in this tab will display additional features, as shown below.



- **Type:** Shows what Type (if any) has been assigned to this layer within the CAMtastic!® 2000 Designers' Edition Layer Table.
- **ON:** Toggles between selected (layer is displayed) and not selected (layer is hidden).
- **Current:** Makes selected layer current. The same result may be obtained by double-clicking the layer name in the Workspace Bar.
- **Lock:** Toggles between selected (layer is locked and cannot be modified) and not selected (layer is unlocked and open for editing).
- **Delete:** Deletes selected layer. (This action cannot be undone.)
- **Rename:** Allows user to rename selected layer.
- **Open with Notepad:** Assumes that the selected layer was created from an imported file, and opens it. If the selected layer was not imported from a file, this function will generate an error until some file is created (**File » Export** submenu).
- **Reload File:** Reloads original file (Drill/Rout/Mill or Gerber) to remove unwanted edits.

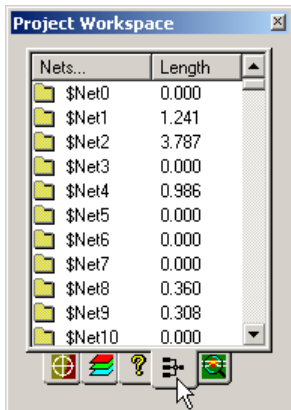


The **Info View** tab displays all relevant information for queries and measurements. Scroll bars are available if the requested information fills more space than is available in the current dimensions of the Workspace Bar. The Info View will create a folder of information for each queried object, as shown in the figure here.



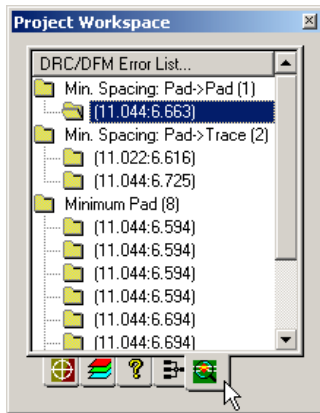
Double-clicking on individual folders will open or close them. The measurement and querying tools in CAMtastic!® 2000 Designers' Edition is described in the *Inspection Tools* section of *Chapter 4: Non-Editing Tools*.

The **Netlist View** tab displays all nets resulting from running Netlist Extraction. Selecting any individual net will zoom to and highlight it in the Design Window. To refresh this list, select **Inspect » View Nets**.



This tab will always be visible once a netlist has been extracted from the active session. (CAMtastic!® 2000 Designers' Edition offers the ability to extract nets from displayed images, such as Gerber data.) If this tab is not displayed in your session, follow the instructions on Netlist Extraction described in the *Inspection Tools* section of **Chapter 4: Non-Editing Tools**.

The **DRC/DFM View** tab displays any violations resulting from running a design rules check and/or design for manufacturing check on the current design.



Major folders display the error in question, and subfolders will be created for each instance where the rule has been broken. Selecting any of these subfolders will zoom to and highlight the error in the Design Window. To refresh this list, select **Inspect » View Errors**.

This tab may not appear in the Workspace Bar if a DRC/DFM Check has not been performed on the current session.

### Status Bar

CAMtastic!® 2000 Designers' Edition's Status Bar will be displayed if there is a mark beside Status Bar in the View menu. The status bar is located at the base of the screen and contains information about the active session.



This bar displays a single line of text describing the currently active process—if no function has been activated, then this line will remain blank. On the left end of the Status Bar is the Coordinate Box, and towards the right end are the Image Extents boxes in X and Y measurements. All of these values will display in the currently selected units. Finally, at the far right end of the Status Bar is the Total Box.

The Image Extents display the width and height of the image in the session. These values will update automatically whenever the image is redrawn, and can be very useful to quickly determine the overall size of a job. The Total Box lists the number of currently selected objects, if any.

### Coordinate Box

The Coordinate Box has two main purposes. The first is to display the current location of your mouse or pointing device. The second is to assist with drawing or editing functions by accepting X:Y values (up to 6 decimal places) instead of a mouse click.

For example, select **Draw » Line**. Instead of choosing the starting point with your mouse, however, type 1:1 in the Coordinate Box and press **Enter**. Then clear this line with either the **Backspace** or the **Delete** key, type 1:2 and press **Enter**. You will see a horizontal line drawn upon the active layer from (1,1) to (1,2). Continuing with this sequence will draw any number of lines until you press **Esc** or right click the mouse. This method of entry is called Absolute Values.

The Coordinate Box can also accept Relative Values from an initial point. These can be entered in coordinates (Vector) or with a distance and an angle (Polar).

To draw a Vector from an initial point, select **Draw » Line** and choose an initial point (either with a left click in the Design Window or with an Absolute Value in the Coordinate Box, as described above). Now type @1, 0 in the Coordinate Box and press **Enter**. A horizontal line one unit long is now drawn from the initial point in the Design Window.

To draw using the Polar method, begin as before (selecting **Draw » Line** and choosing an initial point), then clear the Coordinate Box and type @1<45 and press **Enter**. A line one unit long is drawn at a 45° angle from the initial point in the Design Window.

Absolute Values (Coordinates): **X:Y** Enters a point at (X,Y).

Relative Values (Vector): **@X,Y** Enters a point X and Y distance from initial point.

Relative Values (Polar): **@DISTANCE<ANGLE** Enters a point with DISTANCE and ANGLE from initial point.

### Mouse

As in other Windows applications, CAMtastic!® 2000 Designers' Edition uses the left mouse for clicking, selecting and dragging. When moving the mouse, a corresponding selection tool (or cursor) movement occurs on the screen.

The familiar "pointer" Arrow Tool is used for standard Windows operations, such as choosing from menus and dialogs.

For user convenience, CAMtastic!® 2000 Designers' Edition offers shortcuts to many commonly-used functions in a right-click menu. The contents of this menu depend upon the currently-active function. If no drawing or editing function is active, right-clicking in the Design Window will prompt the standard menu, giving you access to various different zooms, the redraw (refresh) function, and the snap menu. This menu also allows you to cancel the current action or repeat the previous one.

Many CAMtastic!® 2000 Designers' Edition processes, such as drawing or editing, require several key sequences or mouse clicks. If you are in the middle of a process, a right-click will generally complete it. (Contrast this with **Esc**, which cancels an active function.)

## Shortcut Keys

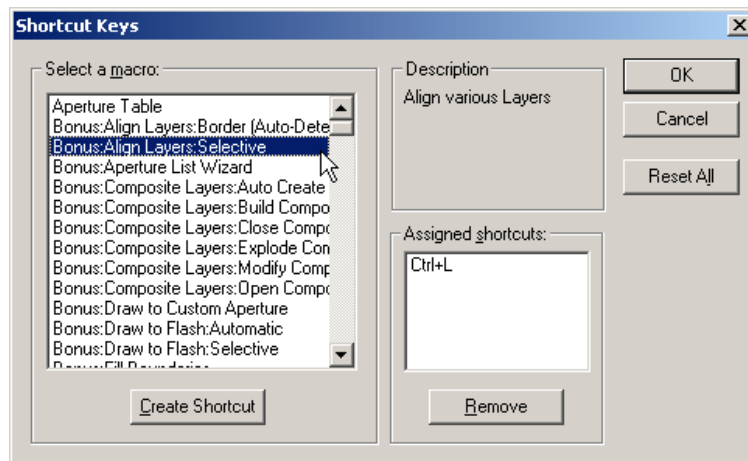
For users who prefer using the keyboard over the mouse to access functions, CAMtastic!® 2000 Designers' Edition has made browsing menus easy to do with the keyboard. This process is the same as in many other Windows programs: simply holding down **Alt** then typing the letter of an underlined word in a visible menu will either activate the process or open a submenu. For example, pressing **Alt+A** while in adding selection mode will select the entire image.

As you browse through these menus, you may notice key sequences listed to the right of some commands. These shortcut keys may be used instead of the menu-browsing method and can save you time once you learn them.

You may learn the shortcut keys already present in CAMtastic!® 2000 Designers' Edition simply by noticing them as you browse through the main menu. A list of all existing shortcut keys has been included in the appendix of this manual.

While there are nearly 200 macros available in CAMtastic!® 2000 Designers' Edition, only 50 have shortcut keys assigned to them by default. As you discover the processes that you run most frequently, you may apply shortcut keys to them.

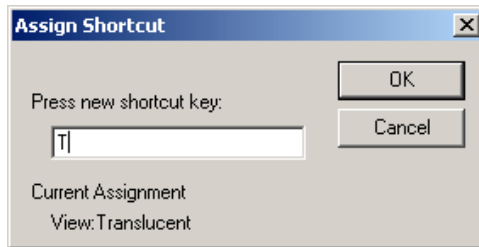
Choose **Help » Shortcut Keys**, which opens the *Shortcut Keys* dialog, shown below.



Browse through the list of macros to the process you want. These are generally referenced by the Menu Item under which the process is located. Highlighting any macro will cause a short Description to appear in the top right corner of the dialog. If any shortcut keys are currently assigned to the selected process, its key sequence will appear in the Assigned shortcuts area.

You may remove an existing shortcut and replace it with any key sequence you prefer.

Select **Create Shortcut** to open the *Assign Shortcut* dialog.



Press the new key(s) for the macro. If the displayed sequence is correct, simply choose **OK** and the new shortcut key(s) now will be displayed when the macro is highlighted.

You may assign more than one key sequence to start the same process. Each key sequence, however, may only apply to one process. If the new key sequence you enter in the *Assign Shortcut* dialog is already in use, a note will appear telling which process is currently assigned to that key sequence. For example, choosing **T** as a new shortcut key will summon a message that this shortcut key is already assigned to *View: Translucent* (as shown in the example above). If you proceed, the new process will replace the old when you press that shortcut key.

CAMtastic!® 2000 Designers' Edition is not case-sensitive, so only one feature may be assigned to each letter or key sequence.

If you would like to remove all customizations you have made to the shortcut keys and restore the original configuration, simply select **Reset All**.

## Viewing Images

CAMtastic!® 2000 Designers' Edition allows you to open and view up to four sessions concurrently. All open files are listed at the bottom of the Windows menu, with a mark displayed beside the active document. Select **Window » Cascade** to have the images arranged so that the Title Bar of each file is visible; then clicking on any Title Bar will make its Design Window visible and active. Otherwise, you may select **Window » Tile** to arrange the images evenly to fill the screen.

Double-clicking on any Title Bar will maximize (fill the screen with) that session. If any sessions have been minimized (only the Title Bars are displayed), you may choose **Window » Arrange Icons** to have these Title Bars lined up in the lower left corner of the screen.

Only one session may be active at a time—its title bar will appear differently from any other open sessions depending on the color display scheme you have chosen for your computer. You may modify the current view by zooming in towards or away from the image, or by panning one way or another. In most cases, you may do this without affecting the status of any processes you are currently running.

CAMtastic!® 2000 Designers' Edition offers several different zoom tools. These can be accessed through shortcut keys, toolbar buttons, or the **View » Zoom** submenu. The cursor location acts as the center point for most zoom options.



**Zoom All:** Displays all objects contained in active layers, centering their image on the screen.

**Zoom Previous:** Returns to the zoom immediately previous to the current one (functions like an Undo for zoom).



**Zoom Window:** Displays a magnified view from the current view, given a Window selected by the user. Click once on each corner of the area you desire to view.



**Zoom In:** Magnifies the current view.



**Zoom Out:** Lowers the current view's magnification.



**Dynamic Zoom:** Allows zoom to be controlled by the cursor being dragged up or down on the screen. The initial mouse click defines the center of the zoom. An upward drag zooms in, while a downward drag zooms out.

**Zoom Film Box:** Displays all images that fit inside the current Film Box. This feature is not active if film box is not displayed.

**Zoom Dcode:** Zooms out to largest area that displays all Dcodes in use. The current Dcode is also highlighted.

For more information about Dcodes, see the *Building Blocks* section of *Chapter 3: Basics*. For more information about the Film Box, refer to the *Viewing Tools* section of *Chapter 4: Non-Editing Tools*, respectively.

Panning, or nudging the view in one direction or another, can be done with the arrow keys. Two additional panning options are also available: Center Pan and Dynamic Pan. All of these panning options can be accessed through shortcut keys, toolbar buttons, or the **View » Pan** submenu. The cursor location acts as the center point for most zoom options.

**Center Pan:** Waits for you to click somewhere in the Design Window, then repositions the display with that point as the center.



**Dynamic Pan:** Allows pan to be controlled by a click and drag of the mouse.

## Selecting Objects

New users may find selecting objects in CAMtastic!® 2000 Designers' Edition a bit awkward. Most programs have trained users to select first, then decide what to do with the selection. CAMtastic!® 2000 Designers' Edition offers the opposite approach. First, choose a process (Query, Chamfer, etc.) and then select the objects to which it will apply. Said another way: if selecting items is part of a process, simply initiating the process will put you into selection mode.

Selections in CAMtastic!® 2000 Designers' Edition are cumulative, meaning that selecting a new item does not cancel previous selections. Items can be added or removed from a selection either individually or in groups.

CAMtastic!® 2000 Designers' Edition selection mode will remain active until the function is either completed (right click) or cancelled (**Esc** key).

When a function requiring object selection is activated, the cursor will default to a square pickbox. The status bar will display the name of the function you have chosen, followed by instructions on selecting objects, draws, vertexes, traces, texts, or boundary edges.

Clicking upon any object selects it (an object will turn white when selected). Clicking on an empty space will move you into window mode (the cursor changes to a crosshair). If this is not what you want, simply click the mouse once again as close to the original click as possible, leaving the selection window empty. This will return you to the pickbox for more single-click selections.

Instead of selecting objects one by one, you may want to select all of the objects within a certain region. There are two types of selection windows available in CAMtastic! 2000 Designers' Edition: the standard Select Window and the Select Crossing Window.

Standard  
Select Window



The standard Select Window has a solid-line border, and will only select objects wholly contained within the window you draw. The Select Crossing Window has a dotted-line border, and will select all items partially or wholly contained within the window you draw.

Select Crossing  
Window



You may activate either of these modes by selecting their buttons in the Select Toolbar. Either selection window button will allow you to draw a single selection window, after which the cursor will default back to the pickbox for additional selections.

Advanced users will prefer a different method of accessing selection windows. As mentioned above, when the pickbox is clicked upon an empty space, the original click is now used as one corner of a selection window. By moving the mouse to the left, a Select Crossing Window is drawn. Moving the mouse to the right draws a standard Select Window.

Select  
Flashes  
Select  
Draws



Both Flashes and  
Draws are enabled  
here for selection

By default, both Flashes and Draws are enabled on the Select toolbar, meaning that you can select anything on your screen when selection mode is enabled. If you only want to select flashes in a certain area, click on the **Select Draws** button to disable it (if it is still enabled), then draw your selection window. The same logic applies to selecting draws in a certain area: disable the **Select Flash** button on the toolbar before defining your selection area.



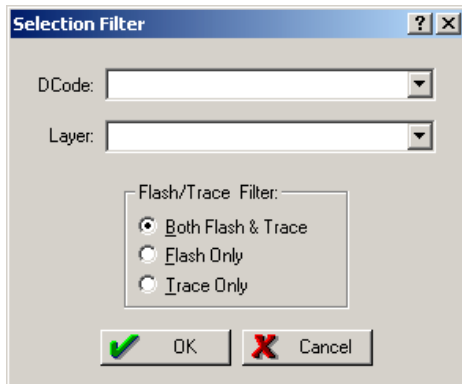
All flashes, draws, or both can be selected by enabling their respective buttons and then choosing the **All** button.



The same will apply only to the draws and/or flashes visible in the current zoom of the document by choosing the **Display** button.



The **Filter** button on the Select toolbar gives you additional control over your selections. Choosing this button will open the *Selection Filter* dialog, shown below.



The Dcode and/or Layer number(s) should be entered, separated by commas. Ranges may also be indicated. You may type, for example, 1, 3, 5-7 which would select D1, D3, D5, D6, and D7 (or Layers 1, 3, 5, 6, and 7). Leaving the line blank will select all Dcodes or Layers, and preceding a number or range with an exclamation point will select everything else.

The pull-down lists are filled as they are completed individually, meaning that complex selections need only be entered once, even if they are used again in the future.

Once you have selected everything you want, complete the function by right-clicking once. If you want to cancel the function instead of executing it, simply press **Esc**.



If you have inadvertently selected certain objects, you may completely cancel the function by pressing **Esc** to start over. On the other hand, it may save you time to simply deselect those specific items. You may do this by choosing the **Remove** button.



Pick boxes and Selection Windows will continue to operate in exactly the same manner, only deselecting instead of selecting their contents. You may return to selection mode by choosing the **Add** button.



Finally, CAMtastic!® 2000 Designers' Edition memorizes complex selections, and allows you to return to past arrangements by choosing the **Previous Selection** button.

Selection processes may vary slightly depending upon the active editing function. Refer to the instructions in *Chapter 5: Editing Tools* for function-specific details.

Because selection plays a central role throughout CAMtastic!® 2000 Designers' Edition usage, shortcut keys have been applied to each of these toolbar buttons. See the Appendix for a list of shortcut keys.



## Session Management

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This section describes how to work with existing sessions and/or third-party files. When you open CAMtastic!® 2000 Designers' Edition, a new, blank session is automatically generated, which you can edit, save and close. You may import files from other programs into your session, and similarly, you may print or otherwise export information from CAMtastic!® 2000 Designers' Edition in a variety of formats.

### Opening, Saving and Closing Files



Choosing **File » New** will start a new session. This document will not have a name until it is saved. The Title Bar will display the name: [Untitled] until it is saved.



Choosing **File » Open** will open an existing session. As you browse through Windows folders to find the file you want, a preview window will help you determine what each .cam file contains before opening it. Sessions saved by previous versions of CAMtastic!® will automatically be detected, but no preview will be available.

Choosing **File » Close** will close the active session. If modifications have been made, you will be prompted to save the session before closing.



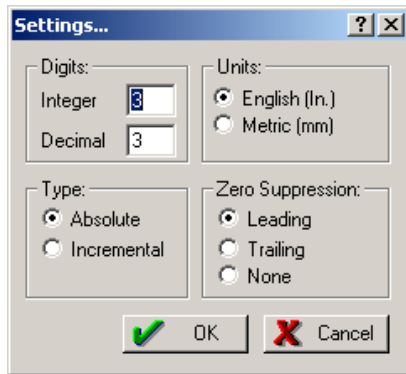
Choosing **File » Save** will save the current session. If this file has been saved before, then all current information will replace information stored in the previous save. If this session has not been saved before, then a dialog will allow you to browse to a desired location and name the new file. All session-specific settings and preferences are saved, and will be restored when the CAM file is reopened.

Choosing **File » Save As** lets you save your session under a different name. All changes that have been made to the file since the previous save will only be reflected in the Saved As file.

### Importing Files

CAMtastic!® 2000 Designers' Edition reads a large variety of files from other systems. General options, such as setting defaults, can be indicated in the *Import/Export Preferences* dialog shown below. You may access this through the **Main** tab of the Workspace Bar (see the *Preferences* section of *Chapter 6: Reference Tools* for details).

While the information in this dialog pertains specifically to Gerbers, one feature is the same in nearly all CAMtastic!® 2000 Designers' Edition imports. Selecting **Import Settings** will pull up the *Settings* dialog, shown below.



- **Digits:** Indicates the number of digits before and after the decimal point (integer and decimal, respectively) that CAMtastic!® 2000 Designers' Edition will read upon import.
- **Units:** Toggles between imperial and metric to match the units in which the information was originally saved.
- **Type:** Toggles between Absolute and Incremental. (Absolute coordinates are always relative to the origin; incremental values are relative to each other.)
- **Zero Suppression:** Ignores Leading or Trailing zeros, unless None is selected.

Changing the settings here will make these your defaults for future Gerber imports. An identical box will be available on all individual imports (and exports) of Gerbers, Drill, Mill & Rout files.

If the import preferences are all set to your satisfaction, you are ready to begin importing individual files. Selecting **File » Import** will show the following options: Drill, DXF/DWG, Gerber, HPGL/HPGL2, Mill/Rout. Importing of aperture lists and aperture library files are also included in this submenu.

## Drill



Drill files contain tool numbers for each drill bit and X and Y locations for each instance that bit is used on the board. Selecting **File » Import » Drill** will allow you to browse to this drill file.

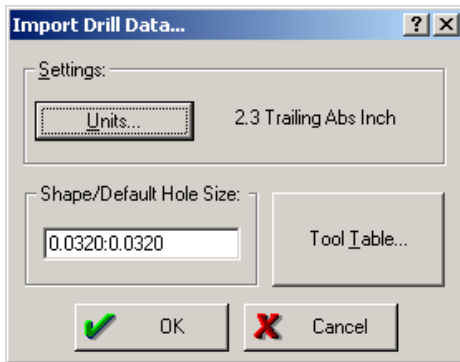
While CAMtastic!® 2000 Designers' Edition can interpret a wide variety of drill file formats, the preferred format is described in the following example.

```

Special commands for Excellon Machines
├── G92
├── M48
├── INCH, LZ
├── FMAT, 2
├── T01C0.0500 } Tools,
├── T02C0.0250 } Diameters
├── DETECT, ON
├── %
├── G90
├── T01 — Tool Number
├── X003Y003 } Coordinates
├── X124Y07  } for drills
├── X003Y069 }
├── T02
├── X022Y0656
├── X0224Y0694
└── M30
    
```

CAMtastic!® 2000 Designers' Edition by default looks for .dr1 and .dpt files, as these are common extensions for drill files. However, any ASCII file can be selected in this menu.

Upon locating the file, the *Import Drill Data* dialog appears.



Selecting **Units** will bring up the standard *Settings* dialog described previously.

In some cases, the tool diameters are not indicated in the drill file, but are supplied separately. If no drill sizes are detected, CAMtastic!® 2000 Designers' Edition will use the diameter supplied in the Shape/Default Hole Size field in the *Import Drill Data* dialog. You may, however, select **Tool Table** to assign tool diameters manually, modify existing tools, or import new ones. The Tool Table will be described in detail in the *Building Blocks* section of this chapter.

Import Drill Data will automatically assign a new tool number if the present tool number is currently being used by another drill layer.

## DXF/DWG

AutoCAD files can be imported directly in to CAMtastic!® 2000 Designers' Edition. Selecting **File » Import » DXF/DWG** brings up the DXF/DWG Import Wizard after the desired file is located.



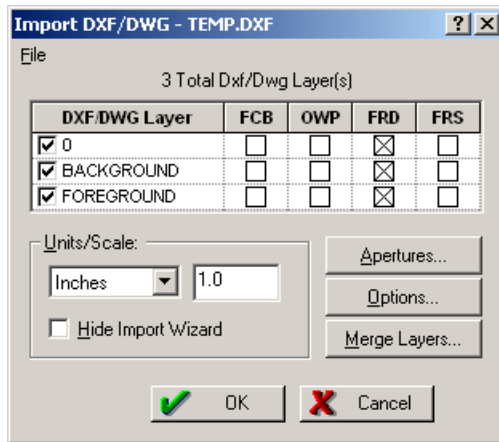
Since many detailed options are available for these imports, four basic groups of settings have been pre-arranged: Standard PCB; Microwave RF; Chemical Drawings and Fab Drawings. The appropriate wizard should save you time in importing different kinds of DXF or DWG files.



If you inadvertently choose a scale that extends the board beyond the borders of the CAMtastic 2000 workspace, you will later be offered a choice to scale down the board.

A pull-down list of Units allows you to choose the system and scale of the imported files. Simply choose the units and decide if you wish all TrueType fonts to be filled, then select **OK**.

If none of the preset wizards successfully reads in your files, you may adjust individual settings yourself by selecting **Skip Wizard**, and choosing **OK**. This will open the *Import DXF/DWG* dialog, shown below.



Each detected layer will automatically be selected for import. Four columns of options are available for each layer.

- **FCB (Fill Closed Boundaries):** If selected, areas bounded by closed 0-width Polylines, solids or traces will be filled. If not selected, the boundary will be outlined and given the line width assigned in the *Text Options* dialog, described below.
- **OWP (Outline Width Polylines):** If selected, the outlined boundaries of all polylines will have their width calculated so as to appear exactly as inside AutoCAD. If not selected, a diameter will be assigned to match the polyline starting width. This diameter will be traced along the polyline (all edges will be rounded, and the polyline will be extended by half the width of the polyline per side).
- **FRD (Flash Round/Donut Pads):** If selected, round and donut shapes are detected within your DXF/DWG files, and flashed apertures are automatically created. If not selected, the boundary will be outlined and given the line width assigned in the *Text Options* dialog, described below.
- **FRS (Flash Rectangle/Square Pads):** If selected, rectangular and square shapes are detected within your DXF/DWG files, and flashed apertures are automatically created. If not selected, the boundary will be outlined and given the line width assigned in the *Text Options* dialog, described below.

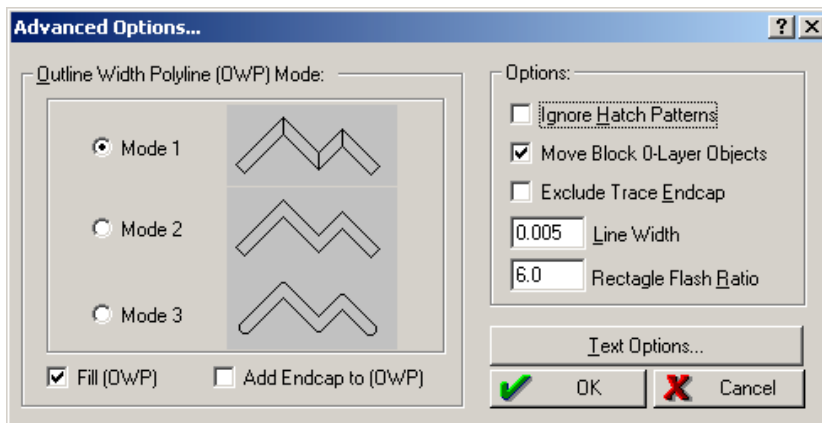
The File menu in this dialog allows you to open or save settings both for DXF/DWG imports or Aperture information. In the Units/Scale section of this dialog, you again have access to a pull-down list of units. In addition, you may rescale the import by changing the Scale value from its default (1.0). Selecting **Hide Import Wizard** will bring you directly to this dialog upon your next DXF/DWG import.

If you are not too familiar with DXF/DWG, we strongly encourage you to only modify the basic settings found on the *Import DXF/DWG* dialog. Once you have loaded the DXF/DWG into CAMtastic!® 2000 Designers' Edition additional modifications can be easily made.

Three additional buttons are available in this dialog. The **Merge Layers** button allows you to combine layers prior to import (this process is linked to Composite Merge, described in the *Advanced Editing* section of *Chapter 5: Editing Tools*). Importing DXF or DWG files with merged layers requires an empty session. A warning will allow you to cancel this action before overwriting any present data.

The **Aperture** button brings up the Aperture Table, described in the *Building Blocks* section of this chapter.

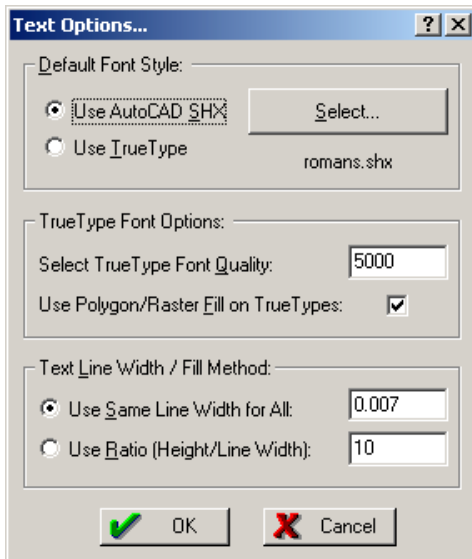
The **Options** button, however, is unique to the DXF import. Selecting this button brings up the *Advanced Options* dialog, shown below.



This dialog allows you to control how the DXF/DWG file will be read into CAMtastic!® 2000 Designers' Edition. Select one of the three OWP modes: segmented, squared corners, or chamfered corners. Modifiable fields in this dialog allow you to change the **Line Width** and **Rectangle Flash Ratio**. Selection boxes allow you to fill or simply outline the imported traces, add or exclude endcaps, import or disregard hatch patterns or move blocks from Layer 0 to destination layer.

When most AutoCAD designers create block libraries, all block objects are usually created on Layer 0. When those blocks are subsequently inserted into different layers, they appear to move, but internally they are still on layer 0. If this feature is selected, CAMtastic!® 2000 Designers' Edition will move those objects to the layer in which the block was inserted, thus giving the effect of how the objects appeared in AutoCAD. If this feature is not selected, objects within blocks will be written to Layer 0.

Selecting **Text Options** opens the dialog shown below, allowing you to control how the text in DXF/DWG files will be imported.



- **Use AutoCAD SHX:** Allows you to use an .shx font file (AutoCAD standard) for text imports. If this option is enabled, choosing **Select** will allow you to browse to change the default file.
- **Use TrueType:** Writes text imports with TrueType fonts. Choosing **Select** if this option is enabled will allow you choose size, fonts and scripts for imported texts.
- **Select TrueType Font Quality:** Controls the line quality used for TrueType fonts.
- **Use Polygon/Raster Fill on TrueTypes:** Fills TrueType fonts with Raster (shape) fills rather than Vector fills. Filling with vectors usually inflates the size of your file.
- **Use Same Line Width for All:** Directly assigns a line width value that will be used on all DXF/DWG text.
- **Using Ratio (Height/Line Width):** Determines the line width by using a fixed ratio (assigned by user) with the text height.

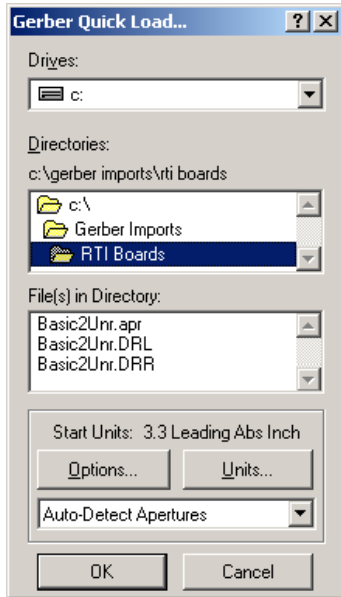
### Gerber

Gerber files can be loaded in groups or individually. If you have a folder containing multiple Gerber files, all of which you want to import, use Gerber Quick Load. If you want to load Gerber files selectively, use the standard Gerber import.

### Quick Load



This feature loads and automatically detects all Gerber and aperture files from a specified folder. Selecting **File » Import » Gerber Quick Load** will open the *Gerber Quick Load* dialog.

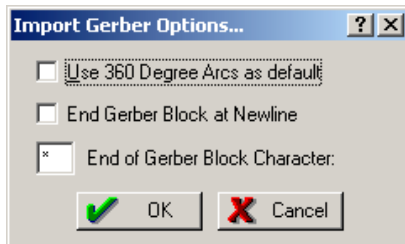


Browse to the drive and folder containing the Gerber files. You may modify the import settings, but if you are uncertain, you should simply accept the settings CAMtastic!® 2000 Designers' Edition has automatically determined.

For this process to function optimally, first ensure that all desired Gerber files are stored in a single folder.

Selecting **Units** opens the *Settings* dialog, described at the beginning of this section.

Selecting **Options** brings up the *Import Gerber Options* dialog, shown below.



**Use 360 Degree Arcs as default:** If selected, CAMtastic!® 2000 Designers' Edition will allow imported arcs to extend beyond 90 degrees.

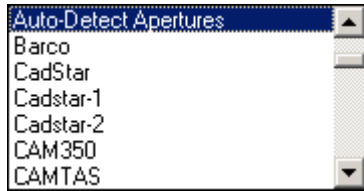
- **End Gerber Block at Newline:** Recognizes a hard return as the end of a data sequence.



- **End of Gerber Block Character:** Recognizes a specific character (an asterisk, for example) as the end of a data sequence.

The defaults for both of these dialogs (*Import Gerber Options* and *Settings*) can be preset in the Import/Export Preferences (see the *Preferences* section of *Chapter 6: Reference Tools* for details).

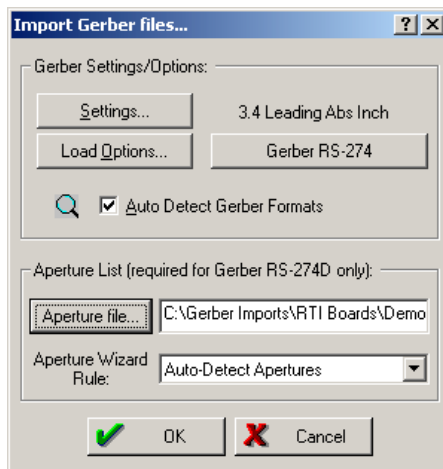
Selecting the Aperture Wizard Rule pull-down reveals a list of wizard templates used during Gerber import.



If the source is unknown, select **Auto-Detect Apertures** (the default setting). New rules can be defined and added to this list; see the *Aperture File Wizard* section of *Chapter 6: Reference Tools* for details.

### Standard Gerber Import

This feature loads in any Gerber (RS-274D, RS-274X, Fire9000) into CAMtastic!® 2000 Designers' Edition. Selecting **File » Import** lets you browse to and select the Gerber file(s); multiple Gerber files can be selected with the **Ctrl** or **Shift** key. If at least one Gerber file has been highlighted, selecting **Open** will bring up the *Import Gerber Files* dialog, shown below.



Some of the buttons in this dialog have been described previously.

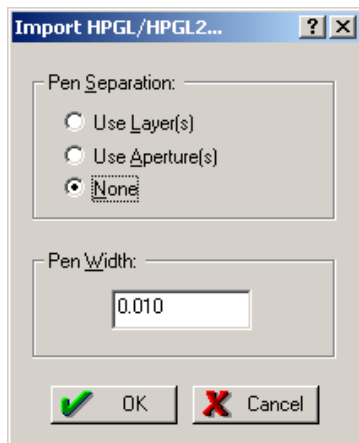
- **Settings:** Opens the *Settings* dialog.
- **Load Options:** Opens the *Import Gerber Options* dialog

- **Aperture Wizard Rule:** Includes the list of rules described in the Quick Load segment, above. Three additional options are available in the *Import Gerber files* dialog.
- **Gerber Version:** Toggles sequentially between Gerber RS-274, Gerber RS-274X, and Fire9000.
- **Auto-Detect Gerber Formats:** Detects automatically all options and settings required to load in a Gerber file(s).
- **Aperture List:** Allows you to browse to an aperture list for the imported file(s).

Gerber RS-274 does require an Aperture list, while extended versions Gerber RS-274-X and Fire9000 do not (all apertures are embedded inside extended Gerber files).

## HPGL/HPGL2

CAMtastic!® 2000 Designers' Edition can import HPGL (\*.hpg, \*.hp, and \*.plt) files. Selecting **File » Import » HPGL/HPGL2** will allow you to browse to the desired file(s); multiple files may be selected using the **Ctrl** or **Shift** keys. The *Import HPGL/HPGL2* dialog (shown below) will then appear.

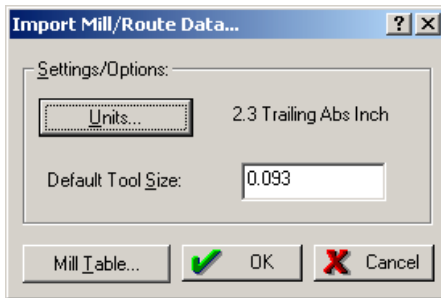


If pen separation is necessary, CAMtastic!® 2000 Designers' Edition can use layers (placing each pen on a separate layer), or apertures (assigning each pen to a separate Dcode). Indicate what type of pen separation you desire—if any—and what pen width you wish to use.

If you have any complex fonts in AutoCAD, simply plot them to an HPGL file, and then load them into CAMtastic!® 2000 Designers' Edition.

## Mill/Route Data

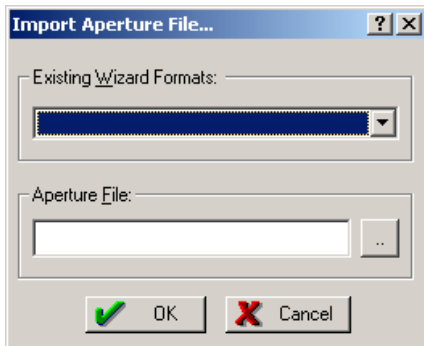
CAMtastic!® 2000 Designers' Edition also imports NC Mill/Route Data (\*.rte, \*.rou) files. Selecting **File » Import » Mill/Route** will allow you to browse to the desired file(s); multiple files may be selected using the **Ctrl** or **Shift** keys. The *Import Mill/Route Data* dialog will then appear.



The **Units** button will open the *Settings* dialog described at the beginning of this section. Selecting **Mill Table** will open the Tool Table (described in the *Building Blocks* section of this chapter), where you may retrieve preset tool sizes or manually assign new ones. Otherwise, the **Default Tool Size** will be used for all milling/routing.

### Aperture Files

If for some reason CAMtastic!® 2000 Designers' Edition has been unable to automatically detect the proper Aperture Wizard Template to use for a particular Gerber import, you may coordinate the correct wizard with the source file by selecting **File » Import » Aperture File (using Wizard Formats)**.



The pull-down of **Existing Wizard Formats** displays the list of templates provided by CAMtastic!® 2000 Designers' Edition, plus any additional wizards you have created yourself (see the *Aperture File Wizard* section of *Chapter 6: Reference Tools* for details).

After choosing an appropriate wizard format, either type in the aperture list file name (including full path) in the lower field or select the browsing button to the right to locate the file. Once you have selected both the correct wizard format and **Aperture File**, select **OK**. You will be asked if the new aperture list should overwrite or simply supplement the existing list.

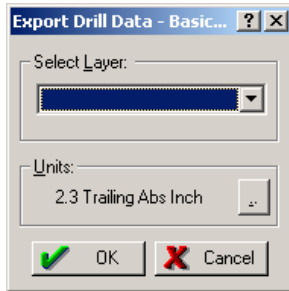
Selecting **File » Import » Custom Aperture Library File** will look for a `.lib` file in which you have stored information on custom parts you have built. Importing frequently-used custom shapes can save time in future projects (see *Reports* section of *Chapter 4: Non-Editing Tools* for details on creating such a file).

## Exporting Files

CAMtastic!® 2000 Designers' Edition exports all the same formats that it imports. Default settings, including the optimization of exported files, can be modified in the *Import/Export Preferences* dialog (see the *Preferences* section of *Chapter 6: Reference Tools* for details).

### Drill Data

This feature writes simple NC Drill files from the current session. Selecting **File » Export » Drill Data** opens the dialog shown below.

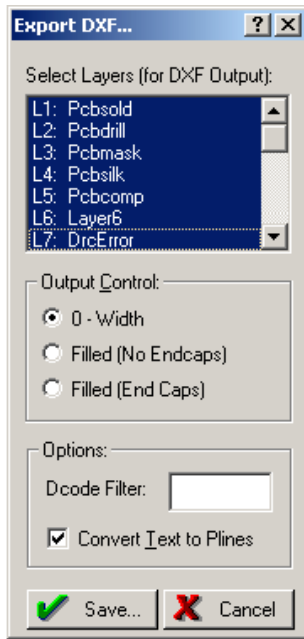


You will only need to select the layer required for export, and modify the units if necessary.

Selecting **OK** produces two text files in the same location: a `.dr1` file and a `.rpt` file. The `.dr1` file contains instructions that may be read by certain Excellon machines, and its format is described above in the segment on Importing Drill files. This file can also be imported into other CAMtastic!® 2000 Designers' Edition projects. The `.rpt` file is a report listing the number of holes each tool will drill.

### DXF

This feature writes a DXF from the current session. Selecting **File » Export » DXF** opens the dialog shown below:



All detected layers will automatically be highlighted, any of which may be removed with a single click.

You may determine if the lines will be exported as 0-width outlines or filled lines. Your filled lines may also include Endcaps (Military Spec), which causes an exported image to display in AutoCAD exactly as it appears in CAMtastic!® 2000 Designers' Edition.

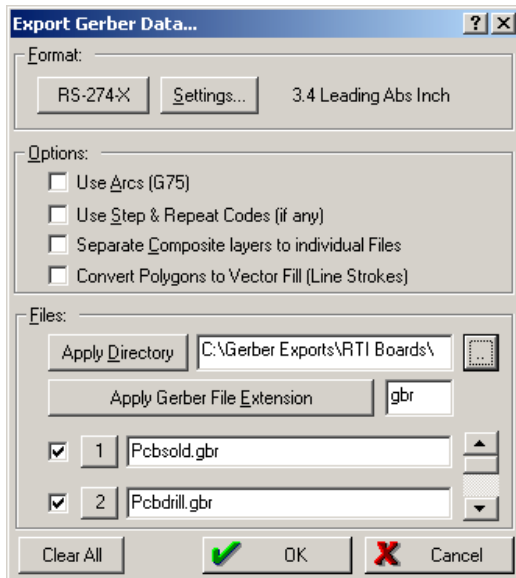
To decrease the size of DXF files, you can also filter out any unnecessary Dcodes, such as line-strokes (used to fill boundaries), or any other useless type of data for DXF export that is currently displayed in the CAMtastic!® 2000 Designers' Edition image. Texts may also be converted to polylines.

Choose **Save** when you are ready to proceed with the DXF export and browse to a drive location to save the new file.

Most DXF files created from Gerber are very large. To decrease the file size of your DXF file, you may use 0-width lines. This will also improve the redraw speed and is recommended especially if you are using the DXF/DWG as a reference file.

### Gerber

This feature creates Gerber files from the current session. Selecting **File » Export » Gerber** opens the *Export Gerber Data* dialog shown below.



In the Format section, a button allows you to toggle between standard Gerber formats: RS-274D, RS-274X, and Fire9000. The **Settings** button brings up the standard *Settings* dialog.

The Options section exists to allow photoplotters with limited capabilities to plot the sometimes complex and extensive Gerber files created by CAMtastic!® 2000 Designers' Edition.

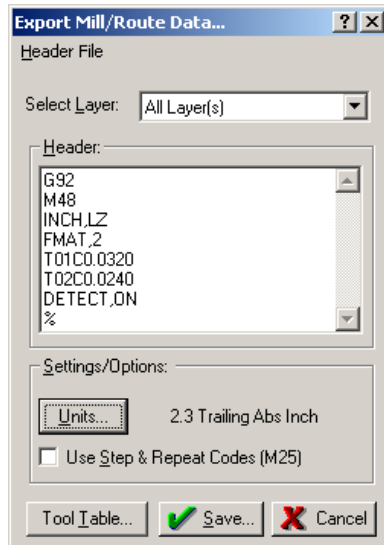
- **Use Arcs (G75):** This option will include true arcs in your Gerber files. The data must already be an arc in CAMtastic!® 2000 Designers' Edition. If not selected, arcs will be sectored.
- **Use Step & Repeat Codes (if any):** This option will include Step & Repeat data in your Gerber files. The data must already have Step & Repeat information. If not selected, Step & Repeat data will be exploded into individual objects.
- **Separate Composite Layers into individual Files:** This option will separate a composite layer into individual Gerber files. The data must already have composite information.
- **Convert Polygons to Vector Fill:** This option will fill polygons with line strokes. The data must already have polygons or polygon voids.

In the File section, all detected layers are selected. Deselecting individual lines will prevent Gerber generation for those layers, and selecting **Clear All** will remove all selections (choosing the same button again—now called **Write All**—will once again select them all). A unique file name is assigned for each layer according to its layer name, but these fields may be modified. If you would like the same three-character extension to apply to all exported Gerber files, simply type in the three characters in the field beside **Apply Gerber File Extension** then select that button.

The target directory for these files can be indicated and applied in this screen, while individual file names and locations can still be modified in their individual fields. Clicking on the number beside any layer number will allow that Gerber file to be exported singly.

## Mill/Route

This feature writes NC Mill/Route files from the current session. Selecting **File » Export » Mill/Route** will open the dialog shown below.



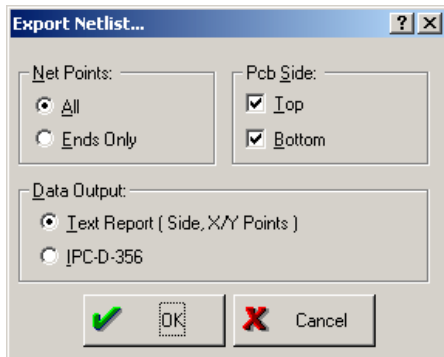
Simply choose the layer you want to export (or else choose All Layers) from the pull-down list, and modify the Header information, if necessary.

Select **Header File** if you have header information already saved in a text file.

Selecting **Units** opens the standard *Settings* dialog. Select **Use Step & Repeat Codes** if any have been defined in the session. The **Tool Table** button opens the Tool Table, which is explained in the *Building Blocks* section of this chapter.

## Netlist

This feature exports a simple netlist from the current session. It behaves like a bed of nails tool, allowing you to test points on the top and bottom of the board. Selecting **File » Export » Netlist** opens the dialog shown below.



You may toggle between **All** net points and **Ends Only**. The former will detect the center point locations of all pads and vias; the latter will disregard the vias.

For a single-sided board, select only the PCB Side that has been assigned in the Layer Table. The netlist may be exported in a Text Report or IPC-D-356 format (this \*.ipc version is the most common way to transfer netlist information from one CAD/CAM system to another).

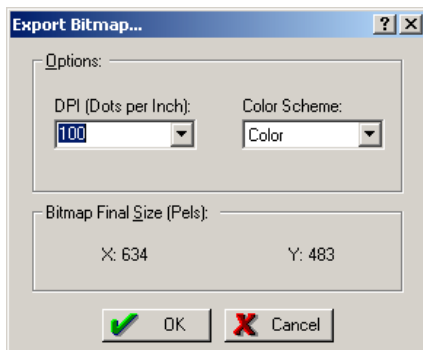
For a netlist to export successfully, either Top or Bottom must be assigned in the Layer Table, as well as a Drill (top or bottom) layer. See the *Building Blocks* section of *Chapter 3: Basics* for details about the Layer Table.

### IPC-D-350

This exports the active session as version 350 \*.ipc file. Selecting **File » Export » IPC-D-350** opens a standard Save As dialog. Simply browse to the location where you wish to store this file and choose **OK**.

### Bitmap

This feature allows you to create a bitmap from an object or selection window. Selecting **File » Export » Bitmap** opens the dialog shown below.





A bitmap is created with an alterable resolution. Simply choose a **DPI** from the pull-down list or type in the resolution you desire. You may also choose between a monochrome and color output. The image extents of the bitmap are reported in X and Y measurements. Selecting **OK** will allow you to browse to the target folder for this bitmap file.

The default background for bitmaps exported from CAMtastic!® 2000 Designers' Edition is white.

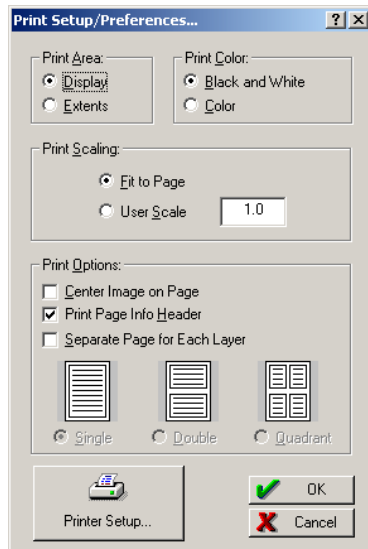
## Printing

CAMtastic!® 2000 Designers' Edition offers several printing options. A print preview is also available before you actually send the image to the printer. CAMtastic!® 2000 Designers' Edition images may, of course, be printed from other applications if the image is copied onto the Windows clipboard and pasted into the target application.

While CAMtastic!® 2000 Designers' Edition displays the images on your computer screen with light colors against a black background, all prints (monochrome or color) are drawn with dark lines against a white background.



When you are ready to print images from CAMtastic!® 2000 Designers' Edition, select **File » Print**. This will bring up the *Print Setup/Preferences* dialog, shown below.



- **Print Area:** Toggles between Display and Extents. The Display option will print whatever portion of the image is currently filling the Design Window; the Extents option will print the whole image, regardless of the current view.
- **Print Color:** Toggles between Black & White and Color.

- **Print Scaling:** Toggles between Fit to Page and User Scale. The Fit to Page option will enlarge or shrink the image to fill the page size you have selected. The User Scale option allows you to enlarge or shrink the size of the image manually.
- **Print Options:** Offers three choices, any or all of which may be enabled: Center Image on Page, Print Page Info Header, Separate Page for Each Layer. If the latter option is enabled, the user may further indicate to have each layer on its own page, or split the page in half or quadrants for the printing of separate layers.
- **Printer Setup:** Offers standard printing setup options, including the printer selection, properties, page orientation, and paper sizes and sources. Also a **Network** button will allow you to connect to a Shared Printer.

If no advanced printing features need to be modified, simply choose **OK** to print.

Selecting **File » Print Screen** will give the identical result as setting the Print Area to Display.

Selecting **Printer Setup** will open an additional dialog, wherein CAMtastic!® 2000 Designers' Edition will automatically detect the printers you have installed on your operating system, and will subsequently offer a standard assortment of options, depending upon the printer you select. Choose **Network** to browse your network for printers not showing in this list. Choose **Properties** for additional options concerning layout, print quality and other graphic controls.

Selecting **OK** in the *Print Setup/Preferences* dialog (shown earlier) will open a final dialog, in which you may indicate how many copies you want to print. Many of the other printing preferences available elsewhere can be double-checked and even modified from this dialog. Choosing **OK** will send the job to the selected printer.



All images may be previewed before sending them to the printer. Selecting **File » Print Preview** will open the same *Print Setup/Preferences* dialog shown earlier. When the **OK** button is chosen, the image will display on the screen with buttons allowing zooming and browsing through multiple pages (if applicable). Also, a **Print** button will proceed to the *Print* dialog shown above, allowing you to proceed directly to printing.

If you would like to print the CAMtastic!® 2000 Designers' Edition image from another application, you may export the image in a variety of formats, including a bitmap image (see Exporting, above). In addition, selecting **File » Copy to Clipboard** will copy the current view of the Design Window to the Windows clipboard, ready to be pasted into other Windows™ applications.

The image will be copied as it appears in CAMtastic!® 2000 Designers' Edition, with the dark background and any visible grid dots.

## Building Blocks

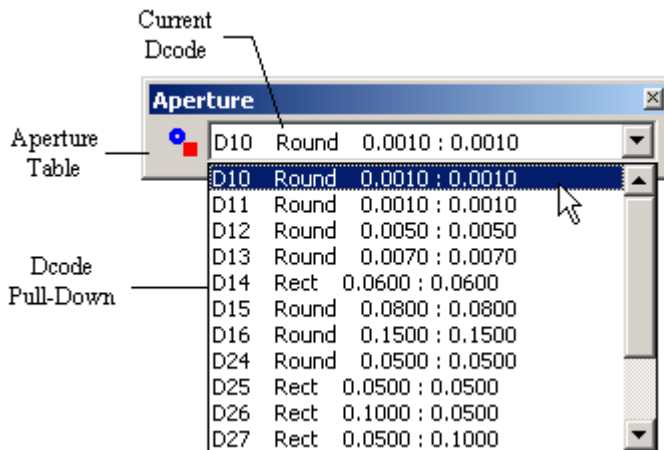
Several overriding concepts apply throughout CAMtastic!® 2000 Designers' Edition and will be introduced in this section. These include Dcodes (apertures), layers, drawing modes, and tools for drilling, routing and milling.

### Dcodes

A code number between D10 and D999 will be assigned to all different shapes and sizes (apertures) used in your current session. This list is available for modification in the Aperture Table. If you import an image into CAMtastic!® 2000 Designers' Edition, the Aperture Table will automatically generate all the Dcodes necessary to assemble the image.

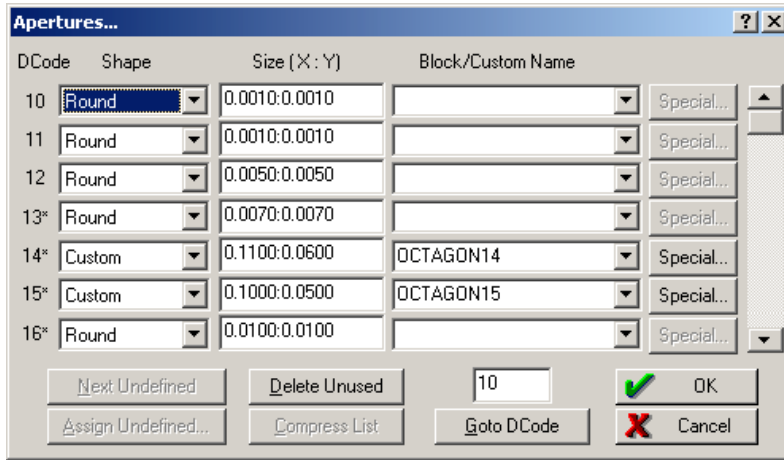
The Aperture toolbar contains a button for the Aperture Table and a pull-down list of all assigned Dcodes.

The Dcode Pull-Down displays the current Dcode—any drawing process you begin will use this Dcode as the pen. Picking any other Dcode from the pull-down list will make it the current Dcode.



Shapes must be defined in the Aperture Table, however, before they can be placed in the current image. Once defined, the shape or size of an aperture may be modified by returning to the Aperture Table. Any changes you make to an existing Dcode will automatically replace all instances of that Dcode with the new aperture definitions.

The Aperture Table may be accessed from the Main View of the Workspace Bar or by selecting the Aperture Table button in the Aperture toolbar.



In a new session, this list will be blank until images are imported or defined manually. CAMtastic!® 2000 Designers' Edition will create an aperture list automatically from imported files, such as Gerbers. Otherwise, shapes can be added or modified manually by changing the fields listed in the *Aperture* dialog.

A Dcode number between D10 and D999 is available for each aperture you wish to create. An asterisk (\*) is placed next to all currently used Dcodes. Fourteen options are available in the Shape pull-down list, and the Size format varies slightly between shapes.

Shape	Size Format	Shape	Size Format
Custom	X:Y (extents)	Polygon Void	Length
Diamond	Length:Height	Square	Length
Donut	Outside Diameter:Inside Diameter	Rect	Length:Height
Oblong	Length:Height	RoundRect	Length:Height
Octagon	Length:Height	Target	Outside Diameter
Round	Diameter	Thermal	Outside Diameter:Inside Diameter
Polygon	Length	Undefined	None

Custom parts must have special attributes assigned to them. For example, if you choose Custom as a new shape, then enter X and Y dimensions as indicated above, then exit the table, you will find that no aperture has been created. On the other hand, if you have instances of a normal aperture already placed in the Design Window, then you change the shape to Custom in the Aperture Table,

then close the table, all the shapes will turn to small squares. Returning to the Aperture Table, you will find that the **Special** button will return an error if you try to assign custom attributes to it now.

The correct method is to first choose a shape that can handle special attributes. Any shape but Round, Donut, Polygon, or Polygon Void may be rotated. A RoundRect also allows you to choose its corner radius. A Target will let you choose between one and four rings, and modify the width of its component tracks. Conversely, a Thermal will allow you to choose two or four spokes and modify their width.

Rotation degrees may be entered between 0 and 360. No negative values will be accepted.

Once any aperture has been assigned special characteristics, its shape is changed to Custom. After this point, you may modify any of the special attributes, but you may not change its dimensions by simply retyping in the Size field, as you would with normal apertures. To change the dimensions of a custom aperture, you must change it back to a normal aperture first, change the size, then apply the special attributes anew.

When importing Gerber, DXF or DWG images into CAMtastic!® 2000 Designers' Edition, an aperture table will be created, including a pull-down list of all current Block & Shape names defined in the original files. If you need to map one of these to a Dcode, select the aperture shape & size to be mapped, and then choose which Block or Shape you need to use from the pull-down list. Additional entries will be included in this pull-down list when elements in your design are drawn to custom apertures (see the *Advanced Editing* section of *Chapter 5: Editing Tools* for details).

If any undefined apertures have been used in the current session, the **Next Undefined** button will be enabled, scrolling down to the next one on the list. If all apertures have been assigned specific shapes and sizes, this button will become disabled.




An asterisk appears beside all Dcodes that are represented in the design window. The **Delete Unused** button will locate all Dcodes that have not been used in the current session and erase their data, returning them to default settings. This can be useful if you wish to free up additional room for new apertures. CAMtastic!® 2000 Designers' Edition will not hold more than 990 Dcodes in a single session.

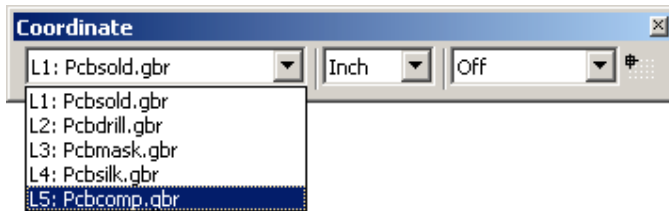
Any number between 10 and 999 may be typed in the **Goto Dcode** field; clicking on the button will automatically jump to the aperture described on that line.

## Layers

All images in CAMtastic!® 2000 Designers' Edition are drawn or imported onto layers. When a new session is created, at least one layer must be added for any images to appear on the screen. If the user does not add a layer manually, one will be automatically created when any Dcodes are placed in the Design Window.

CAMtastic!® 2000 Designers' Edition allows up to 50 layers to be used in a single session. Several tools are available for layer management: the Layers View of the Workspace Bar (described in the *Workspace Management* section of this chapter), the Layers toolbar, and the Layer Table.

-  The Layers toolbar offers several commonly-accessed functions. All layers may be displayed (turned on) by selecting **All ON**, and similarly, all layers may be turned off by choosing **All OFF**. A new layer may be created by choosing **Add Layer**.
-  As described previously, the current layer will have an X through its color box in the Workspace Bar. The current layer will also be displayed on top of the Layer Control Pull-Down, which is available on the Coordinate Toolbar (shown below).
- 



To change the current layer, select a different layer from this pull-down list. Each layer has its own number, assigned in the order it was created or imported.

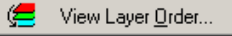
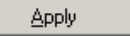
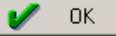

Multiple layers may be combined in a variety of ways. A merge will simply create a new layer out of existing ones, while composite layers are used to create complex shapes, like donut holes, which require overlapping layers to display properly. See the *Advanced Editing* section of *Chapter 5: Editing Tools* for details on Combining Layers.



The main tool for working with layers, however, is the Layer Table. You can open the Layer Table in two ways: selecting its button in the Layers toolbar, or by double-clicking its icon in the Main View of the Workspace Bar.

The Layer Table appears in the following format, with columns for Layer Number, Name, Type, Draw Color, Flash Color, On, Lock and Delete.

#	Name	Type	Draw	Flash	On	Lock	Delete
1	Pcbsold.gbr				<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Pcbdrill.gbr				<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Pcbmask.gbr				<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Pcbsilk.gbr				<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Pcbcomp.gbr				<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

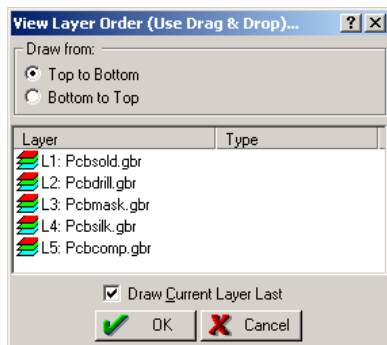
   

- Layer Number:** Displays Layer Numbers. Each layer is assigned a number in the order it was originally added. The order of this list cannot be modified, although the order in which the layers are drawn can be—see View Layer Order below.

- **Name:** Displays the Layer Name. Simply clicking your mouse upon any existing layer name will allow you to rename it.
- **Type:** Indicates the Layer Type, if any. Some CAMtastic!® 2000 Designers' Edition functions require a Type to be assigned first—for example, Pad Removal requires at least one layer to be assigned as Internal. Clicking in this field will display a pull-down list, from which you may choose Top, Bottom, Internal, Neg Plane, Pos Plane, Drill Top, Drill Bot, Drill Int, Silk Top, Silk Bot, Mask Top, Mask Bot, Paste Top, Paste Bot, Rout/Mill, Insulator, Refdes Top, Refdes Bot, Temporary, Border, Dark Image, Clear Image, or nothing at all.
- **Draw Color:** Shows the layer used for all draws on a particular layer. Clicking on any color will display CAMtastic!® 2000 Designers' Edition's standard 14-color palette from which a new choice can be made.
- **Flash Color:** Shows the layer used for all flashes on a particular layer. Colors may be modified in the same manner described above for the Draw Color column.
- **ON:** Selected boxes indicate which layers are currently displayed.
- **Lock:** If selected, the corresponding layer will be locked. A locked layer cannot be drawn to or edited.
- **Delete:** If this is selected, the corresponding layer will be deleted when either the **Apply** or **OK** buttons is selected.

As indicated in the Layer Table's title bar, right-clicking in the header of any of the last three columns will toggle between selecting and deselecting all of the boxes below.

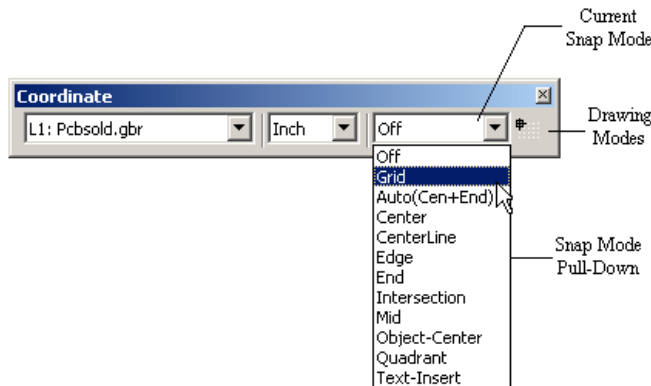
Selecting **Apply** will execute all changes without closing the dialog. This is a time saver when you have multiple functions to apply to different layers. Choosing **View Layer Order** will open a dialog allowing you to change the drawing order of the layers.



Selecting **Draw Current Layer** Last will change the system default for this value. The corresponding box in the *General Preferences* dialog will be updated automatically.

## Drawing Modes

Besides the Layer Pull-Down, the Coordinate toolbar also contains a **Drawing Modes** toolbar button and shortcut pull-down menus for different units and snap modes. Units may be set to inches or millimeters. Many different options are available in the Snap Mode Pull-Down menu, shown below.



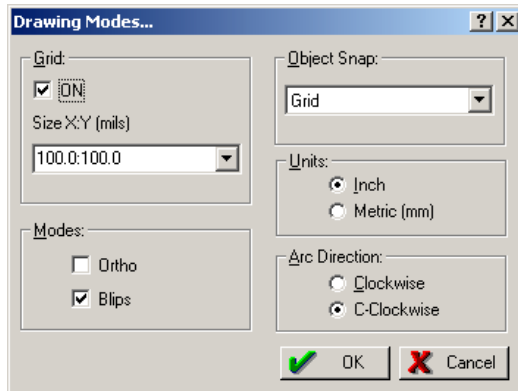
If the snap mode is off, then the cursor location will be the point location for drawing functions. If any other mode is set, then a target marker (⊠) will appear as the cursor approaches relevant locations. Clicking while the target is displayed will use the target location, rather than the true cursor location, as the point selection.

- **Off:** Lets the cursor move freely around the Design Window.
- **Grid:** Snaps the cursor to the currently defined grid-points.
- **Auto (Center + End):** Snaps to the ends of lines, or to the true center of any arc's circle.
- **Center:** Snaps to the center of any flash.
- **CenterLine:** Snaps along the center of a draw (disregarding its width.)
- **Edge:** Snaps to an outside edge of a draw's width.
- **End:** Displays a target symbol over the end point of a line when the cursor nears it.
- **Intersection:** Snaps to the intersection of two draws (lines or arcs). They need not have the same width or even be on the same layer.
- **Mid:** Snaps to the mid-point of any line or arc.
- **Object-Center:** Snaps to the calculated center of an arc or polyline. Think of this as a center of gravity for the object—the object center of an arc, for instance, will not be the center of the projected circle, but will depend upon the amount of arc actually displayed.
- **Quadrant:** Snaps to the North, South, East, or West point on an arc (or circle). The center point of the arc's width is the precise snap location.



- **Text-Insert:** Snaps to the insertion point of any existing Text. In CAMtastic!® 2000 Designers' Edition, text is not necessarily anything you can read—if a text has been composed of lines or exploded into polylines, then no snap point will appear.

The **Drawing Modes** button brings up the *Drawing Modes* dialog, shown below.



A dot grid is displayed at certain zoom levels in CAMtastic!® 2000 Designers' Edition if the **ON** box is selected. The size and spacing of the grid can be chosen from the **Size** pull-down menu or typed in manually. **Ortho** mode helps you draw, edit, or measure at 90 degree increments. **Blip** mode causes a reference plus sign (+) to appear at points that are entered when no drawing or editing function is active. These reference points are temporary and will disappear when the image is refreshed.

The pull-down list of snap modes is also available in this dialog, as is the option to toggle between the imperial and metric systems. Finally, the default direction of arcs is defined in this dialog. Remember that regardless of the default, the direction of arcs can be changed individually as they are drawn.

## Tool Table

This table contains all drill, mill and route tools used. If you have indicated drills or any routing/milling on the board, then this table will be updated automatically to describe all necessary tools for drilling, routing and milling (see the *Advanced Editing* section of *Chapter 5: Editing Tools* for details). Otherwise it will remain empty unless you enter tool sizes manually. Dcodes (beginning at the first available code after 499) will be assigned to each tool.

The Tool Table may be opened from the Main View of the Workspace Bar.

#	Size (Inch)	Comp. (Inch)	Feed (In/Min)	Speed (RPM)	Z-Axis (Inch)	Plated	Ref. Dcode	Comments
1						<input checked="" type="checkbox"/>		
2						<input checked="" type="checkbox"/>		
3						<input checked="" type="checkbox"/>		
4						<input checked="" type="checkbox"/>		

- **Number (#):** Tool numbers (1-99)
- **Size:** Drill diameter
- **Comp.:** Cutter compensation
- **Feed:** Infeed rate
- **Speed:** Spindle speed
- **Z-Axis:** Depth offset
- **Plated:** Plated or unplated bit (selected or not selected)
- **Ref. Dcode:** Existing Dcode used for display of route path
- **Comments:** Reference notes

Tool files may be created or imported also, but there is little leeway in the format of this file. Below are the crucial components of a Mill/Rout Table Settings file, which must be saved in ASCII format.

```
[any text line]
Ver=2
[any text line]
Tool=1,[Size],[Comp.],[Feed],[Speed],[Z-Axis],[Tab],[Dcode],[Plated],[Comments]
Tool=2, etc.
```

If any of these values is unknown or non-essential, a zero should be entered in its field (except for Comment, which should be left blank). Unplated is indicated by a 0; plated is indicated by a 1.

The Ref. Dcode does not create a Dcode, it simply allows assignments from its pull-down list. So if a particular Dcode has not been assigned in your Aperture table, then this Ref. Dcode box will remain blank, even if its number is contained in the .mts file.

## Non-Editing Tools

Many users are interested in viewing imported files to read and verify their contents. CAMtastic!® 2000 Designers' Edition offers a variety of tools for viewing and inspecting files. Several types of reports can be generated from these files.

### Viewing Tools

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The most commonly used viewing tools (zooming and panning) are covered in the *Workspace Management* section of *Chapter 3: Basics*. In addition, CAMtastic!® 2000 Designers' Edition offers a variety of alternative viewing options. Anything you print will reflect the active view.

#### Fill Toggle



An outline sketch of your image can be seen by selecting **View » Fill**. By default, the Fill Toggle is active, meaning that trace widths, flashes and polygons are all filled in. When disabled, this feature will display all flashes and polygons as outlines and traces as 0-width lines. Custom apertures are not affected by this command.

#### Negative Toggle



A negative of your image may be displayed by selecting **View » Negative**. When enabled, this feature displays the current Image using the opposite field. While the standard view consists of a normal background and colored images, the negative view will show a colored background with clear images.

#### Translucent Toggle



This feature displays objects with a transparent effect, allowing you to see objects partially or entirely overlapped by others. It may be activated by selecting **View » Translucent**. While powerful and useful, this feature opens you up to certain hazards. Stacked objects are sometimes displayed in white—a color otherwise seen only in selections. This can be confusing when making selections, as some overlapping objects may appear to be selected when they are not. In addition, the editing redraw speed is faster when the translucent view is not enabled.

## Difference

Layers may be compared with CAMtastic!® 2000 Designers' Edition showing only their differences. Simply enable the layers you wish to display, then choose **View » Difference**. Only elements that are not precisely the same on at least one other layer will appear.

## Highlight Dcode



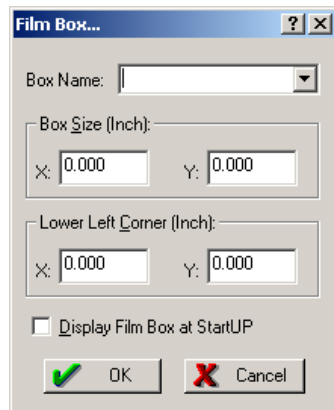
All instances of a particular Dcode may be highlighted together. First verify that the current Dcode (the one displayed above the Dcode pull-down list) is the one you want to highlight. If it is not, choose another, then select **View » Highlight Dcode**. This feature is for viewing only, and will not be available if an editing or drawing function is active.

While the Highlight Dcode displays the apertures as if they were selected, this is not a true selection, as no editing feature can be enabled during use. To edit these items together, activate the editing function, select the **Filter** button from the Select toolbar, type the Dcode number(s) in the top field, and choose **OK**. Then drag a selection window across the desired area.

## Film Box

The film box is a rectangle used as a visible reference, usually for placement of objects before export to Gerber. If a film box has been previously defined, then selecting **View » View Film Box** will display it.

A film box may be defined or modified by selecting **View » Film Box**, which opens the dialog shown below.



A pull-down list of previously defined film boxes is available. A new film box may be defined by typing in a **Box Name** and defining its measurements and relationship to the origin. Select **Display Film Box at StartUP** if you want this box to appear at the beginning of your next CAMtastic!® 2000 Designers' Edition session.

While the **Box Size** must be greater than zero and no more than 65 inches, the dimensions of the **Lower Left Corner** may be positive or negative.

## Extent Box

The Design Window fills the screen, but not all of this screen is necessarily accessible by the user. CAMtastic!® 2000 Designers' Edition allows 65 by 65 inches for design work—this area is called the Extents Box. This area may be displayed by selecting **View » Extents Box**. If you cannot see the entire Extents Box at your current view, zoom out until the dashed line is entirely visible. You'll notice that the X:Y Coordinate Box (on the far left side of the Status Bar) reports the cursor's location as "Out of Limits!" for any movement outside of the Extent Box.

## Origin



The origin is usually invisible, but the X and Y axis may be displayed by selecting **View » Origin**. This origin automatically resides at some point within the 65 by 65 inch Extent Box area. Its default location may be indicated in the General Preferences (see the *Preferences* section of *Chapter 6: Reference Tools* for details). However, the origin may be changed on an individual basis by choosing **Bonus » Set Origin** then choosing the new location. The numbers shown in the X:Y Coordinate Box (on the left side of the Status Bar) will reference the new origin.

The lower left corner of imported files will be placed at the origin, so you may get an import error if your origin is too close to the upper right limits of the Extent Box area. You will be asked if the origin can be adjusted to fit the document inside.

## Redraw



The Design Window will be periodically refreshed, usually upon the execution of a function within CAMtastic!® 2000 Designers' Edition. However, the screen may be automatically refreshed at any time by selecting **View » Redraw**. All enabled layers are redrawn in the viewing order established within the Layer Table (see the *Building Blocks* section of *Chapter 3: Basics* for details).

## Inspection Tools

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CAMtastic!® 2000 Designers' Edition makes it easy to measure distances and perform queries on single or multiple objects. If enough information is provided, it can also run design rule checks and generate netlists.

### Measurements



Distances between points are calculated by selecting **Inspect » Measure: Point to Point**. Indicate the first point, then the second. The Info View of the Workspace Bar is automatically brought into focus, reporting the distance, angle, coordinates of each point, and the X and Y displacements of the line.

For precise measurements, point coordinates may be entered manually in the X:Y Coordinate Box (left side of the Status Bar). Pressing **Enter** is the same as left-clicking on a point with the mouse.

If you are interested in measuring the distance between objects rather than points, select **Inspect » Measure: Object to Object**. The results are once again displayed in the Info View of the Workspace Bar.

The actual selection of Point 1 and Point 2 when measuring between objects will depend upon the snap mode selected before the Measurement feature is activated.

### Queries

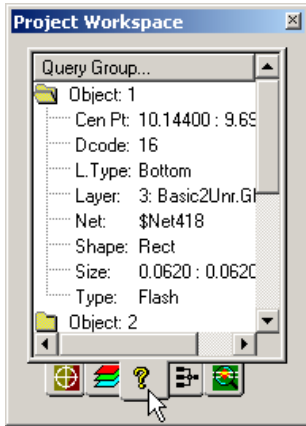
Objects (flashes or draws) may be queried for information.



Selecting **Inspect » Query** will turn the cursor into a pointing finger, ready for object selection. One object may be selected at a time in this mode. A list is generated displaying the object's Dcode, Layer Type, Layer name and number, Length, Net (if already extracted), Shape, Size, Type, and closest Vertex. As with measurements, this information appears in the Info View of the Workspace Bar, which is automatically brought into focus.

A group of items may be queried together with an associated function. Selecting **Inspect » Query Group** will turn the cursor into a pickbox, which will allow selections in the standard format: single picking or selection windows (see the *Workspace Management* section of *Chapter 3: Basics* for details). A tally of selected objects will appear in the Total box (right end of the Status Bar), and right-clicking in the Design Window will generate the query list.

This information is again displayed in the Info View of the Workspace Bar, but each individual query is contained within an object folder, as shown in the example below.



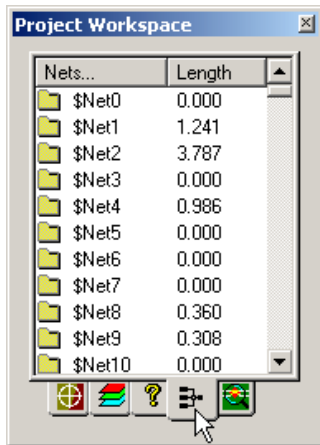
Double-clicking on an open object folder will close it.

An additional query function is available for nets if the Netlist Extraction process has already been performed on the image. Selecting **Inspect » Query Net** will turn the cursor into a pointing finger, and clicking on any object will highlight its entire net and display net information in the Workspace Bar. This query displays the net number assigned by CAMtastic! 2000 Designers' Edition, and its length and layer information (name, number and type).

Querying one net after another will not refresh the screen, meaning that a first net will remain highlighted after a second net is selected. Redrawing the screen after a new net is selected will display the image with only that net highlighted.

## Netlist Extraction

This function generates netlist information from displayed images, such as Gerber data. A single net is assigned for all connected images on each layer. Selecting **Inspect » Netlist Extraction** will generate this list of nets and display them in the Netlist View of the Workspace Bar, as shown below.

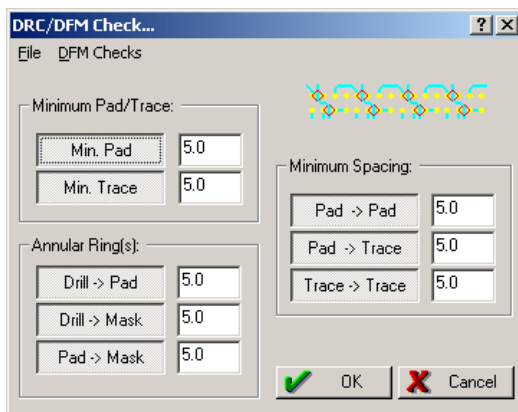


Before running this process, make sure that you have defined the following applicable layer types in the Layer Table: Top; Bottom; Drill Top; Neg Plane; and Pos Plane.

Clicking on any folder will highlight that net and zoom into it in the Design Window. This list may be refreshed at any time by selecting **Inspect » View Nets (in Workspace Bar)**, and any new objects will be assigned nets of their own. Once generated, the netlist may be exported according to descriptions in the *Session Management* section of *Chapter 3: Basics*.

## Design Rule Check (DRC)

Several tools help you check your designs in CAMtastic!® 2000 Designers' Edition for any violations under the rules that you define. Selecting **Inspect » DRC/DFM Check** will convert the cursor into a pickbox, ready to select single objects or drag selection windows across the screen. A single right click in the Design Window will open the dialog shown below.

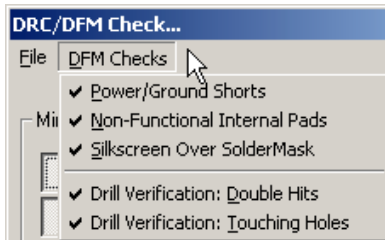




The main portion of the window describes size and clearance constraints for objects and layers. Modify the minimum clearance (either in mils or millimeters, depending on the current settings) to the right of each field name or disable the field altogether by clicking on the name itself.

The DRC can check for annular rings on the pad layer even if a pad layer has not been created. Simply substitute it with a component or solder trace layer and CAMtastic!® 2000 Designers' Edition will create its own pad layer using the flashes from the substituted layer.

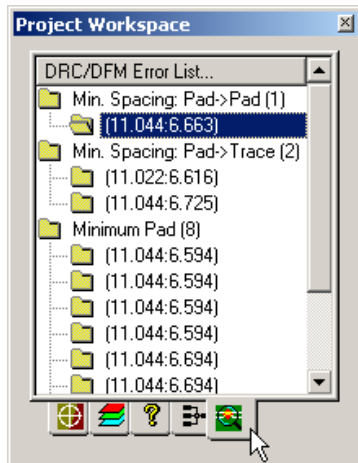
The DFM (Design For Manufacturing) Checks include additional options as shown below. Simply select any of these options to add it to or remove it from the list of checks.



The File menu option within this same dialog will allow you to open or save box settings. Select **OK** to begin the check. You will be informed if no violations were detected; otherwise a DRC Summary of Violations appears on the screen. The Error View of the Workspace Bar is now made available with a folder for each category containing errors and a subfolder for each individual error.

A reference layer named `DrcError` is automatically created (placing a diamond upon each error location), and selecting any individual error subfolder in the Workspace Bar will jump to and highlight the error marker for that violation. A detailed DRC report (named `DrcReport.txt`) is automatically saved in the same folder as the CAMtastic!® 2000 Designers' Edition session, listing the number of violations for each check, the X & Y locations for each specific violation, and the total number of violations.

This list of violations shown in the Error View of the Workspace Bar may be viewed at any time by selecting **Inspect » View Errors (in Workspace Bar)**, but this will not recheck the design for additional violations. To use this feature, you must already have run a DRC on the board, otherwise you will receive a message that the `DrcError` layer was not found.



An additional check for invalid polygons is available. Polygons are continuous outlined boundaries that are Raster filled. Raster-filled boundaries cannot support overlapping or multiple shared vertices. If your design contains invalid polygons are present on your design, the data you export can cause you machine to crash or give unwanted results. To search for invalid polygons, select **Inspect » Invalid Polygon Check**. If an invalid polygon is located you will receive a message: # Invalid Polygons Found. The Invalid Polygons will be highlighted and assigned to an empty Dcode.

## Copper Area Calculation

The Copper Area of any selected objects can be calculated in CAMtastic!<sup>®</sup> 2000 Designers' Edition.

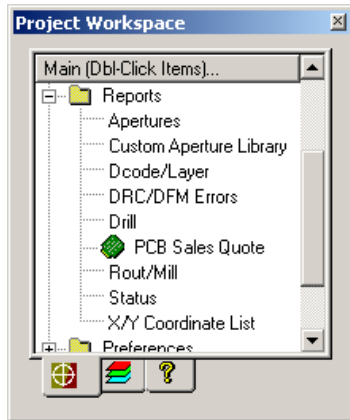
Selecting **Inspect » Copper Area Calculation** will change the cursor to a selection pickbox. Follow the general selection procedure to determine which portions of your board should undergo this calculation. A single right click in the Design Window will begin the calculation for all enabled layers. A report file (Copper.txt) is created and displayed, showing the amount of copper used on each layer. The total copper area is also indicated.



## Reports

---

Reports may be generated at any time from active sessions. In the Main View of the Workspace Bar a Reports folder may be opened to show the nine options shown in the figure below. Each will be described in this section.



All reports are saved in ASCII format and placed in the last folder that was opened in CAMtastic!® 2000 Designers' Edition. If you are generating a report from a session that has not yet been saved, its location may vary. In this case, you should check the folders CAMtastic!® 2000 Designers' Edition has used most recently. Of course, you may simply use the Save As feature in the text editor and give any report a name and location of your own choosing.

Some reports will take their names from the active session, while others receive a generic name. In the latter cases, a file location will be the only clue as to its source.

No warning is offered if a new report is about to replace an old one. This can be a problem for users who have multiple CAMtastic!® 2000 Designers' Edition sessions saved in the same folder. Since some reports will have the same name (`drill.rpt`, for instance) regardless of which session is used to create them, we recommend you rename these files if you have multiple `.cam` files saved the same folder.

### Apertures

Choosing the Apertures Report will create a text file from your current Aperture Table and display it. As shown in the example displayed below, this file will include header information, default settings, and a list of defined Dcodes with their associated apertures.

```

CAM Products 2000   Aperture List

Format:  3.4
Zero Suppression:  Leading
Type:    Absolute
UNITS:   English (In.)

DCODE:           TYPE:           X : Y  BLOCK/CUSTOM:
-----
10             Poex             0.0000:0.0000
11             Round            0.0070:0.0070
12             Round            0.0350:0.0350
13             Round            0.0320:0.0320
14             Round            0.0150:0.0150
15             Round            0.0010:0.0010
16             Poex             0.0010:0.0010
510            Donut            0.0400:0.0350

```

This file is saved with an .lst extension and may be accessed in CAMtastic!® 2000 Designers' Edition by selecting **File » Import » Aperture File** (see the *Session Management* section of *Chapter 3: Basics* for details).

## Custom Aperture Library

The details of all custom shapes in the current session's Aperture Table are documented in this report file.

```

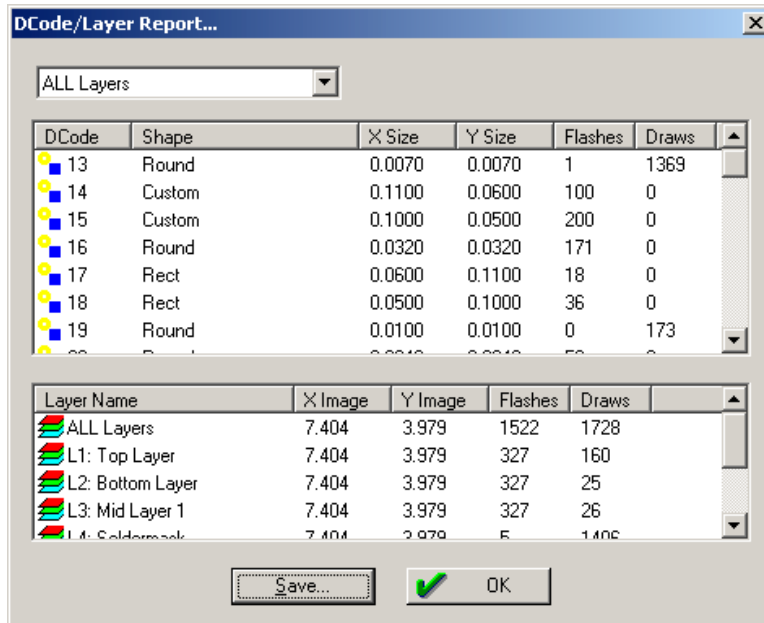
%AMOCTAGON14*
4,1,8,0.055000,0.012400,0.037400,0.030000,-
0.037400,0.030000,-0.055000,0.012400,-0.055000,-
0.012400,-0.037400,-0.030000,0.037400,-
0.030000,0.055000,-0.012400,0.055000,0.012400,0.0*
%
%AMOCTAGON15*
4,1,8,0.050000,0.010400,0.035400,0.025000,-
0.035400,0.025000,-0.050000,0.010400,-0.050000,-
0.010400,-0.035400,-0.025000,0.035400,-
0.025000,0.050000,-0.010400,0.050000,0.010400,0.0*
%
%AMROUNDRECT30*

```

This file is saved with a .lib extension and may be accessed in CAMtastic!® 2000 Designers' Edition by selecting **File » Import » Custom Aperture Library File** (see the *Session Management* section of *Chapter 3: Basics* for details).

## Dcode/Layer

Selecting this report brings up a dialog in which the scope of the report may be narrowed.



A pull-down list allows you to select ALL Layers, ON Layers, or any individual layer names. (ON Layers, of course, refers to those layers currently enabled in the Design Window.) The rest of this dialog shows the ensuing information that will be written to the report file if the **Save** button is selected. The top half of the report shows the Dcode number, shape, and size for each aperture, then the number of times it is flashed and the number of times it is drawn in the selection. The lower half of the report arranges information by layers, starting with the total, and descending into each individual layer. The extents of each layer are reported, as are its total number of flashes and the total number of draws. If saved, this information is written to a file named `Report.txt` which will include the information shown above, as well as some brief header information (session file name, time, date, etc.).

## DRC/DFM Errors

If a DRC/DFM check has been run in the current session, a report named `DrcReport.txt` has already been generated (see the *Inspection* section of *Chapter 4: Non-Editing Tools* for details). Selecting this report in the Main View of the Workspace Bar will simply reopen this report for you.

No error report will be generated if no errors were detected in your design.

## Drill

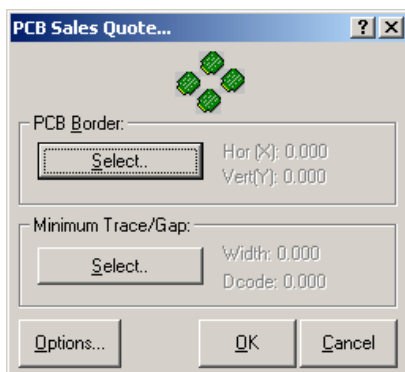
A text file named `Drill1.RPT` will describe all drills that have been made on the board. Each drill will be reported by its tool number and size described in the Tool Table (see the *Building Blocks* section of *Chapter 3: Basics* for details), and the number of instances it is used in the image.

CAM Products 2000 Drill Report		
Units: English (Inch)		
TOOL	SIZE	COUNT
====	=====	=====
1	0.1000	88
2	0.0540	38
3	0.0630	46
4	0.1400	4
5	0.0320	45
6	0.0240	19
7	0.0400	22
8	0.1250	2
9	0.1100	44
10	0.0640	19
11	0.0730	23
12	0.1550	2

This report will show all drill points, whether or not their respective layers are displayed.

## PCB Sales Quote

CAMtastic!® 2000 Designers' Edition will generate a report to send to prospective PCB fabrication and assembly shops for issuing quotations. This keeps your design work confidential, laying out only the information a shop will need to estimate a production cost, such as dimensions (trace width, gap spacing) and total pads and vias.



Selecting the PCB Sales quote will immediately open the dialog shown above. At least one route layer must be assigned before building a PCB report (see the *Building Blocks* section of *Chapter 3: Basics* for details about the Layer Table).

- **Select PCB Border:** Returns you to the main screen where your cursor has changed to a pickbox, ready to select the border. You may click directly on each trace of the border or drag a selection box across it. A single right click will return you to the *PCB Sales Quote* dialog with the Horizontal and Vertical data completed. If you have made a mistake in your selection, simply choose the **Select** button again and start over.
- **Select Minimum Trace/Gap:** Returns you to the main image in the same manner as the PCB border selection (above). Here you will either choose the smallest trace on the board or drag a selection window across any portion of your design. We recommend that you drag a selection window across the entire PCB image to ensure that the smallest Trace/Gap and Dcode in use will be considered in the PCB report.
- **Options:** Opens the dialog shown below.

**PCB Report Options...**

**Overall Pcb Dimensions:**

- Size (X,Y)
- Area
- Perimeter Length
- Cutouts (#,Length)
- Min. Trace Width
- Min. Gap Spacing

**Drill Holes:**

- Total Hole Count
- Total Hole Sizes
- Min. Hole Size
- Max Hole Size
- Min. Annular Ring

**SMT Pads:**

- Total SMT Pads
- Min. SMT Pad Size
- Min. SMT Pitch
- # of Min. SMT Pads

**Calculate Gold Area:**

- Route (Top,Bottom)
- Mask (Top,Bottom)

**Via Holes:**

- Total Vias
- Via Pad Size
- # of Buried Vias
- # of Blind Vias

**Gold Fingers:**

- Orientation (Hor,Vert)
- Size (X,Y)
- Which Side?
- Gold Area

**Options:**

- Layer Count Table
- Gerber Desc. Table
- Count # of PCB's per panel

Report Units:

Panel size:

OK

Cancel

CAMtastic!® 2000 Designers' Edition offers over 30 fields that fabrication houses may

consider when generating quotations. Simply deselect any field that will not affect the price of fabrication for your particular project, and that feature will not be included in the final report.

After selecting the options you wish to include, simply choose the **Report Units** and **Panel Size**, then select **OK** to return to the previous dialog.

Once the border has been selected, the minimum trace/gap and Dcode have been defined, and all other options have been specified, select **OK** in the *PCB Sales Quote* dialog. Immediately a text file named `PcbReport.txt` will be written to your hard drive and opened for viewing. This file will contain the CAMtastic!® 2000 Designers' Edition session name, date, time, units, and any fields you have selected in the *PCB Report Options* dialog.

```

CAMtastic! PCB Report File: Demopcb
Date: 2/16/2000
Time: 14:36:45
Units:      Inch

Dimensions:
=====
Horizontal(X):      7.060
Vertical(Y) :      3.060
Total PCB Area (Sq. In):  21.604
Perimeter (Length) :    20.240

Panel Size/Count:
=====

```

This report may also include additional comments, such as `Paste Layer(s) Not Detected`.

## Rout/Mill

A text file named `Rout.RPT` will be written describing all defined rout/mill paths on the board. See the *Advanced Editing* section of *Chapter 5: Editing Tools* for details on creating these paths.

```

CAM Products 2000  Rout-Mill Report
Units: English (Inch)

TOOL      SIZE      COUNT      DIST
=====
  1        0.0100     2          1.0366
  2        0.0200     2          1.0800

```

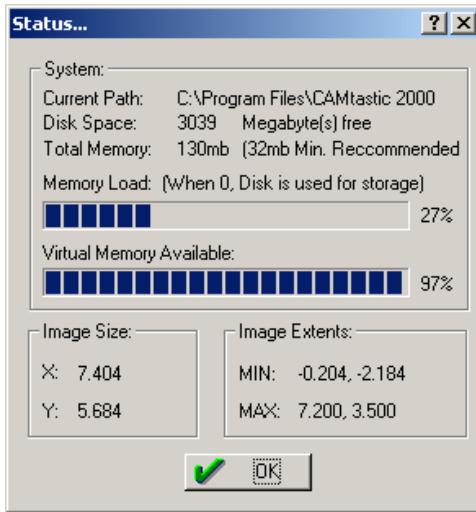
This file will contain tool numbers and sizes as indicated in the Tool Table, then the number of routing paths for that tool. The total routing/milling distance covered by each tool is indicated last.

As with the Drill Report, this file will describe all routing paths, whether or not their respective layers are displayed.



## Status

The Status Report, unlike other reports, is not written to a text file, but simply displays a dialog showing session and system information.



This report can warn you when you are nearing the limits of available resources.

## X/Y Coordinate List

Double-clicking on this function will not generate a report immediately, but instead waits for you to select the portions of the design to analyze. Upon right-clicking when the selection is finished, a file named `xylist.rpt` will be automatically generated.

```

CAM Products 2000 X/Y Report
Units: English (Inch)

Total Objects Selected: 1

X1,Y1,X2,Y2,Start Angle,End Angle,Radius,Bulge
=====
Trace: Vertex Count=4
-0.375632,0.219888,-0.369026,0.188814
-0.369026,0.188814,-0.345511,0.193812
-0.345511,0.193812,-0.352116,0.224887
-0.352116,0.224887,-0.375632,0.219888
    
```

The coordinates here described are not the same coordinates shown in the Design Window, but rather relative coordinates to an origin placed near the center of the selection extents.



## Editing Tools

The instructions in this chapter are of an introductory manner, and will describe processes in terms of menu options and mouse clicks. For precision editing, bear in mind that the X:Y Coordinate Box in the Status Bar can replace the use of the mouse for any point locations. Additionally, the *General Preferences* dialog offers the ability to Auto Repeat Functions, which will save time when several similar edits must be performed (see the *Preferences* section of *Chapter 6: Reference Tools* for details).

### Basic Concepts

Most of the tools for modifying (rather than simply viewing) CAMtastic!® 2000 Designers' Edition sessions are found under the Draw and Edit menu options. A few concepts apply throughout these features and should be touched upon here.

- **Undo/Redo:** **Selecting Edit » Undo** negates the last Drawing or Editing function. You may only undo one step. Similarly, you may change your mind about an undo you performed, and redo it (**Edit » Redo**) as long as no subsequent edits have been made.
- **Step & Repeat:** CAD files have a tendency to inflate in size, causing difficulties when hard disk space is limited. Certain features such as panelization and data arrays will allow a Step & Repeat function, which uses a loop code rather than rewriting identical sequences in the saved file. If these codes are used in a session, any Gerber or NC Drill/Mill output files will use them also, offering improved performance for photoplotters and NC drilling or milling machines. If you have used a Step & Repeat in your file, but later wish to make individual modifications, you may select **Bonus » Step/Repeat** and choose either Modify or Explode.
- **Closure:** Several features will require lines to be closed, but this means more than simply having lines meet or cross. Only polylines and polygons can be automatically closed in CAMtastic!® 2000 Designers' Edition. Other lines, however, may be closed manually; see the *Join* heading in the *Edit* section of this chapter for details.

## Drawing

---

Any drawing tools will use the current Dcode as the point of its pen. The current Dcode is displayed in the Dcode pull-down menu on the Coordinate toolbar, and may be changed by simply selecting another aperture from this pull-down menu.

### Flash



A single placement of any aperture is called a flash. You may place a flash anywhere in the workspace by choosing **Draw » Flash**. Then click upon the desired location—or for more precise placement, type the coordinates in the X:Y Coordinate Box and press **Enter**.

### Line

If you simply need to draw straight lines, you may use the **Draw » Line** feature. Line closure is only available with the **Draw » Polyline** feature.

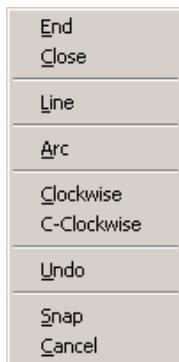


To draw straight lines, select **Draw » Line**, then choose the starting point. Another point selection will set down the next vertex, and so on until your sequence of straight lines is complete. Right-clicking (or pressing **Esc**) will end the line.

One advantage that the standard line feature has over the polyline is the ability to change Dcode and/or Layer mid-line.



To draw lines that need to be closed or that will contain arcs, click on **Draw » Polyline**. This feature behaves identically to standard lines until the right mouse button is clicked. Instead of automatically ending the line, right-clicking in Polyline mode will offer a drop down list of options, shown below.



- **End:** Ends the line without closing it.
- **Close:** Draws a final line from the last vertex to the original vertex, closes it, and ends it.
- **Line:** Toggles from arc mode to straight line mode.

- **Arc:** Toggles from straight line mode to arc mode.
- **Clockwise:** Draws arc from previous vertex in a clockwise direction.
- **C-Clockwise:** Draws arc from previous vertex in a counter-clockwise direction.
- **Undo:** Negates previous vertex.
- **Snap:** Enables or Disables the Snap mode during polyline draw.
- **Cancel:** Negates all vertices placed during this polyline function. Lines will disappear when screen is redrawn.

Any polyline may be broken into its component lines, and any continuous line may be converted into a single polyline. See **Explode » Polylines** and **Join » Single** in the *Basic Editing* section of this chapter for details.

If you need to draw a series of lines, selecting Line or Polyline from the main menu may become tedious. After a line is ended, you may right click in the Design Window and choose **Repeat**, which will restart the previous drawing or editing function.

## Rectangle



Selecting **Draw » Rectangle** will allow you to select two corners. Simply click on one corner and then on the opposite corner—the rectangle will be drawn on the active layer with the current Dcode.

## Arc

Arcs may be drawn as a part of a polyline (see above) or they may be drawn individually. Several different methods of drawing arcs are available to suit your different needs and preferences. An arc that is drawn with any portion outside the Extent Box is ignored by CAMtastic!® 2000 Designers' Edition and will disappear upon the next redraw.

The following options are available in the **Draw » Arc** submenu:

**Center, Start, Sweep Angle:** Accepts center and start point, then asks you to enter the sweep angle degrees (positive values will sweep counter-clockwise, negative values will sweep clockwise).

**Center, Start, End\*:** Accepts center, start, and end points, respectively.

**2-Points\*:** Draws a 90-degree arc between any two points.



**3-Points (Start, End, Tangent):** Accepts start and end points, then displays the potential arc between them as you move the mouse. Left click or press **Enter** when you see the arc you wish to draw. This function is also available on the Draw Toolbar.

**Tangent, Tangent, Radius:** Allows you to select two non-parallel lines, then indicate the radius. An arc will be drawn between the lines, convex with respect to their intersection. If polylines are to use this feature, only adjacent straight lines from the same polyline are eligible tangents. Otherwise you must explode the polyline before drawing the arc.

\* These methods of drawing arcs will determine the arc direction from the *Drawing Modes* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details).

Remember that the relevant points of any arc may be defined precisely by entering the consecutive points in the X:Y Coordinate Box, then pressing **Enter**. The Snap Grid may also aid you in defining your points with precision.

## Circle

As with arcs, a variety of methods is available for drawing circles. The current Dcode and Layer are used for all methods.

Selecting **Draw » Circle** reveals the following options:



**Center, Tangent Point:** Accepts a center point then a perimeter point. This function is also available on the Draw Toolbar.

**Center, Radius:** Accepts a center point, then prompts you to type in a radius.

**Tangent, Tangent, Radius:** Allows you to select two non-parallel lines, then indicate the radius. If polylines are to use this feature, only adjacent straight lines from the same polyline are eligible tangents. Otherwise you must explode the polyline before drawing the circle.

**2-Points:** Accepts any two perimeter points defining diameter.

**3-Points:** Accepts three perimeter points. These points must not lie along the same plane.

## Ellipse

Selecting **Draw » Ellipse** will wait for you to indicate two opposite corners of the reference rectangle which will bound the ellipse. After the first corner is located, the screen will display the potential ellipse as you move the mouse. When you see the ellipse you want, click once or press **Enter** to draw the ellipse.

## Polygon

A polygon is a raster-filled boundary that requires an outline to be made of straight lines. It must have three or more distinct vertices. Selecting **Draw » Polygon** will allow you to select a starting point, and then all sequential points until you are ready to end the polygon. Right-clicking once will fill the polygon.

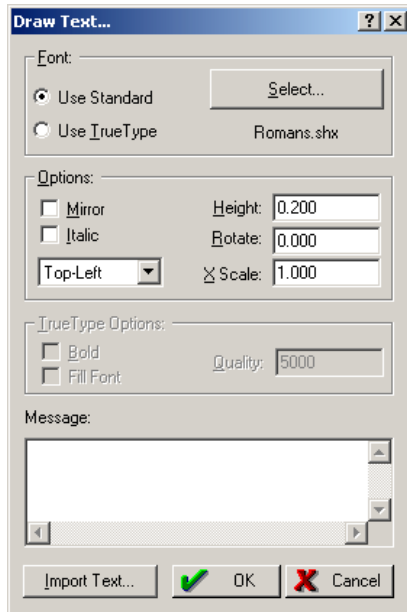
In contrast, a Polygon Void is an area that will be emptied of any draws or flashes. Otherwise it behaves exactly as a polygon. Selecting **Draw » Polygon Void** will allow you to select a starting point, then all sequential points until you are ready to end the polygon void. Right-clicking once will empty the boundary.

## Text



Both single stroke and TrueType text fonts are available in CAMtastic!® 2000 Designers' Edition. Selecting **Draw » Text** will let you indicate the point of placement in the Design Window. A *Draw Text* dialog will then appear as shown below.

By default, the **Use Standard** (rather than the **Use TrueType**) option is selected when you open the *Draw Text* dialog. In this case, the **Select** button will allow you to browse to the AutoCAD Text/Shape file (\*.shx) you plan to use.



- **Mirror:** Mirrors the entire text paragraph, if enabled.
- **Italic:** Makes the entire text paragraph italic, if enabled.
- **Justification Pull-down:** Controls the character placement within your selected paragraph rectangle. Justification options include Top-Left, Top-Center, Top-Right, Middle-Left, Middle-Center, Middle-Right, Bottom-Left, Bottom-Center, Bottom-Right.
- **Height:** Accepts the height to be used for the text message.
- **Rotate:** Accepts the rotation value for the text.
- **X Scale:** Determines the length scaling for the text.
- **Message:** Accepts the character string information that will be used.
- **Import Text:** Allows you to browse to any existing text document. Its contents will be imported automatically into the Message window.

If you have selected **Use TrueType** (instead of **Use Standard**) in the Font section, then the **Select** button will display a *Font* dialog. There you will be able to choose from a list of TrueType fonts and any associated Scripts. You may also indicate a custom font size.

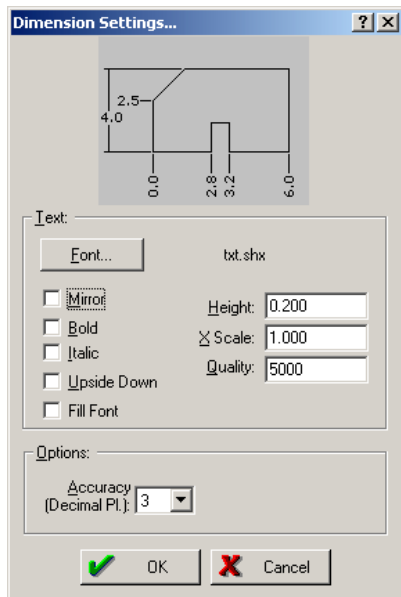
Three additional fields become available when the Use TrueType option is selected:

- **Bold:** Makes the entire text paragraph bold.
- **Fill Font:** Fills every character using raster fill.
- **Quality:** Controls the font quality.

As with all other drawing features, the current Dcode and Layer will be used for Text.

## Dimension

Dimensions can be placed vertically or horizontally in CAMtastic!® 2000 Designers' Edition. Before any dimensions are drawn, however, you should verify all the settings for fonts, accuracy, and spacing. Selecting **Draw » Settings** will display the dialog shown below.



- **Font:** Allows you to browse to a font file. CAMtastic!® 2000 Designers' Edition will automatically look for AutoCAD Text/Shape files (\*.shx).
- **Mirror:** Mirrors the dimension text.
- **Bold:** Makes the dimension text bold.
- **Italic:** Italicizes the dimension text italic.
- **Upside Down:** Flips the dimension text upside down.
- **Fill Font:** Fills every dimension text character using raster fill.
- **Height:** Assigns the height to be used for the dimension text message.



- **X Scale:** Determines the length scaling for the dimension text.
- **Quality:** Controls the font quality of the dimension text.
- **Accuracy:** The decimal places of accuracy for dimension text. This number is also displayed beside the dimension's end point.

Once all values are set to your satisfaction, select **Draw » Dimension** to place a dimension on your image. The following submenu will appear:

- **Ordinate:** Creates a dimension describing the appropriate X or Y coordinate. (A horizontal dimension will display the Y-axis value; a vertical dimension will display the X-axis value.)
- **Horizontal:** Creates a dimension displaying the horizontal distance between two extension points. Enter both endpoints, then a third somewhere between them where you want the measurement to display.
- **Vertical:** Creates a dimension displaying the vertical distance between two extension points. Enter both endpoints, then a third somewhere between them where you want the measurement to display.
- **Radius:** Creates a dimension displaying the radius of any arc. Select a point on the arc then another point away from it to draw the leader. Right-clicking will end the line and draw the dimension.

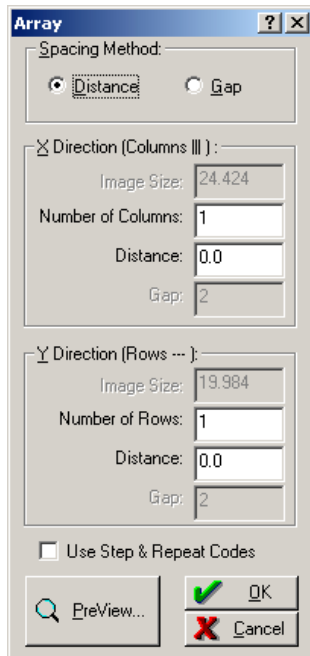
## Basic Editing

### Array

Selected objects may be copied along the X-axis, the Y-axis, or both.



Access this feature by choosing **Edit » Array**. The cursor is converted to a pickbox, ready to select single objects or areas. When everything you wish to array is selected, right click once. This will open the dialog shown below.



Two methods of spacing are available: Distance and Gap. If **Distance** is selected, then the enabled fields will include the **Number of Columns** and **Rows**, and the X and Y **Distance**. These distances will equal the amount of shift along the X and Y axes you wish the selected objects to appear for each copy.

If the **Gap** spacing method is chosen, the Distance fields become disabled, while the **Image Size** and **Gap** for the columns and rows become enabled. The gap indicates how far between images. The image size reports the extents (X and Y) of the selected area, but it may be modified to provide an additional gap or boundary around the selected image.

Images may overlap by entering a negative value for the X or Y gap, or if the sum of the Gap and modified Image Size is lower than the original Image Size.

In all cases, the units depend on the system—imperial or metric—that has been selected in the *Drawing Mode* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details).

Step & Repeat Codes are also available in this function, which can greatly reduce the file size and improve performance (see the *Basic Concepts* section of this chapter for additional details).

Selecting **Preview** will sketch a block outline of the image size spread across the indicated rows and columns. This will give you an idea of how accurately you have chosen the Distance or Gap values.

## Break



Any straight trace may be separated into two individual segments by selecting **Edit » Break**. Click on any and all points where you wish to segment traces; right click when done.

## Chamfer

Two adjoining trace edges may be bevelled by selecting **Edit » Chamfer**. A dialog lets you enter the X and Y distances from the intersection that the new connecting line should be drawn. Separate these distances with a colon, then choose **OK**. The cursor will become a selection pickbox; click on the first then the second line. The chamfer distance may not exceed the extents of the selected lines.

## Copy

Objects may be copied and placed either once or multiple times in the same CAMtastic!® 2000 Designers' Edition session. Choosing **Edit » Copy » Single** will change the cursor to a selection pickbox. Select items singly or drag the cursor across an area until your selection is complete (see the *Workspace Management* section of *Chapter 3: Basics* for details on selecting objects). Right click to end selection mode, then left click once to determine the reference point. Moving the mouse will now pivot a frame of the selection extents around the reference point. A final left click will place the copied selection.

The image may be panned at any time using the arrow keys without disrupting the sequence of clicks in this process.

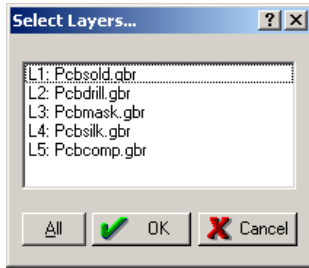


Selecting **Edit » Copy » Multiple** will allow you to place the same copied selection multiple times. This feature works exactly like the Copy Single mode, except that placing the selection does not end the process. The selection will remain on the cursor, ready for additional placements until the right mouse button is clicked.

In either of these copying modes, a single selection may contain objects from several different layers—but each selected object will always be copied onto its same layer.



If you are trying to copy items or groups onto a separate layer, you should select **Edit » Copy to Layers**. The cursor changes to a selection pickbox; use any necessary selection strategies until selection is complete. Right-clicking will open the *Select Layers* dialog, shown below.



All existing layers are shown, and may be selected individually with single mouse clicks or as a group by choosing **All**. The entire selection will be merged onto each selected layer.

## Erase



To delete objects from a CAMtastic!® 2000 Designers' Edition image, select **Edit » Erase**. This will activate selection mode, highlighting each object as it becomes selected. If any objects are inadvertently selected, you may remove items from the selection using the Select toolbar, or cancel the whole process by pressing **Esc**. Right click when finished, and refresh the screen, if necessary, to see the modified image.

To delete a single segment of a polyline, use either the Break or Explode Polyline feature first, then the Erase feature.

## Explode

Polylines, Text, and Custom Apertures are considered to be a single object in CAMtastic!® 2000 Designers' Edition, even though they are composed of multiple draws or flashes. In some instances you may need to ungroup or fracture these objects into their component parts. For example, drawing arcs or circles between tangents will not work optimally until the polylines are exploded or fractured into their single-line components.

Selecting **Edit » Explode** shows the submenu of Polylines, Text, and Custom Apertures. The process is the same for all of these features: simply select the relevant objects, then right click to explode them.

Exploding Text will separate the parts into component polylines. Exploding Polylines or Custom Apertures will separate the parts into their most basic components (lines and/or flashes).

If any Step & Repeat codes have been applied within your session, these too may be exploded—meaning that the space-saving codes are deleted, and the repeated data is written out every time it appears. See the *Advanced Editing* section of this chapter for additional information.

## Extend

A line may be extended to meet another. Selecting **Edit » Extend** changes the cursor to a pickbox. Click first upon the target line, then upon the line you wish to extend. If extending the second line will never intersect with the target, an error message will be displayed.

Multi-edged polylines may be selected as the target, but not as the line you plan to extend. If you must extend a portion of a multi-edged polyline, explode it first (see above) into its component lines. Arcs cannot be extended.

## Fillet

Any two adjacent lines may have their connecting edge rounded by selecting **Edit » Fillet**. A dialog immediately asks the desired fillet radius. The units of this value will depend on the current settings in the *Drawing Modes* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details). Choosing **OK** lets you choose two adjoining lines, the corner of which will be replaced with an arc as specified.

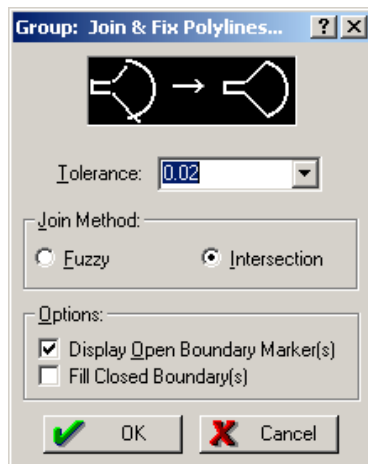
The fillet radius should be chosen carefully, as the lines will be extended forward until the arc is made to fit.

## Join (and Fix Polylines)

Separate lines or polylines may be joined together. If two lines of equal width are touching, then selecting **Edit » Join » Single** will let you join them together with a single click.

It is not enough, however, for the line ends to intersect—their ends must meet perfectly or very closely. This may be done by setting the Snap grid to End and drawing a trace between the two lines you wish to connect.

More options are available with the **Edit » Join » Group** feature. After selecting objects and/or areas you wish to fix, right click to open the dialog shown below.



**Tolerance:** Accepts a distance value (from either pull-down menu or keyboard). If two selected ends are separated by a value greater than the tolerance you have set, they will remain open. If their gap is less than the set tolerance, they will be closed (fixed).

- **Fuzzy Join Method:** Locates the nearest existing endpoint for use when the polyline is created. The endpoint locations may be slightly altered depending on the tolerance that you supply, but this alteration will never be more than the tolerance size that you assign.
- **Intersection Join Method:** Automatically calculates the intersection point between two neighboring objects for use as endpoint when the Polyline is created. This option can create perfect boundaries from the original data.
- **Display Open Boundary Markers:** Places error markers over each open end and draws them on a new layer called Polyline PRO Open Markers. This layer is temporary and should not be used to hold design information, as it will be erased and regenerated each time the **Join » Group** feature is executed.
- **Fill Closed Boundary(s):** Fills any polylines completely enclosed by boundaries.

Choosing **OK** will generate a report based on your settings and the selection you made previously. An example is shown below.



If certain boundaries remain open, you may wish to repeat this function using a higher tolerance.

## Mirror

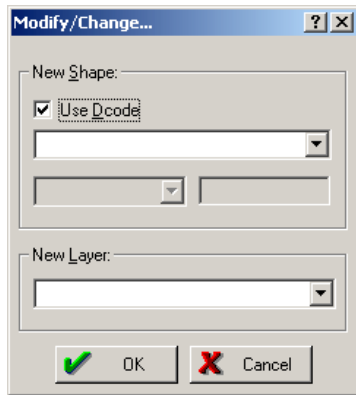


Any group of items can be mirrored. Selecting **Edit » Mirror** will allow you to select all desired items. Right click to end selection mode, then left click to place the mirror. Moving the mouse will adjust the mirror plane (vertical or horizontal) and a final left click will execute the function. You will be asked if you wish the original items to be deleted upon mirroring.

## Modify/Change



Groups of items may be selected together and assigned a common Dcode or Layer. Selecting **Edit » Modify/Change** will allow you to begin selections. Right click when finished. A dialog will then appear as shown below.



You may choose to change the shape and/or the layer for the selections. Leaving a field blank will cause no changes to occur in that field.

If the **Use Dcode** box is selected, all selected objects are modified to a defined aperture chosen from the pull-down list. If the **Use Dcode** box is not selected, you must choose from a pull-down list of available shapes and assign a size.

The size must be entered in inches or mm, depending upon the system selected in the *Drawing Modes* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details). This number may be changed slightly once the aperture is calculated internally.

If you would like to move all selected objects to a new or existing layer, select the target layer from the pull-down list.

If you choose **New Layer** a layer will be created and named by CAMtastic!® 2000 Designers' Edition, for example, `LAYER4`. This layer may be renamed in the Workspace Bar or the Layer Table.

## Move



Objects may be selected and moved within a CAMtastic!® 2000 Designers' Edition image. Selecting **Edit » Move** will put the cursor in selection mode, ready to pick individual objects or drag windows over areas to be selected. Right click when selection is complete, then left click on a displacement or pivot point. Moving the mouse now displays a frame around the extents of the selection; a single left click will move the objects from their original placement to their new destination. All components will remain on their original layers.

The image may be panned at any time using the arrow keys without disrupting the sequence of clicks in this process.

## Offset



Any trace or arc may be offset (shadowed). If the trace is closed, then running this feature will create an outline or internal border, depending on which side of the boundary you choose for the offset to appear. Selecting **Edit » Offset** will prompt you for the offset distance (units will depend upon your current Drawing Modes settings). Selection mode will be activated, but will only allow pickbox (single object) selections. Once any trace is selected, you must click on one side of it. The offset line(s) will be drawn on that side at the distance you have indicated.

You may cancel this function with a single right click or by pressing **Esc**.

## Rotate



Single objects or groups may be rotated by selecting **Edit » Rotate**. The cursor is put in general selection mode. Right click once when the selection is complete, then left click upon the pivot point. You will be prompted to enter the rotation angle in degrees; a positive value will rotate the selection counter-clockwise, and a negative value will rotate the selection clockwise.

The X:Y Coordinate Box and/or the Snap grid may help you choose the pivot point with precision.

## Scale



Single objects or groups may be enlarged or reduced based on a selected base point and scale factor that is uniform in both X & Y directions. Selecting **Edit » Scale** will put the cursor in general selection mode. Right click when done, then left click upon the base point. The X:Y Coordinate Box and/or the Snap grid may help you choose the base point with precision.

A dialog will appear asking you to enter the scale factor. The default is at 100%, which will cause no change to the selection. A higher number will enlarge the selection, while a lower number will shrink it. You will also be given the option to scale apertures. Only positive numbers will be recognized in the scale factor field; an absolute value will taken from any negative entry.

## Text

Existing text may be modified by selecting **Edit » Text**, then clicking on any individual text string. The *Draw Text* dialog appears as shown earlier—see the *Drawing* section of this chapter for more information on Text options.

If a text has been exploded into polylines or if the text was drawn in CAMtastic!® 2000 Designers' Edition with placed lines rather than text, then it will not be eligible for modifications.

## Vertexes

Vertexes may be added, deleted, or moved in CAMtastic!® 2000 Designers' Edition. Any line or polyline may have a vertex added (thus making it a polyline if it wasn't one before), and any polyline that contains more than two vertexes may have a vertex deleted or moved.

Adding a vertex to any straight line may be done by selecting **Edit » Vertex » Add**, then clicking on the line you wish to modify. A flash of the same Dcode as the line you have chosen hovers over the mouse, ready to mark the new vertex. Left click again to place it. The new polyline will be redrawn automatically.



Deleting a vertex from any polyline may be done by selecting **Edit » Vertex » Delete** then clicking on the vertex you wish to delete. Clicking on any segment of a polyline will delete the oldest vertex.

An existing vertex may be moved by selecting **Edit » Vertex » Move**. Click on any straight line within an existing polyline. While the whole polyline will appear to be selected, a reference line will trail from the nearest vertex. This is the vertex that will be moved—clicking the mouse on the new location will move it.

The vertexes of arcs may not be moved.

## Advanced Editing

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Many advanced editing tools are available in other menu choices. These are arranged in alphabetical order and explained individually.

### Align Layers

Entire layers may be shifted to match other layers. The easiest way to do this is if there is a matching outline border or a target on both layers. Enable all layers that contain a matching border, then select **Bonus » Align Layers » Border (Auto-Detect)**. Click on the target border, then all layers with a matching border will be automatically aligned to it. Any layers where no matching border is detected will be left alone.

The selected border should be a straight edge of a closed boundary.

Layers may be aligned to one another individually. Multiple layers may be enabled together, but as only two layers may be involved in this process at a time, we recommend that all other layers be turned off. Select **Bonus » Align Layers » Selective**, then click on an object on the base (target) layer. Now click on an object on the layer you wish to move. The selected entity should be common to both layers (such as a PCB outline corner or target). If the selected objects do not match precisely, then the point of selection on each layer is matched.

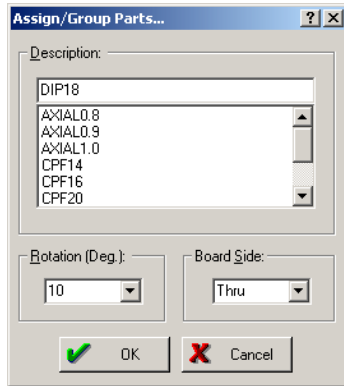
You may need to repeat either of these functions multiple times until the layers are aligned to your satisfaction.

### Assembly Utilities

CAMtastic!® 2000 Designers' Edition allows you to build a parts list from the displayed image by grouping identical footprints. These parts may be defined by selecting **Tools » Assembly Utilities » Create & Group Parts**. This puts the cursor in general selection mode.

Grouped parts may not contain items from separate layers. Neither may they contain parts already grouped.

Right-clicking will end the selection and open the dialog shown below.



- **Description:** Allows you to add or select a name that best describes the selected part.
- **Rotation (Deg.):** Allows you to indicate the rotation of the selected part.
- **Board Side:** Allows you to choose the Board Side for the selected part (choose Top, Thru, or Bottom).

Choosing **OK** will search for matching groups, all of which will be redrawn as filled rectangles with an X through the center. While searching, CAMtastic!® 2000 Designers' Edition looks only on the same layer and it only recognizes exact matches (shape, size, and rotation). Any additional items may be added to this parts list manually by running the process again, selecting a new instance of the part, and assigning it the same name. The rotation and board side information may also be modified.

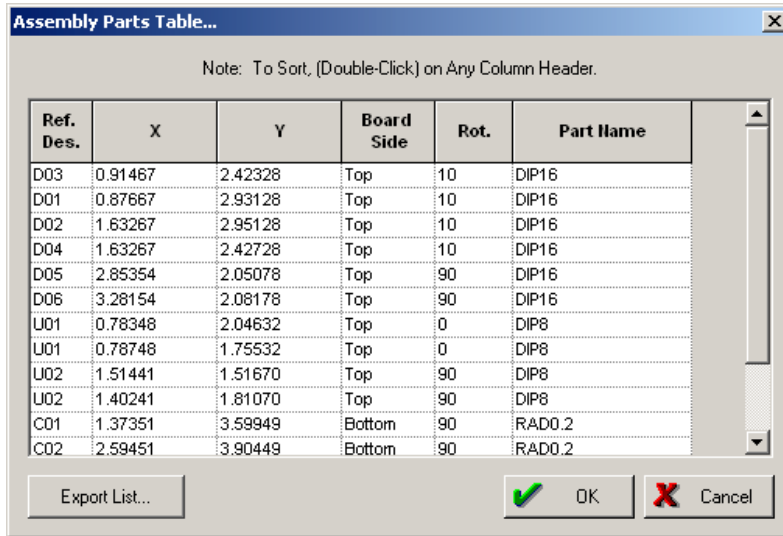
Any information you enter manually will *not* be verified by CAMtastic!® 2000 Designers' Edition; dissimilar selections may be assigned the same footprint name and/or rotation.

Reference Designators may be added to any successfully grouped parts. Selecting **Tools » Assembly Utilities » Assign Ref Designators** will change the cursor to a pickbox and allow you to click on any grouped part. A dialog will prompt you for the Reference Designator for this part. Once entered, the new designator will appear in the center of the grouped part.

The second designator you place will automatically increment one the previous integer by one. This will assist you in assigning designators to all instances of the same part.

If a group has already been assigned a reference designator, it is still eligible for a new assignment, giving you the ability to revise your designations.

All parts grouped by CAMtastic!® 2000 Designers' Edition's Assembly Utility will be listed in the Assembly Parts Table, including the following information: Center Point; Part Description; Reference Designators; Rotation; and Board Side. This table may be accessed in the Main View of the Workspace Bar.

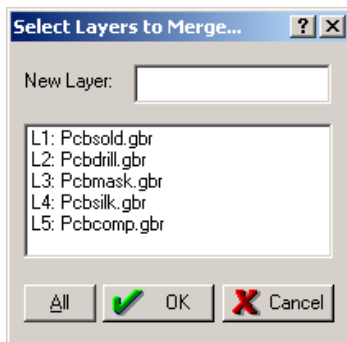


Choosing **Export List** allows you to save any displayed information as a text file (Part Centroid File, \*.pcf).

These fields merely describe the image in the Design Window—modifying any of them will not affect the image when the table is closed. Any changes that are made within the Assembly Parts Table will only apply to an Exported List. For example, if the Assembly Parts Table is modified, closed, then reopened, it will again reflect the original settings.

## Combining Layers

A new layer may be created containing the merged images of any group of existing layers. Selecting **Bonus » Merge Layers** opens a dialog as shown below.



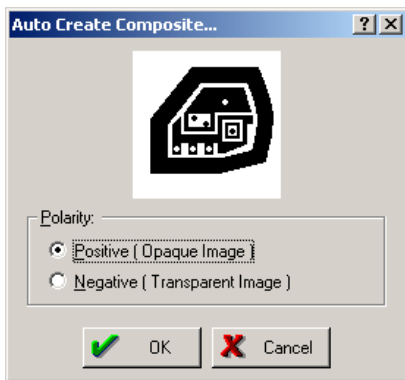
A list of all existing layers appears in this box, and a single click will highlight any layer. Clicking on a highlighted layer will deselect it. Select all layers you wish to merge, type in a name for the **New**

**Layer**, and choose **OK**. A new layer is created containing the merged layer information. The original layers will not be deleted or modified.

The **All** button makes the Merge Layers function the fastest way to create a single layer out of all existing layers.

Certain images can only be created in CAMtastic!® 2000 Designers' Edition with Composite Layers. Much more powerful than a simple merge, a composite layer allows you to add or subtract images from one another (create voids inside filled areas, etc.). Furthermore, a composite layer can be exploded back into its original layers, unlike the merge feature.

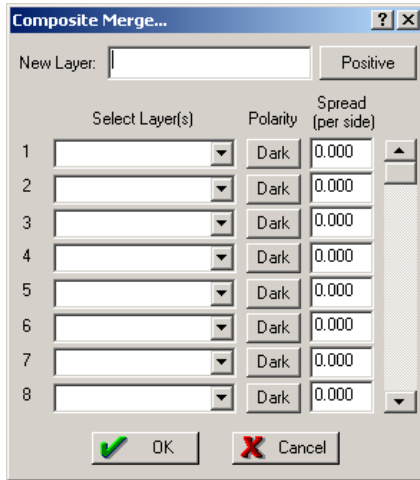
Composite layers may be created from selected items or built with selected layers. Selecting **Bonus » Composite Layers » Auto Create Composite** will put the cursor in general selection mode. Right-clicking to complete the selection will bring up the dialog shown below.



Choose either **Positive** (clear background, dark image) or **Negative** (dark background, clear image) polarity for the composite. Choose **OK** when finished. A new layer is automatically created and named based on the total number of existing layers (for example, if eight layers already exist, the new layer will be called Layer9).

This new layer can be renamed in the Layers View of the Workspace Bar or in the Layer Table.

A composite layer may be built from existing layers by selecting **Bonus » Composite Layers » Build Composite**. A dialog will immediately appear, as shown below.



- **New Layer:** Accepts a new name for the composite layer.
- **Composite Layer Polarity:** Toggles between Positive and Negative polarity. Choosing this button will simply toggle all individual polarity settings.
- **Select Layer(s):** Allows selection of existing layers from pull-down menu.
- **Individual Layer Polarity:** Toggles between Dark and Clear for each layer image. If Dark (the default value) is chosen, the entire layer will be added to the final composite merge. If Clear is selected, all images on this layer will be subtracted from the composite.
- **Spread (per side):** Enlarges or shrinks all apertures on layer. This offers the ability to enlarge & reduce layers simultaneously—a very powerful aid in soldermask and copper pour generation.

The order in which the layers are selected is vitally important because that is the order in which they will be compiled. For example, if you wish a small area to be voided from a larger polygon, it is essential that the void's layer is selected after the large polygon's layer. This method is often called paint and scratch merging, and proper layer sequencing puts the painting before the scratching.

Existing composite layers should not be used to build new ones.

Once you have created a composite layer, you may reopen the *Composite Merge* dialog to modify its parameters. Simply select **Bonus » Composite Layers » Modify Composite**. The cursor becomes a pickbox upon which you may choose any area where the composite shows overlapping images. The composite layer must be displayed for the pickbox to recognize it.

Once the composite layer is detected, the *Composite Merge* dialog reopens. The component layers, however, have been given new names—instead of L1, L2, etc., you will see C1, C2, etc. These layers may be removed (choose the blank space from the pull-down menu) and new layers may be added. In fact, all of the original options from Build Composite are again available.

Should you need to disband a composite into its component layers, select **Bonus » Composite Layers » Explode Composite**. Then click on an area where images are overlapping within the

composite layer. Each composite layer (C1, C2, etc.) is instantly converted to a new layer. These layers will be named Name-1, Name-2, etc. depending upon the name of your composite layer. The Composite Layer itself is deleted. This action cannot be undone.

If you only wish to disconnect the internal layers of a composite temporarily, you should use the **Bonus » Composite Layers » Open Composite for Editing** feature. This will behave like Explode Composite, but once all layer-level edits have been finished, the layers may be reunited by selecting **Bonus » Composite Layers » Close Composite**.

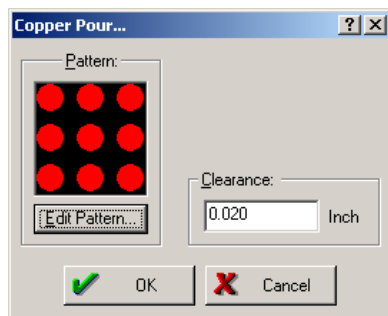
Composites are intended to overlay images to create designs that are not possible with single-layer flashes and draws. To modify or explode a composite layer, you must click on an overlapping area—which assumes that such areas exist. You may find it difficult or impossible to modify or explode layers that are not true composites, but are simply merged layers without any overlapping images.

## Copper Pour



Any closed boundary may be filled with copper by selecting **Tools » Copper Pour**. In CAMtastic!® 2000 Designers' Edition, closed means more than simply enclosed. The only boundaries that are automatically closed are circles and rectangles. Polylines may or may not be closed, depending upon how they were made (see Lines in the *Drawing* section, above). If a boundary is made up of lines that have not been grouped together, you must join them into a single, closed polyline before the copper pour will work within that boundary (see the *Join Group* heading in the *Basic Editing* section, above).

Clicking on a closed boundary will open the *Copper Pour* dialog, shown below.

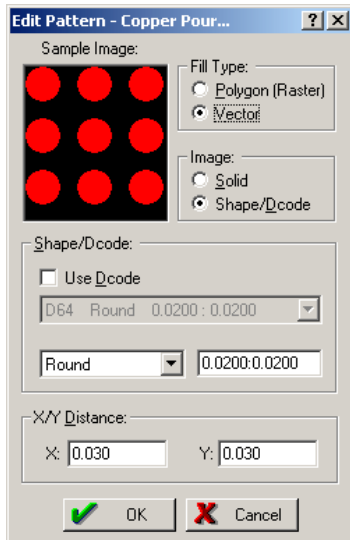


A clearance boundary may be added to the fill. This ensures (especially around arcs) that the pour pattern is contained entirely within the image.

Only positive clearances are accepted. Any negative numbers, if entered, will have their negative sign ignored.

The most recently used pattern is automatically offered each time this dialog is opened. Choosing **Edit Pattern** opens the dialog shown below.

If the Fill Type is set to Polygon (Raster), then all other settings in this dialog are disabled. The boundary will be filled with a solid polygon with a clearance as indicated previously. Notice that a new polygon Dcode will be added to your aperture list for this type of fill. It will display in the Dcode pull-down list as  $\text{P}0\text{ex}$ , signifying it as a polygon shape.



If the Fill Type is set to Vector, then you may choose between using a solid image or a Shape/Dcode. You may choose a shape and size or select **Use Dcode** to highlight an existing aperture for the fill. If Solid is not selected from the Image area, then you may indicate the X and Y spacing of the shape or Dcode.

While the **Polygon (Raster)** fill appears the same as the **Vector (Solid)**, it will be defined by large overlapping shapes rather than minute fills. This will generally keep the file size much smaller, allowing faster redraws.

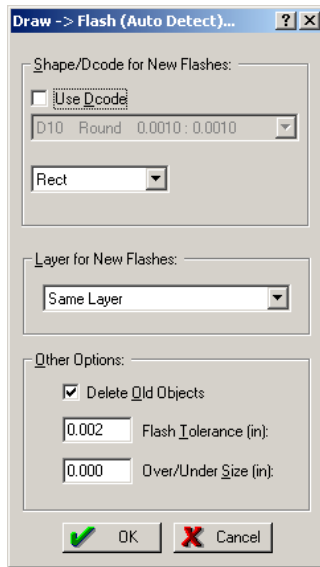
## Draw Conversions

Various conversion techniques are available in CAMtastic!® 2000 Designers' Edition. These have been designed for users who may need to send their images to older, less robust programs. Any object or group of objects that is repeated identically in a design may be replaced with a single aperture.

There are several different ways to do this. Selecting **Bonus » Draw to Flash » Automatic** lets you assign all selected objects to flashes. Select the objects or define the area(s) you wish to convert to flashes—remember that you may use the **Filter** button on the Select toolbar to narrow your selection across the board.

Right-clicking will open the dialog shown below.





If the **Use Dcode** box is not selected, then a shape of your choosing will be applied to all different shapes—its size varying with the items it represents. Otherwise the same Dcode (chosen from the list of existing apertures) will be applied to all selected objects, regardless of their differences.

You may have the new flashes displayed on the same layer, a new layer, or an existing layer, depending upon your choice from the available pull-down. Furthermore, you may **Delete Old Objects** or keep them for reference. You may set a **Flash Tolerance** for matching objects across the selection, and you may enlarge or reduce the final size of the new flashes by changing the **Over/Under Size** value.

This automatic feature is particularly useful if you have carefully tailored your selection. The **Bonus » Draw to Flash » Selective** offers an opposite approach. It allows you to select a single instance of the object you want to be replaced across the board, then searches the current image for matches. Once the prototype is selected, a single right click will pull up a dialog similar to the one for automatic detection, shown above. All of its settings are identical, except that there will be no automatic resizing of different shapes, as only a single sized selection will be made.

Choosing **OK** returns you to the Design Window, where you may select the area you want to search and replace with the designated aperture. Right-clicking at the end of this second selection will make all replacements instantly.

CAMtastic!® 2000 Designers' Edition will automatically detect all aperture sizes required, and will add them to the aperture list (beginning at the first empty Dcode).

You are also offered the alternative of converting all selected objects to a Custom Aperture. Selecting **Bonus » Draw to Custom Aperture** will allow you to select the object(s) you wish to convert to a single Custom Aperture. Right-clicking when finished will open a dialog asking you to name the new Custom Aperture. You may not use an asterisk (\*) in this name.

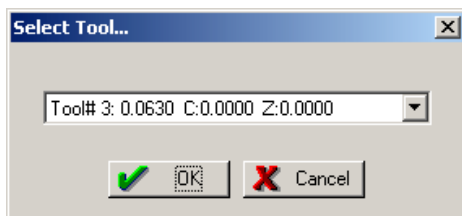
The Custom aperture will be automatically added to the Aperture Table (using the next available Dcode). It can then be redefined if necessary, and inserted anywhere just like a standard flash. This is an excellent feature for grouping objects together, and decreasing the file size for large arrays.

Existing custom apertures cannot be redefined in a new custom aperture.

## Drills

Flashes can be converted to drill points by selecting **Tools » Create Drill** then selecting the individual circular flashes you want to convert, and right-clicking when finished. The tool table will be created automatically. Any existing tool information will not be affected and information may be modified or added manually at any time. For more information about the Tool Table, see the *Building Blocks* section of *Chapter 3: Basics*. If selecting **View » Drill/Rout/Mill** reveals a mark beside **Drill Symbol**, all drill points will be displayed with a white X marking the center point.

If you wish a different tool to be used for certain drills, select **Tools » Modify Drill**, then select all the drill points you wish to change to a new tool. Right-clicking when finished will open the dialog shown below.



Any existing tool may be selected from the pull-down list. All selected drill points will be changed to the new tool upon choosing **OK**.

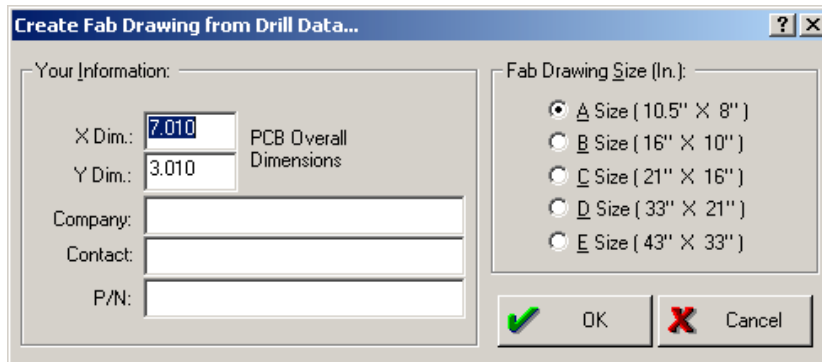
Selecting **Tools » Add Drill Point** will open this same dialog from which any existing tool may be chosen. Upon choosing **OK**, a single instance of the selected drill point will hover on the cursor, ready for placement in the Design Window.

A Drill Layer may be created from Gerber information after drill points have been created. Selecting **Tools » Build Drill Layer (Plated-Through Hole)** will do the same as Create Drill, except all of the Drill information will be written to a new layer named Drill Template, rather than to the individual source layers themselves. All circular flashes on the board will be automatically detected, and displayed on the Drill Template layer. This layer is automatically assigned to Drill Top in the Layer Table's Type field.

Before a Drill Layer can be created, a Top and Bottom layer must be assigned to the Type fields in the Layer Table. See the *Building Blocks* section of *Chapter 3: Basics* for details.



If any layer has already been assigned as a Drill layer (in the Layer Table, Type field), then a Fab Drawing may be created from it. Selecting **Tool » Create Fab Drawing (from Drill)** will bring up the dialog shown below.

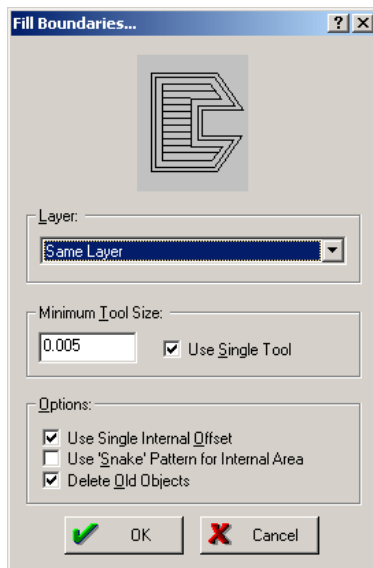


The overall dimensions of the PCB are automatically detected if CAMtastic!® 2000 Designers' Edition recognizes the PCB border. **Company**, **Contact**, and **P/N** information can be indicated, and any of six standard sizes may be chosen for the Fab Drawing. Choosing **OK** will create a new layer named Fab Layer with the PCB drawn with symbols marking each different tool size used on the board. A legend is written to the side of the board describing each tool. This layer may be edited like any other within CAMtastic!® 2000 Designers' Edition before printing.

## Fill Boundaries



Any closed boundary may be filled with optimized line strokes, offsetting towards the center. Selecting **Bonus » Fill Boundaries** will turn the cursor into a pickbox, ready to be clicked on any properly closed boundaries. Right-clicking when the selection is complete will open the dialog shown below.



- **Layer:** Draws the offsets on the same layer, a new layer, or any existing layer.
- **Minimum Tool Size:** Accepts any tool size value—nothing larger will be used to draw the offsets.
- **Use Single Tool:** Determines if one or more tools should be used to draw the offsets. Deselecting this option allows CAMtastic!® 2000 Designers' Edition to optimize the number lines filling each boundaries.
- **Use Single Internal Offset:** Offsets a single time only, then proceeds to fill the boundaries with line patterns.
- **Use 'Snake' Pattern for Internal Area:** Allows CAMtastic!® 2000 Designers' Edition to use diagonal lines (if necessary) to fill the remaining area once offsets are halted.
- **Delete Old Objects:** Deletes original boundaries.

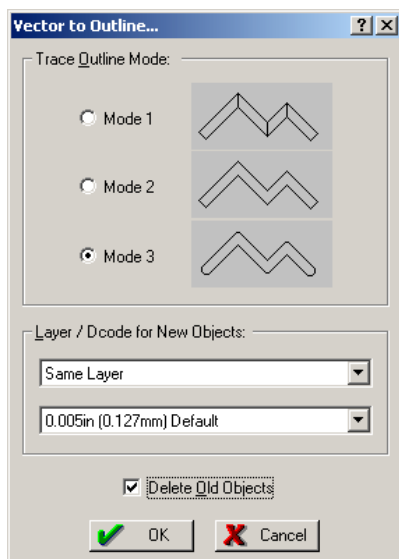
Choosing **OK** will begin offsetting all selected boundaries inward until another offset is no longer possible. A line pattern will then be used to fill the remaining area.

## Generate Outlines

While one trace may appear wider or thinner than another in CAMtastic!® 2000 Designers' Edition, the width is cosmetic rather than inherent to the line. Turning off the **View » Fill** feature will reveal the skeleton of the drawing, wherein a thick line displays identically to a thin line. If, however, an outline is generated of the different lines, the width of its pen (Dcode) will be made apparent, as an outline is extracted from all drawn objects.



Selecting **Bonus » Generate Outlines** will put the cursor in general selection mode. Once all objects you wish to outline have been selected, right-clicking will open the dialog shown below.



- **Trace Outline Mode:** Offers three modes for outlining traces: segmented, squared corners, or chamfered corners.
- **Layer Pull-Down:** Draws the new outlines on the same layer, a new layer, or any existing layer.
- **Dcode Pull-Down:** Lists the entire list of Dcodes from the Aperture table with which the outlined traces may be drawn. Two additional options are also available: 0.005 inches (the system default), and polygon.
- **Delete Old Objects:** Deletes original traces from the session. Deselecting this option will allow you to keep the original traces for reference.

Generate Outlines can be used with more than one layer simultaneously.

### Pad Removal (Isolated/Stacked)



All isolated and/or stacked pads can be identified and removed in CAMtastic!® 2000 Designers' Edition. This tool helps eliminate potential problems in the PCB manufacturing process. Selecting **Tools » Pad Removal** will scan all active internal layers for stacked or isolated pads, and remove them. A report will be generated automatically and display on the screen, as seen in the figure below.

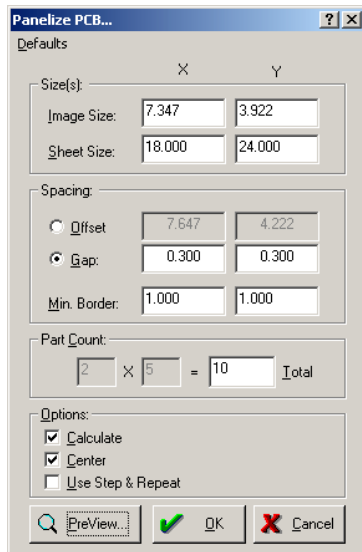


At least one Internal Route layer must be defined before running this function. Open the Layer Table and designate the Type of one or more layers as Internal.

### Panelize PCB



CAMtastic!® 2000 Designers' Edition offers simple methods of board panelization. Selecting **Tools » Panelize PCB** put your cursor in general cursor mode, ready for you to define all objects you wish to panelize. A right click upon completing your selection will open the dialog shown below.



All fields will initially be filled, according to your board size and certain defaults that you can manipulate according to your own requirements. Any of these fields may be changed manually.

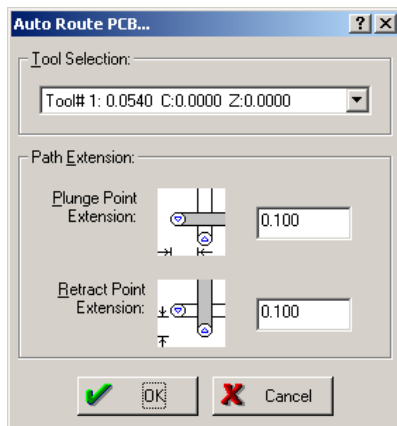
- **Image Size:** Displays the X and Y extents of the selected image. These fields can be modified when Gap Spacing is selected.
- **Sheet Size:** Displays the sheet size onto which you will panelize the selected image.
- **Offset:** Shows the center-to-center X and Y distances between panels, based on the Minimum Border.
- **Gap:** Shows the X and Y Gap between images.
- **Minimum Border:** Shows the minimum border allowed between the panelized image and the sheet edges.
- **Part Count:** Displays the columns, rows and total number of panels to appear on the sheet. The row and column fields are only open to manipulation if the Calculate option is not selected.
- **Calculate:** Calculates the maximum part count and spacing for the given image and sheet sizes. If not selected, the column and row fields may be manipulated, and the sheet size will show the minimum space needed to contain all panels.
- **Center:** Centers panelized board on the sheet.
- **Use Step & Repeat:** Uses embedded codes to generate panels rather than rewriting all data information for each panel, thus saving space (see the *Basic Concepts* section of this chapter for details).

- **Preview:** Arrays columns and rows of frames representing the selected area, allowing you to verify that your spacing is correct.
- **Defaults:** Fills the Sheet Size, Minimum Border, and Gap Spacing fields with default entries the next time this feature is activated.

## Routing/Milling

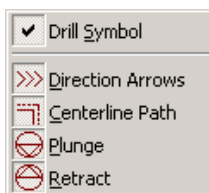
Routing and Milling paths may be created and modified within CAMtastic!® 2000 Designers' Edition.

A complete routing path around the board may be created automatically. Selecting **Tools » Auto-Rout PCB Border** will let you select the border of the PCB. The placement of this first click will be plunge/retract point for the routing/milling tool. As you move the mouse, a thread will follow the cursor from that initial point as you choose the direction (relative to the plunge point) for the tool to cut. A dialog will appear then as shown below.



A pull-down list shows all the tools previously created in the Tool Table; auto-routing will not be possible if this table is empty. Each tool lists its size, compensation and depth. If there is no compensation assigned to the tool you choose, you will have the option to assign a default value (same as the size) before proceeding. Extensions for the plunge and retract points are to be entered in the units (inches or mm) shown in the *Drawing Modes* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details).

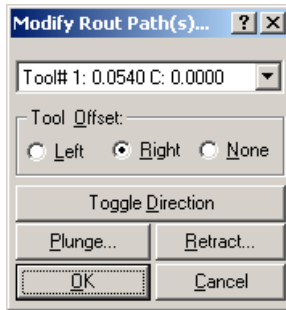
Choosing **OK** will create a new layer with a name derived from the layer on which the boundary was originally found. It will contain the routing path with certain symbols, depending upon your View settings. Selecting **View » Drill/Rout/Mill** opens the submenu shown here.



The **Drill Symbol** mark has been explained under the *Drill* heading of this section. The other items all refer to Rout/Mill layers, and if they are enabled, these symbols will appear when viewing the newly created layer. The **Plunge** and **Retract** symbols will appear by the vertex chosen initially, and the **Direction Arrows** will be seen along the trace. The **CenterLine Path** displays the routing path (normally a dashed line) as a solid line.

The effects of the **CenterLine Path** viewing option can only be recognized when **View » Fill** is turned off.

CAMtastic!® 2000 Designers' Edition allows users to modify existing routing paths or create new ones. These features may be accessed by selecting **Tools » Create Rout Path(s)** or **Tools » Modify Rout Path(s)**. In either case, select all relevant traces in the normal fashion, right-clicking when finished. The dialog boxes for these two features are essentially the same; the *Modify Rout Path(s)* dialog is shown below.

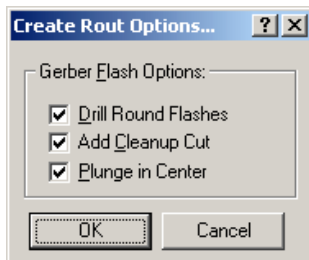


The tool may be changed, as may be the tool offset (if any). Choosing **Toggle Direction** will reverse the direction arrows and replace all plunge points with retract points, and all retract points with plunge points. The **Plunge** and **Retract** buttons allow you to change the position of these points from their default locations.

Certain modifications to plunge and retract points may not be undone.

Unless connecting lines are joined together as a single polyline, each line will have its own plunge and retract points. Joining a line together (**Edit » Join**) before routing will ensure that only one plunge and one retract point is created. Conversely, plunge and retract markers may be added to a routing paths by breaking (**Edit » Break**) the path at all desired locations.

While routing normally refers to traces, certain options can be set to manage the inclusion of flashes in the routing path. Selecting **Tools » Rout Options** opens the dialog shown below.



- **Drill Round Flashes:** If selected, any round flashes found in the selected routing path will be drilled rather than routed. If not selected, a normal routing path will be determined for flash.

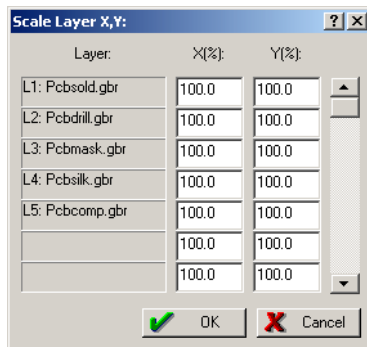


- **Add Cleanup Cut:** The algorithm is repeated to optimize paths.
- **Plunge in Center:** If selected, the plunge point is placed at the center of the aperture. If not selected, the plunge point is placed at an edge.

The following apertures cannot be used in a rout/mill path: Custom, Diamond, Donut, Target, and Thermal.

## Scale Layers

Entire layers may be rescaled CAMtastic!® 2000 Designers' Edition. Selecting **Bonus » Scale Layers (X/Y)** will open the dialog shown below.

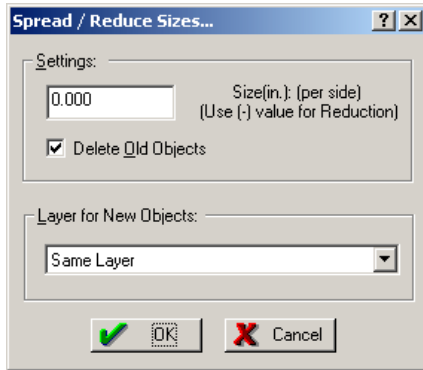


All existing layers are listed, and may all be modified to a new size or each to individual sizes. Values greater than 100 will enlarge the layer, values between zero and 100 will shrink it. Leaving a value at 100% will result in no change, while negative values will mirror the layer on either axis.

Apertures are not scaled; should you need to scale apertures, you should use the Scale feature described in the *Basic Editing* section of this chapter.

## Spread/Reduce Sizes

In addition to rescaling objects and layers, CAMtastic!® 2000 Designers' Edition offers yet another way to resize objects. The Spread/Reduce feature is powerful because it can thicken or thin apertures without moving them, and is valuable when designing silkscreens and paste masks. Selecting **Tools » Spread/Reduce Sizes** will put the cursor into general selection mode, until all desired objects are selected. Right-clicking will open the dialog shown below.



In the Settings box, enter a value for the spread (per side) of the selected items. The units will depend upon the settings assigned in the *Drawing Modes* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details). Enter a negative value to reduce the sizes of all selected objects. Select **Delete Old Objects** unless you wish to keep the original images for reference. The changes may be reflected upon the same layer, a new layer, or any existing layer, depending upon the selection made from the available pull-down list.

If you reduce sizes and write to the same layer, nothing will happen unless Delete Old Objects is selected.

## SMT Utilities

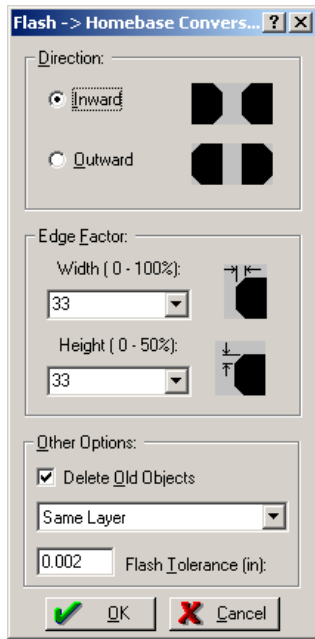
CAMtastic!® 2000 Designers' Edition has added tools to assist in SMT stencil manufacturing.

### Homebase Pads

Homebase pads are used for improving the area of paste (per pad) deposited with an SMT stencil. Any two flashes may be selected then converted into a Homebase Pad across any selected portion of your image.

Selecting **Tools » SMT Utilities » Homebase Pad Conversion** will put the cursor in selection mode. Select the pair of pads you wish to convert. While CAMtastic!® 2000 Designers' Edition will allow the original pair to be made of dissimilar pads, only the smaller pad will be used to determine the size of the Homebase Pad.

Once the pads are selected, right click once. This will bring up the dialog shown below.



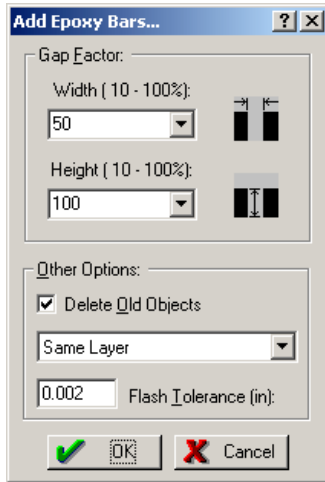
- **Direction:** Determines whether bevels on the pad pair will face inward or outward.
- **Edge Factor:** Determines the width and height of the bevel. This value is entered as a percentage of the width and height of the selected pads.
- **Delete Old Objects:** Deletes the original pads. If not selected, the original pads can be kept as reference.
- **Layer Assignment:** Specifies the layer upon which the converted pads will be written. Choices include the same layer, a new layer, or any existing layer.
- **Flash Tolerance:** Indicates the margin of error allowed when searching for matching pad pairs. The units (inches or mm) will depend upon the settings in the *Drawing Modes* dialog (see the *Building Blocks* section of *Chapter 3: Basics* for details).

Once all fields are correct, choosing **OK** will return you to selection mode. Choose all objects and/or areas where you want the conversion to take place. Right-clicking when done will change all matching flash pairs to a Homebase Pad.

Once converted, the Homebase Pad is treated as a single object, although unconnected. Selecting end will automatically select its partner.

### Epoxy Bars

Epoxy Bars may also be added between certain pads across the board. Selecting **Tools » SMT Utilities » Add Epoxy Bars** will allow you to choose any pair of pads (flashes). Right-clicking when finished will open the dialog shown below.



The Gap Factor of the Epoxy Bar indicates the width and height of the bar between the two pads. The width is a function of the horizontal distance between the pads (measured from inside edge to inside edge). The height is a function of the vertical distance covered by the pads (measured from the top edge of the higher pad to the bottom edge of the lower pad). Only values between 10 and 100 percent may be entered for these fields.

The same options for deleting original objects, assigning a layer for the new replacements, and tolerating a certain amount of mismatch described in the Homebase Pad Conversion, are again available.

Choosing **OK** will return you to the image, where you can define the objects and/or areas where matching pad pairs might be found. Right-clicking when the selection is complete will search and write epoxy bars for all matches within the selected area. An epoxy bar will be centered between each pad pair.

If this feature is run twice in a single session, the *Add Epoxy Bars* dialog will only display if the template pad pair is different from the previous template. Otherwise, CAMtastic!® 2000 Designers' Edition assumes you want to apply the same settings, and will allow you to select the conversion area directly.

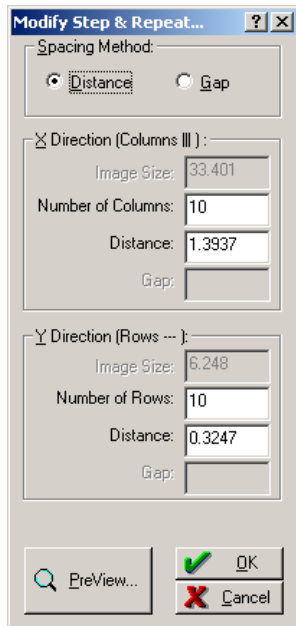
## Step & Repeat Features

Some CAMtastic!® 2000 Designers' Edition features, such as Panelization and Arrays, allow embedded step and repeat codes to deflate the size of files that contain the same information multiple times. If a session includes Step & Repeat codes, only the original image will be fully displayed in the Design Window. It will be framed by a white rectangle, and the projected copies will appear only as blank frames. The lowest and left-most object in the original image will act as the reference point for the Step & Repeat array.

Grids of information using Step & Repeat codes may be exploded (having each copy written out in its entirety) or modified. To stop using Step & Repeat codes for a panel or array, select **Bonus » Step/Repeat » Explode S/R**. Then click the pickbox upon the reference point (see above) in the

original frame. All subsequent frames will fill with copied images while the frames themselves will disappear.

To modify the characteristics of a Step & Repeat panel or array, select **Bonus » Step/Repeat » Modify S/R**, then click the pickbox upon the reference point for the array. This will open the *Modify Step & Repeat* dialog shown below.



These options are all identical to those explained with the Array feature; see the *Basic Editing* section of this chapter for details. The spacing method is automatically calculated in **Distance** mode, but it may be changed to **Gap** and resized. The number of columns and rows may be changed if desired. A preview of the spacing is available, and choosing **OK** will apply the new settings to the entire array.

Objects may be added to or removed from existing arrays using Step & Repeat information. To add a new item to an array, select **Bonus » Step/Repeat » Add Objects to S/R**. This puts the cursor in general selection mode, allowing you to choose all new objects with the left mouse button. Right-click when finished, then left click upon the reference point for the array. This will add the new object to each frame in the array.

If new objects exist outside the original frame, spacing will not be automatically adjusted, and you may find your copied images overlapping one another. Modify the Step & Repeat as explained above to fix any spacing problems.

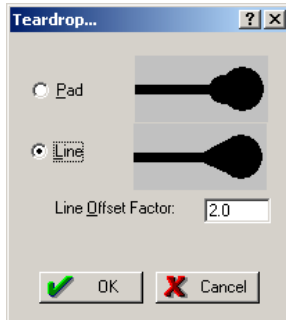
To remove items from an array using Step & Repeat codes, select **Bonus » Step/Repeat » Remove Objects from S/R**. The cursor is placed in general selection mode. Right-clicking when the selection is complete will remove all indicated objects from each frame in the array.

Additions to or removals from existing Step & Repeat arrays are, of course, invisible until the array is exploded. This may be done for verification, then undone immediately by selecting **Edit » Undo**.

## Teardrops



Teardrops may be added making between tracks and pads on all enabled layers, making their junction less abrupt. Selecting **Tools » Teardrops** will put the cursor in selection mode, ready to select flashes. Right-clicking when the selection is finished will open the dialog shown below.

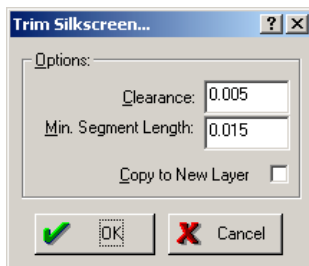


- **Pad:** Places a small pad (half the size of the original pad) at the trace/pad intersection.
- **Line:** Places two lines (tangent to the pad) to fill in the trace/pad intersection.
- **Line Offset Factor:** Accepts a ratio length to use for the teardrop lines. (The larger the factor, the longer the teardrop.) This factor is only applicable when the Line method is selected.

Choosing **OK** will apply the Teardrop settings to the entire selection.

## Trim Silkscreen

Silkscreen images may be trimmed away from the soldermask layer pads in CAMtastic!® 2000 Designers' Edition. Selecting **Tools » Trim Silkscreen** will open the dialog shown below.



- **Clearance:** Accepts additional clearance spacing (beyond the edge of the pad) required for the soldermask. Negative numbers are also accepted.
- **Min. Segment Length:** Defines the minimum length for any trimmed silkscreen object.

- **Copy to New Layer:** If selected, saves the original silkscreen layer for your reference with a .old extension. If not selected, the changes will be made to the silkscreen layer directly.

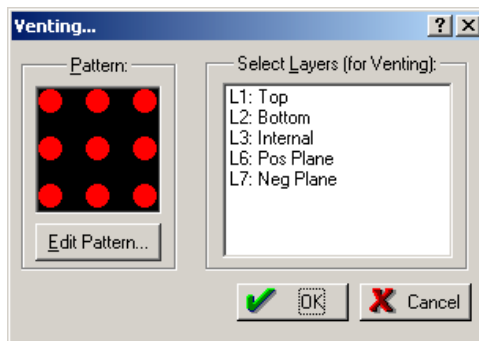
All infringing silkscreen traces will be clipped to clear soldermask pads.

Both a silkscreen and a soldermask layer must be defined before running this function. This is done in the Type column of the Layer Table. Choose a Silk type for the silkscreen layer and a Mask type for the soldermask layer.

## Venting



CAMtastic!® 2000 Designers' Edition allows for a venting pattern to be applied to a PCB panel. If the panel has already been panelized, selecting **Tools » Venting** will open the dialog shown below.



Signal layers (Top, Bottom, and Internal types) and power/ground planes are detected from the Layer Table and listed. By default, they are all selected for venting, but any layer can be deselected with a single click.

The venting pattern operates exactly like the copper pour pattern described earlier in this section. Choosing **OK** will fill the gaps and borders of the sheet with the venting pattern indicated.

The PCB must be panelized (either normally or with Step & Repeat codes) before running this function.



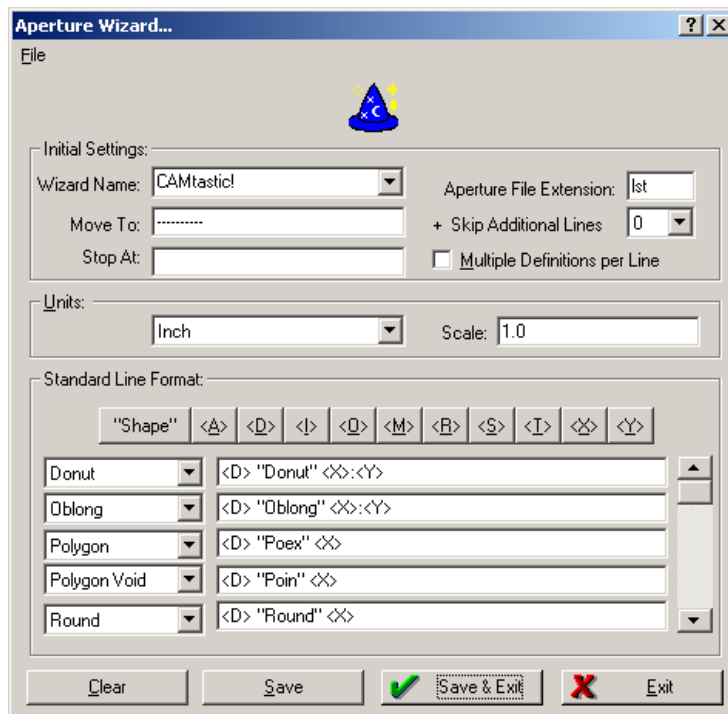


## Reference Tools

### Aperture List Wizard

The Aperture Wizard creates a specific template that CAMtastic!® 2000 Designers' Edition will use to recognize the apertures in imported files, then build an accurate Dcode list. You may modify an existing template, or create new ones of your own.

Selecting **Bonus » Aperture Wizard** will open the dialog shown below.



- **Wizard Name Pull-Down:** Accepts a new name, or any preset from the pull-down list. CAMtastic!® 2000 Designers' Edition includes 50 aperture wizards, but any number of custom wizards may be added.
- **Aperture File Extension:** Associates this wizard with any three character extension. Any Gerber imports with this extension will automatically use this wizard to read their aperture data.
- **Move To:** Indicates the text line after which the aperture definitions begin. Many aperture files begin definitions on the first line, in which case no value should be entered in this field.
- **+ Skip Additional Lines:** Steps any number of lines forward beyond the line following the Move To target
- **Stop At:** Indicates a text entry that will only appear after all aperture definitions are read. If definitions extend to the end of this file, then no value is required in this field.
- **Multiple Definitions per Line:** If selected, Searches for more than one aperture definition per line.
- **Units:** Accepts definition values to be written in inches, mils, or millimeters.
- **Scale:** Allows non-standard units to be read. Choosing millimeters, then entering a Scale of 10, for instance, will read a design written in centimeters.
- **File Menu:** Allows you to open or save an Aperture Wizard Template. This is useful for sharing templates among other CAMtastic!® 2000 Designers' Edition users.

Standard Line Formats include all the shapes and data sequences that this wizard will recognize. From the pull-down list on the left, choose the relevant shape, then fill the line on the right with the data sequence for that shape.

Every data line must contain:

- An aperture position typecast: <A> or <D>
- A shape description: "SQR", "THERMAL" or "CIRCLE", etc.
- At least one size typecast <I> or <O> or <X> or <Y>

Use the skip typecast <S> to ignore any unnecessary words or groups of characters. Additionally, characters not enclosed in "quotes" or <angled brackets> will be specifically ignored. Similarly, extraneous characters that appear in any line may be ignored by typing them in their appropriate place in the data sequence line. All trailing information on a line will be ignored.

Standard Line Format Typecast:

<A>	Aperture Position
<D>	Dcode
<I>	Inside Diameter
<O>	Outside Diameter

<S>	Skip
<X>	X aperture size
<Y>	Y aperture size
<T>	Tie Width
<R>	Rotation
<M>	Miscellaneous, such as the number of spokes on thermals or rings on targets

Buttons for each of the typecast entries have been added for cut and paste entry method. To use these buttons, simply copy a sample line for each aperture from the aperture file, and paste it into a data sequence line of the wizard. Assign the correct shape on the left, then double-click any value on the sample line to highlight it. Then choose the Typecast button it represents to replace the highlighted value with the appropriate Typecast. This method can save time when creating new wizards from aperture files.

CAMtastic!® 2000 Designers' Edition stores each template in a separate file located in the CAMtastic 2000 DE\aptwiz folder. If you are distributing aperture wizard files to other users, copy them to their aperture wizard folder. CAMtastic!® 2000 Designers' Edition detects the presence of any new files placed in that folder.

The following examples may help you learn the annotation techniques for the Aperture Wizard. We have taken a sample line from various aperture formats to show how these are described with CAMtastic!® 2000 Designers' Edition typecast.

**Example 1:**

Sample Line: D19 RECTANGULAR 20.000 100.000 0.000 MULTI

Aperture Wizard Line: Rectangle; D<D> "RECTANGULAR" <X> <Y>

**Example 2:**

Sample Line: 1 D10 DRAW --size 8

Aperture Wizard Line: Round; <S> D<D> "DRAW" <S> <S> <X>

**Example 3:**

Sample Line: 14 Donut 0.0500:0.0200 PAD14

Aperture Wizard Line: Donut; D<D> "Donut" <O>:<I>

**Example 4:**

Sample Line: D322 THERMAL OD45.00in. 1.143mm ID25.00in. 0.635mm 10strap  
45rotation

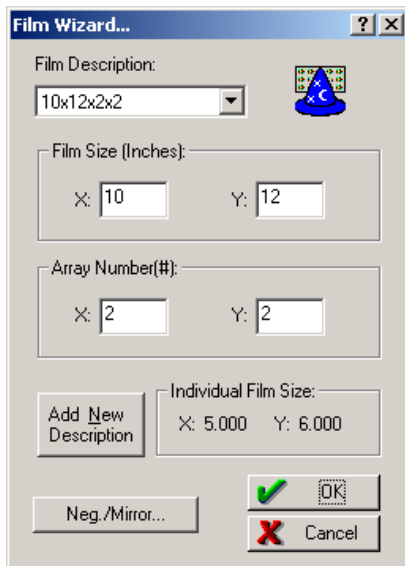
Aperture Wizard Line: Thermal; D<D> "THERMAL" OD<O>in. <S> ID<I>in. <S> <T>strap  
<R>rotation

## Film Wizard

If you need to output Gerber layers onto film, CAMtastic!® 2000 Designers' Edition offers tools to panelize layers within a single film box. It will automatically align all displayed layers (using center locations), then create a new layer containing the paneled information within a film box.

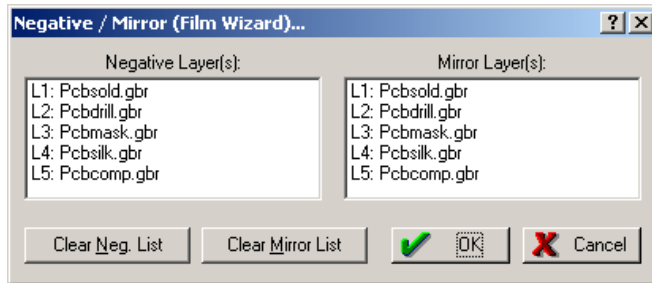
If your session contains layers that you do not wish to appear in this panel, turn them off before proceeding.

To begin, select **Bonus » Film Wizard**. This opens the dialog shown below. All fields are open to modification.



- **Film Description:** Lists standard film sizes, followed by the number of rows and columns that will fit on the film, based on the images shown in all active layers.
- **Film Size, Array Number:** Shows dimensions of the film and number of rows and columns. If an existing Film Description is chosen from the pull-down list, then these fields are filled in automatically.
- **Add New Description:** Adds custom values entered into the Film Size and/or Array Number fields into the Film Description List. This new entry will be available in the pull-down list the next time you use this feature.
- **Individual Film Size:** Calculates the amount of film available for each image in the array based on film size and the number of rows and columns. This image should be at least as large as the image extents (shown on the Status Bar). If it is not, you may proceed, but a warning will appear before you do.

- **Neg./Mirror:** Opens a dialog allowing you to choose which layers should be shown as negatives and/or in mirror format.



Highlight all layers you wish to appear on the film as negatives and/or in mirror format. At any time you may restart this process by choosing either the **Clear Neg. List** or the **Clear Mirror List** button.

Choosing **OK** will return you to the Design Window. You will have the option to delete the original layers before the new layer is created. This action cannot be undone.

## Layer Type Detection Template

Available in the Main View of the Workspace Bar, this dialog is used to help CAMtastic!® 2000 Designers' Edition determine what Layer Types are being used by the names of the Gerber files.

Type:	Layer Type String Template (use ',' to separate):
Top:	art01..gtl,top,..cmp,..top,layer1,soldcom,comp
Bottom:	art02..gbl,bottom,..sld,..bot,layer2,sold
Internal:	art,..in
Neg. Plane:	pgg,pwr,power,..gp,gnd,ground
Pos. Plane:	pgg,pwr,power,..gp,gnd,ground
Drill Top:	dd01..gd1..gg1,drill,..drl,..tap
Drill Bottom:	dd02..gd..gg,drill,..drl,..tap
Drill Internal:	dd,..gd..gg,drill,..drl,..tap
Silk Top:	sst01..gto,silk,slk,sst,..ts
Silk Bottom:	sst,bsilk,..gbo,ssb,silk,..bs
Mask Top:	sm01..cmask,..gts,tmask,..tmk,..smt,mask1,maskcom,..tr
Mask Top:	sm,..gbs,bmask,..bmk,..smb,mask2,masksold,..br
Paste Top:	sp01..gtp,..gpt,..tm,paste
Paste Bottom:	sp02..gpb,..gpb,..bm,paste
Refdes Top:	tref
Refdes Bot:	bref
PCB Border:	BDR,..gko,border,out

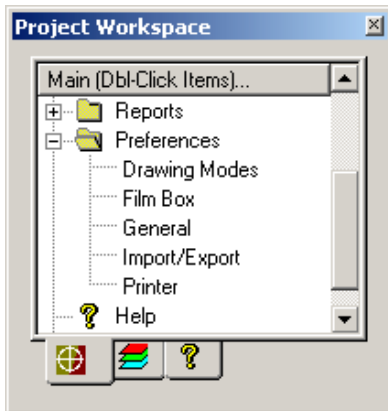
Note that only one imported layer may be assigned to the Top layer, and only one may be assigned to the Bottom layer upon import. (Manually, any number of layers may be assigned to any type.) If multiple imported layers are assigned to, for instance, the top layer, only one will be imported, and the rest will be ignored. The same holds true for other layer pairs. Multiple layers may, however, be imported as Internal.

Any modifications to this table will be applied upon all following imports. When making modifications, follow the same format as shown. Any part of the file name may be tagged, including the extension, if applicable. Separate entries with commas.

## Preferences

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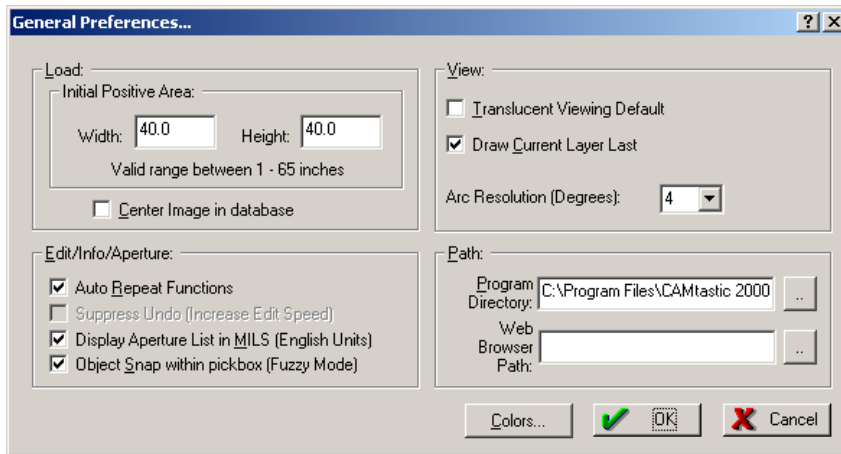
Your installation of CAMtastic!® 2000 Designers' Edition may be customized according to the type of work you generally do. Defaults may be set to your specifications, while any desired modifications on individual files remain available. Double-clicking the **Preferences** folder in the Main View of the Workspace Bar reveals five subfolders: General, Import/Export, Film Box, Printer, and Drawing Modes.



Some preference settings will not take effect until a new session of CAMtastic!® 2000 Designers' Edition has been started. It is a good idea to restart the program after modifying preferences.

Double-clicking on **Drawing Modes**, **Film Box** or **Printer** will bring up familiar dialogs. The only difference between these settings and those explained earlier is that any changes you make here will become the default settings for new sessions. See the *Session Management* and the *Building Blocks* sections of *Chapter 3: Basics* for a description of the *Printer* and *Drawing Modes* dialogs, respectively. The *Film Box* dialog is explained in the *Viewing Tools* section of *Chapter 4: Non-Editing Tools*.

The *General* and *Import/Export* dialogs, on the other hand, are unique to this section. Double-clicking on **General** opens the dialog shown below.

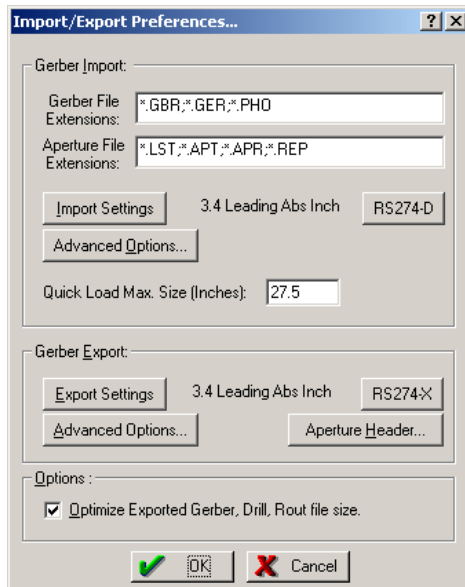


- **Initial Positive Area (inches only):** Decides where to place the origin, or more specifically, how much initial area will be positive when a new session is started. The extents of CAMtastic! 2000 Designers' Edition's working area is 65" x 65" (1651mm x 1651mm), so any initial positive area between zero and the full extents will be accepted.
- **Center Image in Database:** If selected, calculates the extents of the entire image loaded, and centers it within the CAMtastic! 2000 Designers' Edition 65"x65" area. In effect, this feature overrides the Initial Positive Area, as the positive area will depend upon the size of the loaded data.
- **Auto Repeat Functions:** Repeats editing and drawing functions until you either press **Esc** or choose **Cancel** from the right-click menu. This feature can be useful when you require a series of similar draws or edits, and wish to avoid restarting each function manually. For some features (DRC, Set Origin, etc.), Auto Repeat functions have been disabled.
- **Display Aperture List in MILS:** Displays units in mils (1 mil = 0.001 inch), for aperture sizes display in various reports.
- **Object Snap within pickbox (Fuzzy Mode):** Snaps to any existing endpoints within the pickbox.
- **Translucent Viewing Default:** Begins each new session with the Translucent View enabled.
- **Draw Current Layer Last:** Displays the current layer on top of all other layers. This same change can be made in the *View Layer Order* dialog, described with the Layer Table in the *Building Blocks* section of *Chapter 3: Basics*.
- **Arc Resolution:** Controls the displayed arc resolution that CAMtastic! 2000 Designers' Edition will use on Circular Interpolation (true arcs). Arcs will always retain their true arc information, but will be displayed as straight line segments to boost display speed. At any time you may verify that the arc information is preserved by running a query on that arc; the arc information and center point will be displayed in the Info View of the Workspace Bar.



- **Program Directory Path:** Describes the pathway to the executable file: CAMTASTIC.EXE. The destination folder will also contain necessary system files, such as font files (\*.fnt).

While these preferences apply mainly to the entire design environment, the Import/Export preferences apply mainly to Gerber files that you read or create with CAMtastic!® 2000 Designers' Edition. Double-clicking on the **Import/Export** preferences subfolder in the Workspace Bar will open the dialog shown below.



- **Gerber File Extensions:** Considers all file extensions found in this edit box to be Gerber files. When you use **Import » Gerber**, these extensions will be included in your search. This helps you locate Gerber files quickly, without having to filter through all files in a folder.
- **Aperture File Extensions:** Considers all file extensions found in this edit box to be Aperture files. When you use **Import » Aperture File**, these extensions will be included in your search. This helps you locate Aperture files quickly, without having to filter through all files in a folder.
- **Gerber Quick Load Max. Size:** Helps Gerber Quick Load determine the format of potential Gerber files. While Gerber Quick Load is performing its calculations, it will detect Gerber layers over the defined size that must be scaled down.
- **Optimize Exported Gerber, Drill, and Rout file size:** Controls the optimization of Gerber, Drill, and Rout files. By default, identical X, Y, or D values may be omitted on the following line of code (this is called modulation). Some older, less robust software programs cannot handle data modulation during import. These packages may crash or interpret incorrectly the data loaded. If selected, all files exported will be modulated, resulting in smaller and more efficient data. If not selected, the exported will not be modulated. Every repetitive X, Y, and D values will be

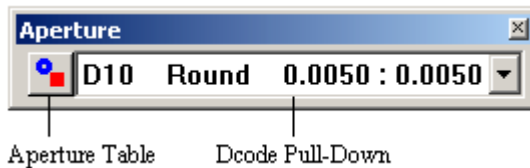
included on the following line. This improves the potential for older software programs to interpret the data correctly.

Other buttons in this dialog provide defaults for settings described in the *Session Management* section of *Chapter 3: Basics* (Importing and Exporting).

## Toolbars

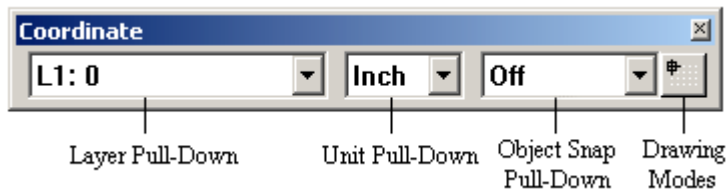
Ten prepared toolbars are available for use in CAMtastic!® 2000 Designers' Edition. They may be displayed or hidden, modified or restored to their original defaults. Each toolbar will be shown below, with references to the portions of the manual in which its functions are described.

### Aperture



Both of these features are described in the *Building Blocks* section of *Chapter 3: Basics*.

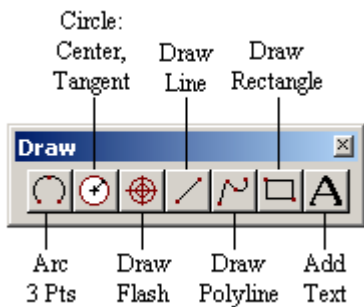
### Coordinate



All of these features are described in the *Building Blocks* section of *Chapter 3: Basics*.

## Draw

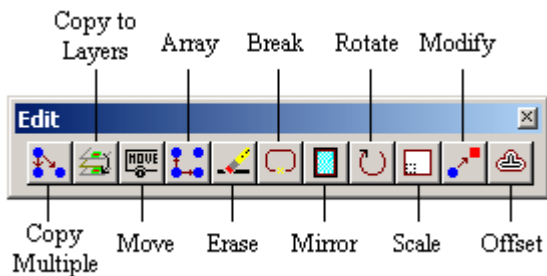
---



All of these features are described in the *Drawing* section of *Chapter 5: Editing Tools*.

## Edit

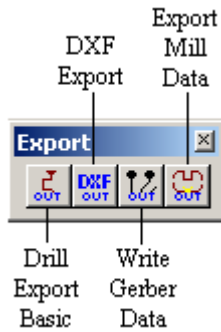
---



All of these features are described in the *Basic Editing* section of *Chapter 5: Editing Tools*.

## Export

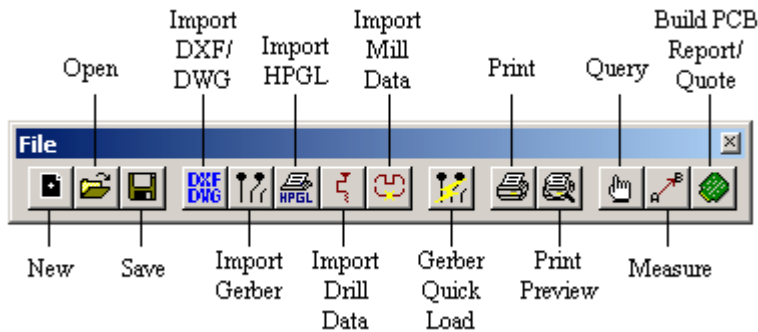
---



All of these features are described in the *Session Management* section of *Chapter 3: Basics*.

## File

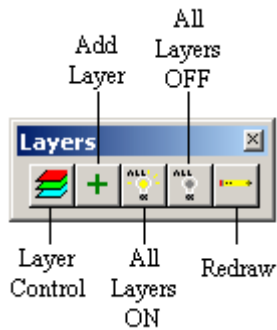
---



- **New, Open, Save, Imports, Print/Preview:** *Session Management* section of *Chapter 3: Basics*.
- **Query, Measure:** *Inspection Tools* section of *Chapter 4: Non-Editing Tools*.
- **Build PCB Report/Quote:** *Reports* section of *Chapter 4: Non-Editing Tools*.

## Layers

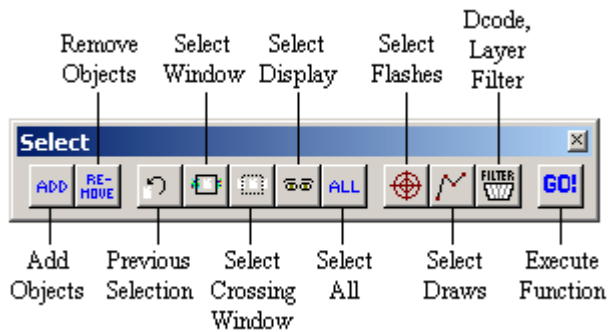
---



- **Layer Control, Add Layer, All Layers ON, All Layers OFF:** *Building Blocks* section of *Chapter 3: Basics*.
- **Redraw:** *Viewing Tools* section of *Chapter 4: Non-Editing Tools*.

## Select

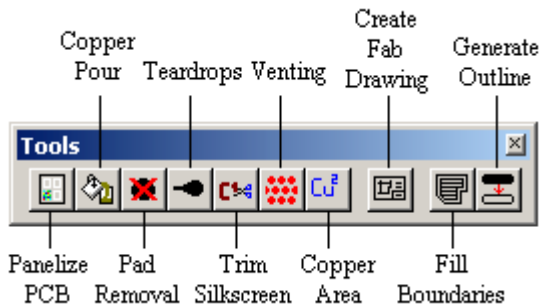
---



All of these functions are described in the *Workspace Management* section of *Chapter 3: Basics*.

## Tools

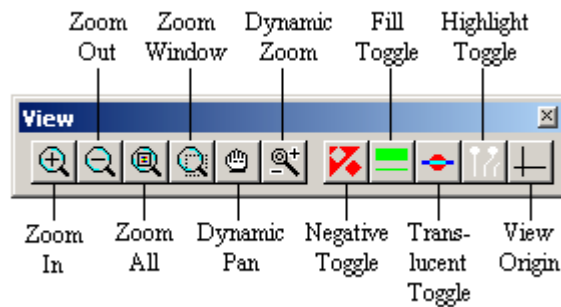
---



All of these features are described in the *Advanced Editing* section of *Chapter 5: Editing Tools*.

## View

---



- **Zooms, Dynamic Pan:** *Workspace Management* section of *Chapter 3: Basics*.
- **View Toggles, Highlight Dcode, View Origin:** *Viewing Tools* section of *Chapter 4: Non-Editing Tools*.





## Shortcut Keys













As described in the *Workspace Management* section of *Chapter 3: Basics*, shortcut keys may be added, modified, deleted, or restored to their original default values at any time. In general, the existing keys have been assigned under the following framework: non-editing features use a single—often obvious—letter; editing features will usually use the **Ctrl** key; and the **Alt** key has been reserved for selection commands.

The following lists show the functions with their preset shortcut keys, and any equivalent toolbar buttons. CAMtastic!® 2000 Designers' Edition is not case-sensitive when entering shortcut keys.

### Viewing Tools








---

<b>Zoom In:</b>	<b>+</b>	
<b>Zoom Out:</b>	<b>-</b>	
<b>Zoom Window:</b>	<b>W</b>	
<b>Zoom Previous:</b>	<b>V</b>	
<b>Zoom All:</b>	<b>Home</b>	
<b>Zoom Film Box:</b>	<b>Ctrl+Home</b>	
<b>Zoom to Current Dcode:</b>	<b>Alt+Home</b>	
<b>Scroll (half screen):</b>	<b>Arrow Keys</b>	
<b>Pan:</b>	<b>P</b>	

<b>Redraw:</b>	<b>R</b>	
<b>Display Film Box:</b>	<b>B</b>	
<b>View Extents Box:</b>	<b>E</b>	
<b>Toggle Fill View:</b>	<b>F</b>	
<b>Toggle Negative View:</b>	<b>N</b>	
<b>Toggle Translucent View:</b>	<b>T</b>	
<b>Toggle Object/Grid Snap:</b>	<b>S</b>	
<b>Toggle Ortho Mode</b>	<b>O</b>	
<b>Display Drawing Modes:</b>	<b>G</b>	
<b>Highlight Current Dcode:</b>	<b>H</b>	
<b>Query:</b>	<b>Q</b>	
<b>Measure: Point to Point:</b>	<b>M</b>	
<b>Open Aperture Table:</b>	<b>A</b>	
<b>Open Layer Table:</b>	<b>L</b>	
<b>Begin New CAM Session:</b>	<b>Ctrl+N</b>	
<b>Print Current Display:</b>	<b>Ctrl+P</b>	
<b>Cancel:</b>	<b>Esc</b>	






## Editing Tools

---

<b>Array:</b>	<b>Ctrl+A</b>	
<b>Modify:</b>	<b>Ctrl+D</b>	
<b>Erase:</b>	<b>Ctrl+E</b>	
<b>Align Layers:</b>	<b>Ctrl+L</b>	
<b>Mirror:</b>	<b>Ctrl+M</b>	
<b>Set User Origin:</b>	<b>Ctrl+O</b>	
<b>Rotate:</b>	<b>Ctrl+R</b>	
<b>Scale:</b>	<b>Ctrl+S</b>	
<b>Move:</b>	<b>Ctrl+V</b>	
<b>Explode:</b>	<b>Ctrl+X</b>	
<b>Redo:</b>	<b>Ctrl+Y</b>	
<b>Undo:</b>	<b>Ctrl+Z</b>	

## Selection Tools

---

<b>Select All:</b>	<b>Alt+A</b>	
<b>Select Window:</b>	<b>Alt+W</b>	
<b>Select Crossing Window:</b>	<b>Alt+C</b>	
<b>Select Display:</b>	<b>Alt+D</b>	
<b>Selection Filter:</b>	<b>Alt+F</b>	

**Previous Selection Set:**

**Alt+P**



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