3D Systems Inc.

3D Lightyear

SLA File Preparation Software

User's Guide

Software Version 1.0

P/N 22130-M10-01 Rev. B

3D SYSTEMS

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What is Stereolithography?

From *stereo*, for three-dimensional, and *lithography*, for printing, *stereolithography* is literally *three-dimensional printing*. It is the term used to describe 3D Systems' patented fabrication process that "prints" three-dimensional, solid objects by solidifying liquid plastic using a computer-directed, ultraviolet (UV) laser beam to cure successive layers of photo-sensitive polymer resin in a vat.

The process "builds" three-dimensional solids from the bottom up, layer by layer. As each layer is created and super-imposed on the layer underneath, a solid object in the shape of a three-dimensional part is created, the origination of which typically occurs in a separate, computer-based modelling application such as CAD, CAM, or CAE.

Developed in 1987 by the founder of 3D Systems, stereolithography was the first commercially available layer-additive process to enable rapid fabrication of objects culled directly from Computer-Aided Design databases.

Today, 3D Systems offers an extensive line of stereolithography machines—called *SLAs*—as well as ThermoJet thermopolymer-based Solid Object Printers. Our products and services are used by marketing professionals, purchasing departments, engineering groups, research and development efforts, and design and testing teams all over the world...to turn their CAD, CAM, CAE designs—their *IDEAS*—into solid, tangible, plastic objects.

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Introducing 3D Lightyear SLA File Preparation Software...

a quantum leap forward in the ease, efficiency, and reliability of preparing solid models for fabrication on 3D Systems' SLA™ series of stereolithographic solid imaging systems.

What is 3D Lightyear Software?

3D Lightyear is a software application for preparing specially-formatted computer image files for export to, and fabrication on *stereolithographic*, or "*SLA*" machines. In its most elementary characterization, ***3D Lightyear*** software is used to prepare STL and SLC three-dimensional model representations into build files that can be "built" on a SLA solid imaging system. It comprises the requisite second phase of the three-phase process for turning ideas on your computer workstation into tangible, three-dimensional, plastic parts.

The ***3D Lightyear*** software application for stereolithography file preparation runs on workstations operating under the Microsoft Windows NT operating system. Working with all of our stereolithography machines (SLA solid imaging systems), as well as our newest, flagship, the SLA 7000, ***3D Lightyear*** software builds on the powerful functionality of its predecessor, 3D Systems' *Maestro*, by adding many convenient features such as:

- A unified, graphical user interface
- "Drag and Drop" object positioning in the workspace
- Significantly faster STL file verification
- Improved overall performance (greater throughput)
- Many times smaller BFF build files

3D Lightyear software is an integral part of the 3D Systems' solution for turning your ideas into solid, three-dimensional objects using our patented stereolithography systems. Figure 1 illustrates the position of stereolithography in the product development process.

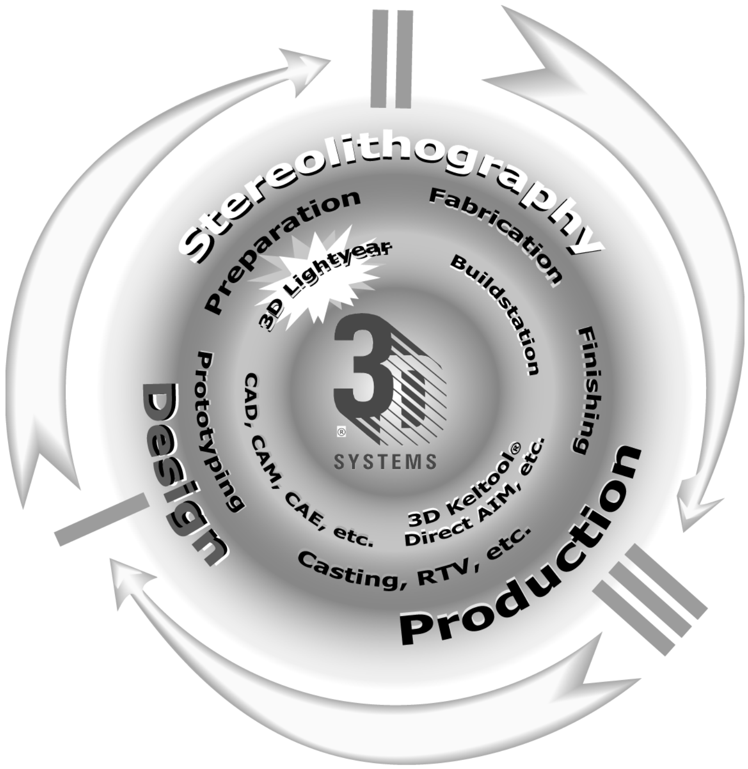


Figure 1. Stereolithography in the Product Development Process

It Begins with an Idea...

...*Your* idea. Perhaps it is an idea for a part, or the model for something that your company could manufacture; some small piece of a housing or tubing that fits into some other part of a larger machine. Perhaps you envision some new design for a housing, or a fan blade, or a fitting, a bushing, an armature, a wheel or cog, or even blister-type packaging—it *could* be almost anything. It starts, however, as an idea and the flat, two-dimensional phosphors representing that idea on your design workstation.

Wouldn't it be nice if you could actually *install* your idea in the place where you think it should go? What if you could *test* it in its final assembly, hold it up to the light, pass it around to your colleagues—*turn it over in your hand*?

It Continues with 3D Lightyear software...

which turns STL files into SLA build files. It comprises the preparatory phase of the process for building your ideas as solid, physical objects using stereolithography. Once you have taken your design to the point where you are ready to fabricate it on your stereolithography machine you must pre-process it using ***3D Lightyear*** software. Figure 2 illustrates that process.

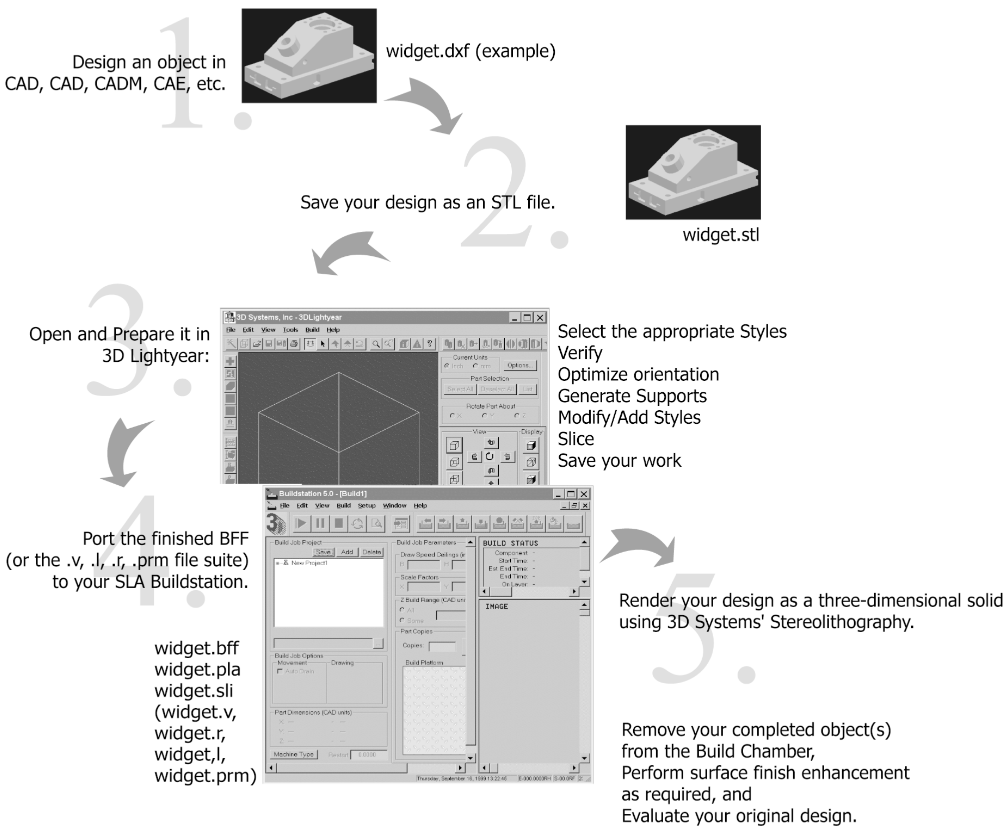


Figure 2. Stereolithography Process Flow

NOTE!
Build files **produced by 3D Lightyear software, in their BFF form, are used by 3D Systems' larger platform SLA machines, the SLA 350, SLA 500, SLA 3500, SLA 5000, and the SLA 7000. Build file output for the smaller, SLA 190 and SLA 250 machines, takes the form of a suite of files consisting of *filename*.v, *filename*.r, *filename*.l, and *filename*.prm.**

BFFs created with *3D Lightyear* software are compatible with 3D Systems' *Buildstation 5.0 SLA Control* software *ONLY*. The ".v", ".r", ".l", and ".prm" output file suite is compatible with version 3.8.3 (or later) of the SLA 190 and SLA 250 SLA Control software.

Beyond its most simple characterization, ***3D Lightyear*** software offers several tools, and performs several prerequisite functions to optimize your part(s) to, in turn, make building them on your SLA system as efficient as possible.

Use it to:

- Verify that your STL file (your "model") is properly formatted, and to automatically perform rudimentary repairs to the format
- Orient your part for optimum building resolution
- Scale, rotate, and/or move your part around on ***3D Lightyear*** software's virtual build platform; generate multiple and/or mirror-image copies of it, if desired
- Create and edit support structures for your part to help preserve its geometry during the build process (these will be removed during the finishing process, after building on an SLA system.)
- Create and edit the position of vents and drains on your part, an optional task, to facilitate the removal of liquid resin that would otherwise be trapped in the interior during a build with the QuickCast™ build style. (For more information, refer to the section on QuickCast, later in this guide.)

- Assign “style” parameters to your part; these are the receptacles for the build parameters that will be associated with your part while it is being fabricated on the SLA system
- And finally, “slice” your part, creating the actual “build file” (or, as appropriate, the .v, .r, .l, .prm file suite) that is used by 3D Systems’ SLA solid imaging systems to “print” your part in three dimensions

File Formats—of STLs, and BFFs

Most commercial CAD, CAM, CAE and/or surface- or solid-rendering applications output files in STL format. ***3D Lightyear*** software reads STL files and, after performing a series of pre-processing functions, generates 3D Systems’ proprietary *Build-Files* (*BFFs)*.

These BFFs are then ported to 3D Systems’ Windows-based SLA machines (SLA 7000, 5000, 3500, 500, and 350.)

Once on the SLA machine, the files—the prepared and style-embellished data that constitutes the stereolithographic facsimile of your original, three-dimensional images—are ready for 3D printing.

Then, the SLA Solid Imaging System Fabricates Your Idea

We make an extensive line of stereolithographic, three-dimensional fabrication machines as well as solid object printers. Depending upon their frame size, our SLA systems use either BFFs (for large-frame machines) or the four-file suite (for the smaller frame SLA 190 and SLA 250-series) output by ***3D Lightyear*** software to create highly accurate, three-dimensional parts from your three-dimensional image files.

We also offer a wide variety of resin polymers for use in our SLA machines, each with unique capabilities and characteristics that allow you to use your finished parts in applications like our own 3D Keltool® and other intermediate tooling processes, investment casting, and room-temperature vulcanization (RTV), Direct-AIM, etc.

Talk with your 3D Systems Sales representative, log on to the 3D Systems site on the World-Wide Web, or call 3D Systems directly for information on our techniques, products, and expertise in:

- Specialty Resins from Ciba-Geigy (a 3D Systems partner)
- 3D Keltool®
- Direct AIM
- Advanced Building and Part Finishing

What's New in this Version of 3D Lightyear Software?

Version 1.0 marks the first iteration of 3D Systems' SLA file preparation applications to accommodate the Windows NT operating system and Intel Pentium platform. Users of our older products migrating to the new platform will notice significant departures from the way the software's predecessors worked.

Among the changes, each of which is covered in detail in this guide there is:

- A completely new, customizable interface (say good-bye to spread sheets)
- A Machine Set Up Wizard that guides you interactively through the process of setting up a 3D Lightyear software work session for the particular type of SLA machine upon which you intend to build parts
- A Styles interface to help you edit Build, Recoat, and Support Styles while minimizing chances of jeopardizing your build's success
- A host of automated features including:

  Part Placement

  Align with Up- or Down-facing Plane

  Reload Part(s) after Verify

  Convert from inches to mm and vice-versa

- Real-time "Pick and Point" and "Drag and Drop" part translation and orienting capability
- Print your workspace to any connected Windows-compatible 2D paper printer

- Save specific views of your workspace for subsequent quick access
- Display reference planes in the workspace to show the starting and stopping places for Build and/or Recoating Styles
- Correct work mistakes with multiple levels of “Undo”
- Fully-integrated Support Generation and Editing tool suite
- STL and SLC thumbnail preview before opening
- Pause/Resume Slice
- Keyboard Shortcuts

NOTE!
Refer to the 3D Lightyear Software Release Notes accompanying your software package for a complete and detailed description of the all the new features and functions.

“Standard” and “Advanced” Licenses

We are trying to make your life easier. History has taught us that when a user encounters a problem with a part build on an SLA system, more often than not there has been implementation of some “non-standard”, non-approved technique, or some on-site modification to the 3D Systems-tested parameters and tools in the preparatory software. In earlier versions of our software, users could—and often *did*—unknowingly institute practices and procedures in preparing their files that produced undesirable results including, in some cases, outright “crashes” of the build process. These problems, in turn, resulted in the customers’ loss of significant time and, accordingly, revenues.

Starting with this version, we have incorporated into the design of our user interface a new operational scheme designed to prevent inadvertent and ill-advised “tweaking” of SLA system build parameters by “novice” users.

The Standard License

...is for users that are relatively new to, and inexperienced with stereolithography. The Standard User License is designed to make it more difficult to make a mistake when modifying Support Generation, Build, and/or Recoating Styles.

At the Standard level, users will find all of the tools and access to machine and preparation parameters they need to enable them to prepare and build the majority of their part(s).

Our team of highly skilled and experienced Software Development and Process Engineers have created, and continue to improve upon the parameters in the default Support-Generation Styles, Build Styles, and Recoat Styles for both our existing line of SL Resins, and for new products offering enhanced performance capabilities. The Standard license level provides “guidance” that helps users to avoid venturing into “uncharted” waters that can lead to problems and frustrations on the SLA Buildstation.

The Standard User License is available as part of the default installation of ***3D Lightyear*** software.

The Advanced License

...is for those users who have adequate experience and/or knowledge of the stereolithographic process to understand the requirements for preparing parts for “healthy”, successful builds on their SLA machines.

At the Advanced level, the degree of access to parameters allows significantly greater latitude in the creation of custom styles. This is to accommodate site- and/or part-specific circumstances that cannot otherwise be addressed without intimate knowledge of what goes on in the vat of their SLA machine.

To qualify for an Advanced User License at your site, there must be at least one user who has attended 3D Systems’ Advanced Training class, or has three years of part building experience on 3D Systems’ SLA machines.

Getting Started

The purpose of this guide is to provide you with the information you need to:

- **Prepare** your work environment for the installation of 3D Lightyear software. This section consists of a list of the specifications necessary for your workstations to comfortably load your three-dimensional model files and run the program's preparatory functions to produce BFFs (and/or .v, .r, .l, and .prm file suites).
- **Install *3D Lightyear SLA File Preparation*** software on your Windows NT workstations, and obtain the necessary license(s) from 3D Systems
- **Use the program in a "Quick Start"** mode that will have you preparing parts in as little time as possible

With the preceding goals in mind, we have organized this booklet as follows:

- **Using this Guide—**This section describes the methods we use to convey instructions and information in printed texts and illustrations in this guide. Also included is an overview of our technical support, online help, and online context-sensitive help systems.
- **Preparing Your Work Environment and Installing the Software—** This list of workstation specifications describes the type of Windows NT workstation and network you will need in order to run *3D Lightyear software* efficiently. Once certain that you have configured the optimum hardware and operating environment, turn to this section for instructions on running the program that installs *3D Lightyear software* on that workstation's hard disk, and what you need to do to license your installation with 3D Systems.
- **Obtaining and Installing Your 3D Lightyear Software License—** This section guides you through a series of steps to obtain the HostID from your workstation which you will use to obtain your license file(s) from 3D Systems' internet website.

Symbols and Conventions Used in this Guide

Notes, Cautions, and Warnings

This symbol calls attention to a "NOTE", "CAUTION", or "WARNING".

When it appears with a "NOTE", the texts or illustrations call attention to a practice or condition that can save time or prevent inconvenience to the user.

When it appears with a "CAUTION", the texts or illustrations call attention to a practice or condition that risks damage to equipment (or in the case of software, malfunction).

Finally, when the symbol appears with a "WARNING", the accompanying condition or practice risks injury to personnel.

Procedures

Instructions, i.e. the tasks or steps that constitute formalized procedures, are numbered, and appear in a distinct type face.

Here is an example:

1. **Click the Windows NT "Start" button, and choose "`Programs`", then "`3D Lightyear 1.00`" to start the program.**
2. **Pull down the "`File`" menu in the menu bar at the top of the screen, and select "`Open`".**

User Input and Program Texts

All references to texts that appear on your computer screen, either within the *3D Lightyear* software, within Windows NT, or within a Command Prompt window, appear in a distinct typeface and are set off by quotation marks. Refer to the preceding passage for examples.

When you, the user, have to enter specific texts (alphabetic or numeric), the area and instructions for it are enclosed in brackets.
Here is an example:

1. **At the "`c:\`" prompt, type: [`ping`], a space, and the TCP/IP address of your SLA machine. For example:**

   "`c:\ping 206.65.88.228`"

Control Functions

Specific keystrokes (as opposed to specific texts)—i.e., instructions to hold down combinations of keyboard keys to execute commands or functions—appear in a distinct typeface *and* are enclosed by the symbols: **<** and **>**
Here is an example:

1. **Hold down <`Ctrl`> and <`Alt`>, and press <`Enter`>.**

Getting Help While Using 3D Lightyear Software

The 3D Lightyear Online Users' Guide is another name for the program's online help system—a kind of "virtual" users' guide from which you can call for help and information at any time, from anywhere while using the program.

Mouse Power!

There are four ways to get information and help on the use of 3D Lightyear software from "within" the program itself:

1. **Move the cursor over any graphical element on the screen and hold it there. After a brief pause, an encapsulized definition of the element over which you are "hovering" will "pop up" in a small window next to the on-screen cursor.**

   In some dialogs, this action will display the applicable range of input values for the field for which you are seek-ing help.

2. **Press the <`F1`> function key at any time. The opening page of the online guide will appear in a separate window.**

3. **If you are working in the 3D Lightyear software's main workspace (as opposed to the Custom Draw workspace), you can also access Help by clicking the "Help"...**

 **icon located in the toolbar at the top of the screen.**

4. **Pull down the "**Help**" menu at the top of the main workspace and select "**Help Topics...**".**

NOTE!
In addition to running concurrently with the program itself, the 3D Lightyear Online Users' Guide also functions as a "stand-alone" application. This allows you to launch and "run" the guide by itself, separate from the 3D Lightyear program. You may find this useful when allocating disk space on your workstation.

We hope that you will come to view this feature of the 3D Lightyear program as a comprehensive complement to the product's printed documentation. Together with its built-in, context-sensitive features it should significantly shorten your "learning curve".

Installing the Software

The 3D Lightyear software installation CD includes an automated setup routine that you can run from within Windows' "Add/Remove Software" facility. During installation, this setup routine performs automatic checks on your system, asks a series of questions about how you want to configure the 3D Lightyear program, and, based on your answers to these questions, copies several files to your hard disk. It then decompresses the files, writes data to areas of your system's registry, and creates Windows' shortcuts to the program for your Windows' system Start menu.

Before You Install—Specifying Your Workstation(s)

The following section of this guide describes the PC workstation and networking environment you will need to be able to run 3D Lightyear SLA File Preparation software.

NOTE!
The 3D Lightyear program runs exclusively on Intel Pentium workstations configured with Microsoft's Windows NT operating system. Depending upon the physical size and geometric complexity of the part(s) you intend to prepare with this software, processing on the 3D Lightyear software workstation can tax memory and storage configurations that might be adequate for other purposes.

Keep in mind that SLA file preparation is but one, requisite step in the process of turning your three-dimensional designs into physical solids. The less time you have to spend at the preparatory workstation, the more cost effectively your Rapid Manufacturing or Rapid Prototyping system will be to operate.

With the preceding tenet in mind, it behooves you to set up a system considering the following specifications as "***median***"—that is, a system that will function adequately "when preparing most files" of the size (kilobytes or megabytes) with which you work routinely. It should be noted that, to arrive at these specifications, our team of Product Assurance Engineers tested the preparation of a variety of parts of arbitrarily-determined "average" file size and varying degrees of part geometry.

While it is known to be ***possible*** to prepare files on PCs with less memory and less powerful (slower) processors, we recommend investing a little more in your working environment to save time and aggravation later on. In fact, adding more system memory (RAM), video memory (VRAM), upgrading to an even more powerful processor, and increasing the size and available free space on your system's hard disk drive has been shown, in our tests, to have significant positive affects on performance and throughput.

NOTE!
While *3D Lightyear* software is known to function minimally on workstations running Windows 95 and Windows 98, it should be noted that functions such as Verify and Prepare call Windows routines that are not supported by these operating systems. Running *3D Lightyear* software with these operating systems and attempting to execute these functions will likely cause unpredictable results.

The following system has been tested, and is recommended by 3D Systems' technicians as a good, mid-level platform for running the ***3D Lightyear*** program.

Table 1. Specifying your PC Workstation for Using the 3D Lightyear Program

Equipment	Specification
Processor	450MHz Intel Pentium® II or Pentium® III (Xeon™ preferred)
Memory	256 MB ECC SDRAM
Disk	9GB Ultra2/Wide SCSI
Video Controller	Full Open GL ICD with 3D Graphics accelerartion, and 8MB RAM on board (16MB preferred); PCI bus (Accelerated Graphics Port (AGP) preferred)
Display	17-inch capable of displaying 16-bit color depth (65k colors), minimum, at 1024 x 768 resolution with 75Hz vertical refresh rate (21-inch monitor with 24-bit color depth preferred)
CDROM	24X IDE or SCSI (only used to load program files)
Network Interface	10/100 10Base T Class A Ethernet (recommended for ease of file transfer between 3D Lightyear and Buildstation)
Operating System	Windows NT 4.0 with Service Pack 3 or higher
Other	Performance keyboard (i.e., 104-key), two-button mouse (Microsoft Intellimouse® supported), 3.5-inch/1.44MB floppy disk drive

NOTE!
The following graphics accelerator cards have been tested by 3D Systems' engineering staff during development of the 3D Lightyear program:

- **Evans & Sutherland AGP Galaxy**
- **AGP Eclipse II**
- **AGP Star II**
- **Tornado 3000.**

While this information does not constitute an endorsement of these products, they were found to perform well with 3D Lightyear software, and to meet or exceed the requirements for Full Open GL compatibility. For more information on Evans and Sutherland products, consult their website at `www.es.com`. Note that during our beta testing of 3D Lightyear software, boards offered by other, third party manufacturers were successfully employed. In fact, we did not find any boards meeting the minimum requirements that did not work properly. When there were issues with a particular board, downloading the latest drivers from the manufacturer's website resolved the issues. Consult the documentation that came with your video graphics accelerator card for information and support.

Memory and Performance

Most CAD applications require significantly more RAM, VRAM, and free disk space than ***the 3D Lightyear*** program. If, however, you are not using a CAD workstation, and are relying upon the specifications in this document to configure your ***3D Lightyear*** software workstation, there a several aspects of the specified configuration to which you should pay particular attention.

The amount of virtual memory on your workstation under Windows NT is typically controlled by the operating system itself. Regardless of how much free RAM you may have at any time, Windows NT will often begin to make memory “swaps” to the free space on your hard disk drive. Usually, the default system settings for virtual memory levels are adequate for running 3D Lightyear software. If, however, you find that the performance of the program is less than acceptable, make sure that you have at least 300Mbytes total virtual memory configured on the non-boot hard disk of your workstation.

Refer to the online Help system or the documentation for Windows NT for instructions on accessing and adjusting virtual memory settings.

A Note Regarding your Network

Once you have used the 3D Lightyear program to successfully prepare parts for building on an SLA Buildstation, you will have to physically transport the data file—the BFF or the .v, .r, .l, and .prm file suite—to the computer on the SLA system. 3D Systems requires its SLA systems to be installed on a network for several reasons, not the least of which is the fact that most BFFs are far too large to move from PC workstation to the SLA Buildstation controller via floppy diskette. The simplest method of porting files from the SLA file preparation workstation to the SLA Buildstation controller is over a network. Make sure to specify a Class A Ethernet.

The Installation Procedure

NOTE!
If you normally use a virus protection program on your PC, we recommend that you turn it off, or override its monitoring of the system before installing 3D Lightyear software. Since the program’s setup program writes information to the system registry, it may not install properly if your virus protection is set to monitor and/or control this type of activity. After 3D Lightyear software installation is complete, you can restart your virus protection program.

To install 3D Lightyear software:

1. **Insert the CD labeled "3D Lightyear SLA File Preparation Software" into your PC's CD-ROM drive.**
2. **Click on the Windows "`Start`" button, in the lower-left corner of the Windows NT "desktop".**
3. **Choose "`Settings`", then "`Control Panel`" on the menu (see Figure 3).**
4. **From the Control Panel, open the "`Add/Remove Programs`" facility of Windows. You will see the dialog shown in the upper area of Figure 4.**
5. **Click on the "`Install`" button as shown in Figure 4. The next dialog will prompt you to begin the Windows' function that scans your drives for installation programs or routines (see the middle dialog shown in Figure 4).**
6. **Click on the "`Next`" button. If the process is successful, Windows will "find" the installation routine, "`Setup.exe`" on your CD-ROM drive. If it is unable to find the correct program, click on the "`Browse`" button to open an Explorer-type dialog that will allow you to locate setup.**
7. **Click "`Finish`". Following the preceding steps launches the 3D Lightyear software setup program (see Figure 5), in which you will be prompted to:**

   - Agree to the tenets of 3D System's software license
   - View release-specific information (see Figure 6)
   - Create a directory structure in which the program will reside on your system (see Figure 7), and
   - Choose which type of installation you wish to perform, Typical, Compact, or Custom. (See Figure 8.)

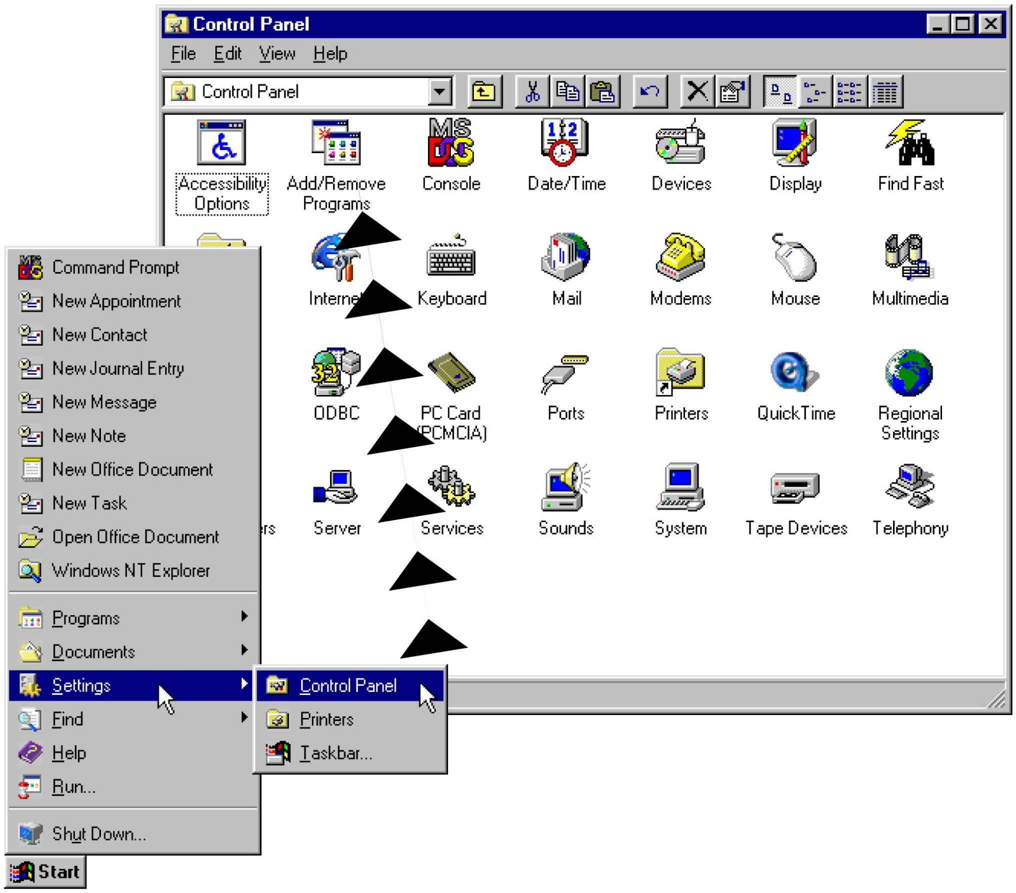


Figure 3. Accessing Windows Facility for Installing New Software.

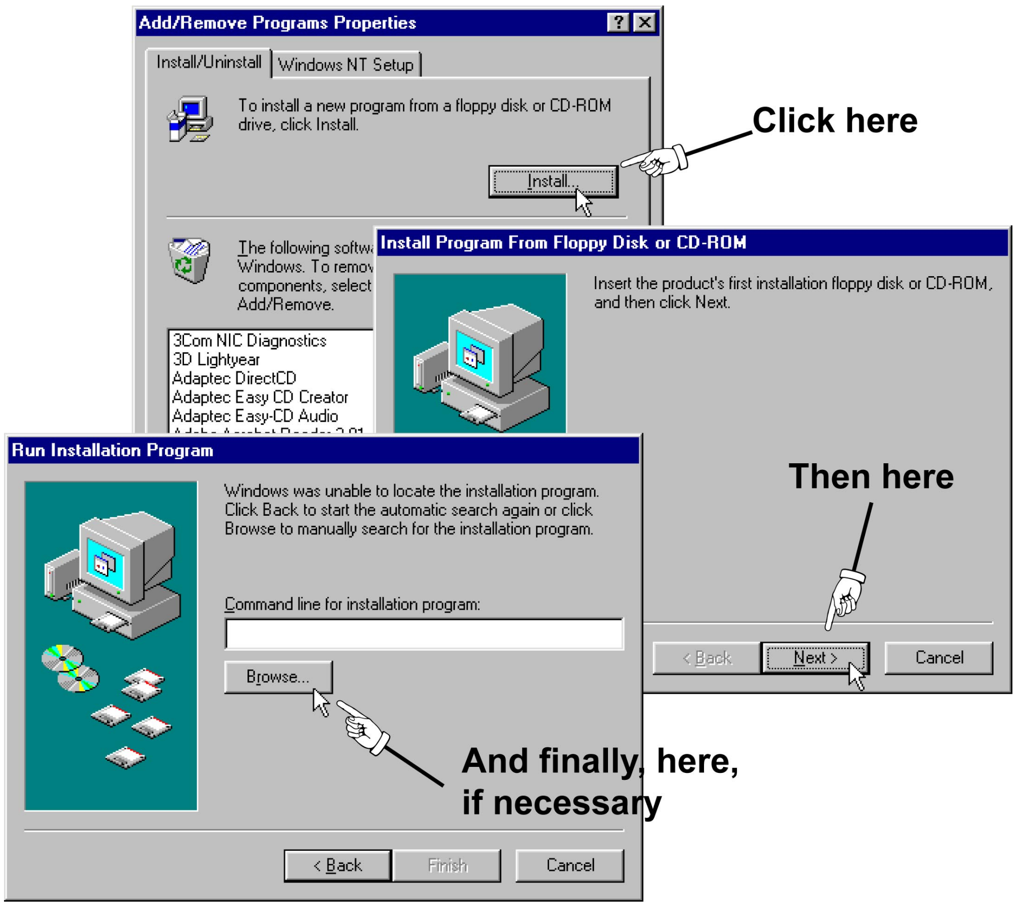


Figure 4. *Click "*`Install`*", then "*`Next`*", then "*`Browse`*" (if necessary) to find the installation program for* ***3D Lightyear***

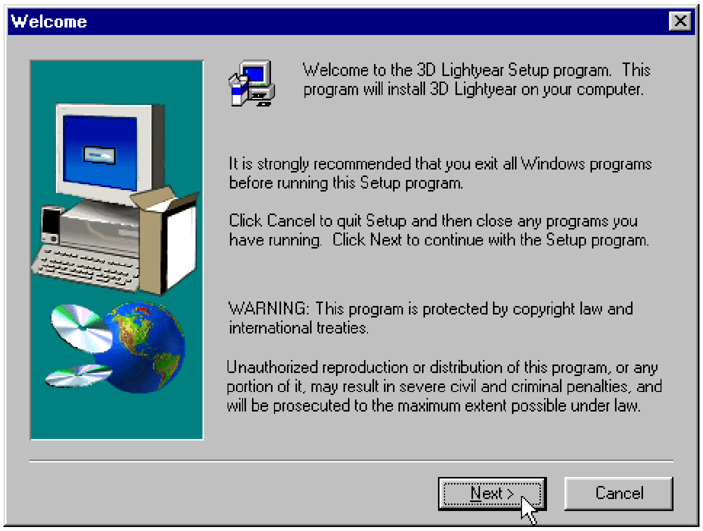


Figure 5. The 3D Lightyear software Setup Program automatically installs the program on your PC's hard disk drive.

Figure 6. Read the last-minute, release-specific notes on screen during the installation process.

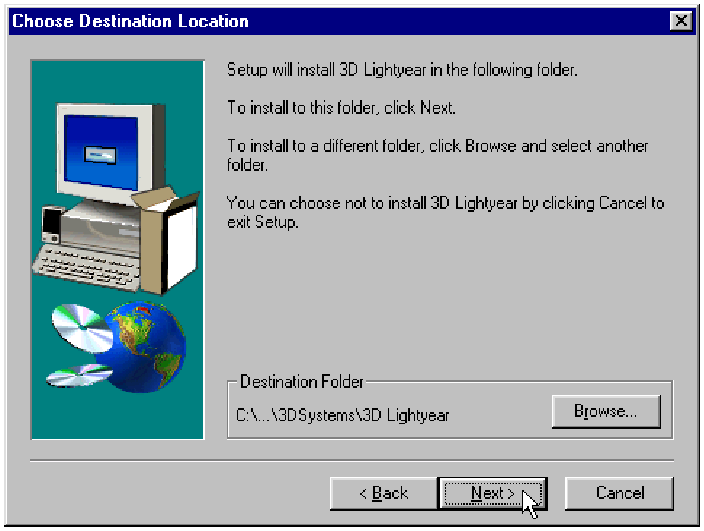


Figure 7. The Setup Program prompts you for the directory in which you would like the 3D Lightyear program sub-directory to reside.

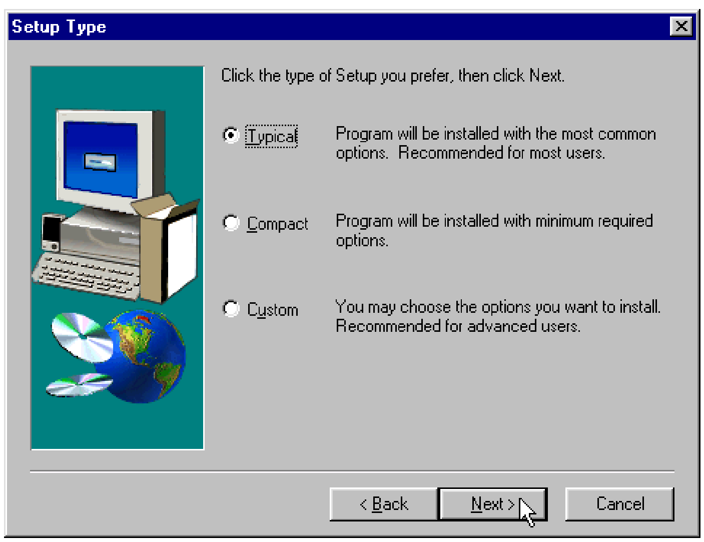


Figure 8. Choose between the Typical (default), the Compact, or the Custom program installation.

The "Typical" installation copies all the files needed to run 3D Lightyear software, including the Online Users' Guide, and basic Styles for Support Generation, Build, and Recoating processes. You should be able to prepare most STL files using the components installed with the "Typical" selection checked at this stage of the installation.

The "Compact" installation does not copy the Online Users' Guide to the designated directory on your workstation. This will save you approximately 92Mbytes of disk space. Note that you can "run" the Online Users' Guide directly from the CD as a "stand-alone" application at any time. Simply double-click on the program "`3DLightyear.hlp`".

NOTE!

If you perform a "Compact" installation, the Online Users' Guide (help system) for 3D Lightyear software will not be accessible from within the program.

The "Custom" installation allows you to pick the program components that you wish to install from the CD.

8. **Follow the instructions given by the setup program on each prompt screen to complete the installation of the 3D Lightyear program. As the program installs, you will see various messages from the setup routine as files are transferred to their appropriate directories and expanded (see Figure 9).**

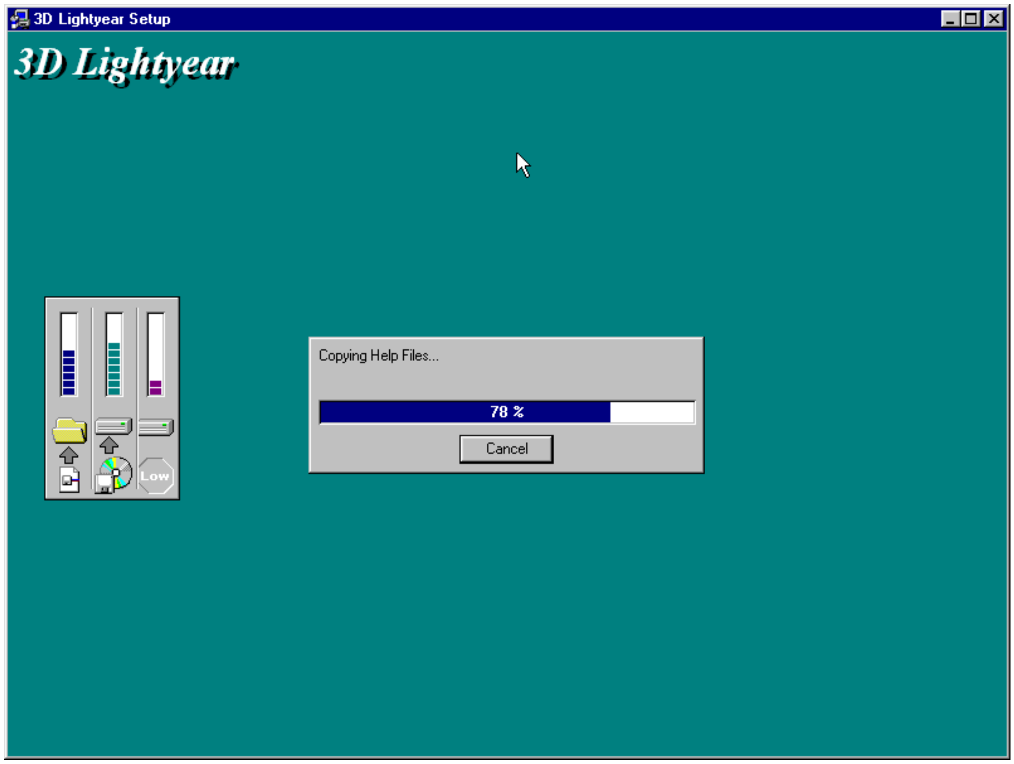


Figure 9. The 3D Lightyear software setup displays progress messages as it installs.

NOTE!
When the installation process is complete, you will see a screen similar to the one shown in Figure 10.

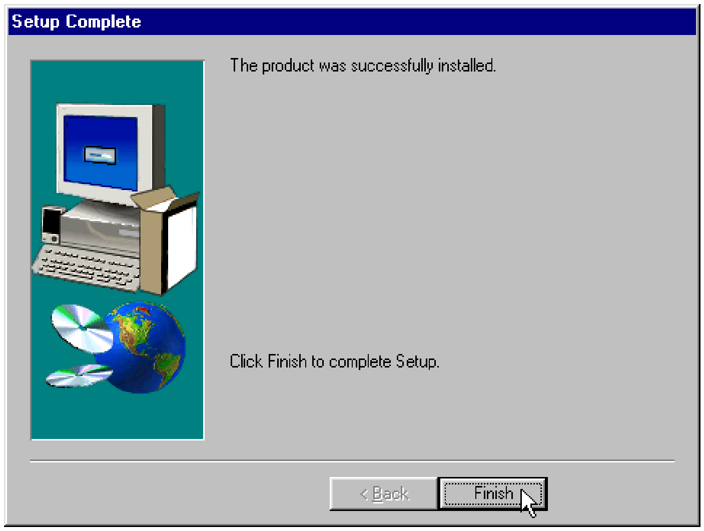


Figure 10. When the 3D Lightyear program has "installed itself" successfully, you see this message.

9. Click "`Finish`" to complete the installation and return to your workstation's desktop.

NOTE!
Your software is now installed and you are ready to obtain a license.

Obtaining and Installing Your 3D Lightyear Software License

NOTE!
YOU WILL NOT BE ABLE TO LAUNCH the 3D Lightyear program until you have obtained a license from 3D Systems.

Before you can begin to use 3D Lightyear software to prepare your files for building on an SLA system, you will have to get a license file from 3D Systems for each workstation on which you have installed the 3D Lightyear program.

Obtaining a license is a multi-step process. Before starting, make sure you have successfully completed the steps to install the software (earlier in this guide).

To get your license:.

1. **Open a Command Prompt (DOS window) from the Windows' "`Start`" menu (See Figure 11).**

2. **Use the "`cd`" (change directory) DOS command to switch to the "`bin`" sub-directory (folder) in the "3D Lightyear" directory where the Setup program created it (See Figure 12).**

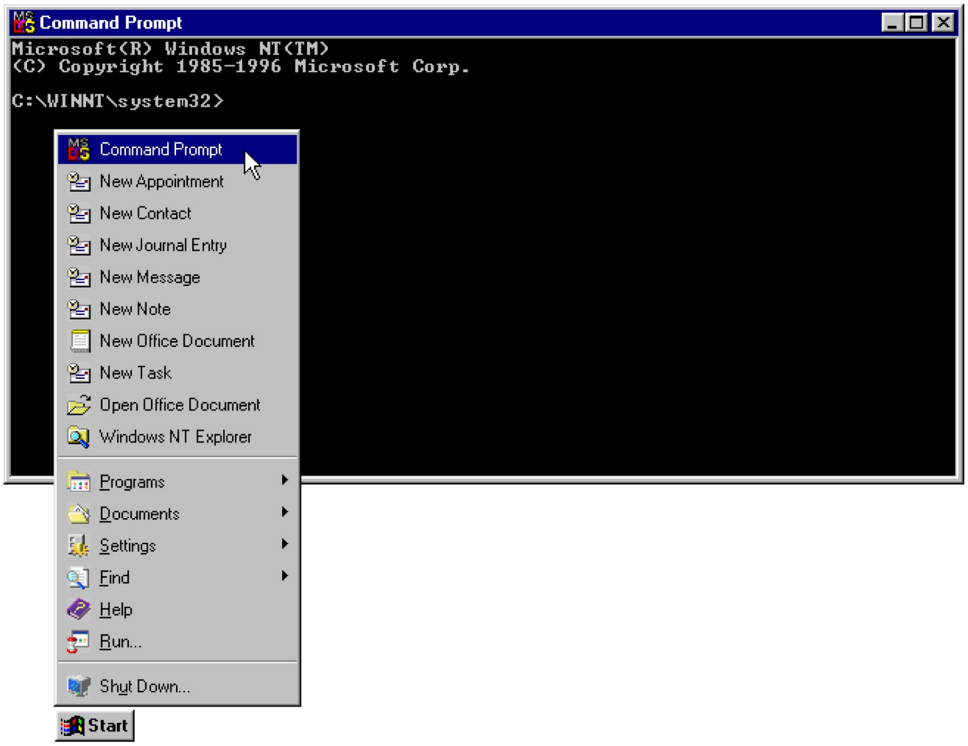


Figure 11. Open a DOS window to start the process of obtaining a license for 3D Lightyear software.

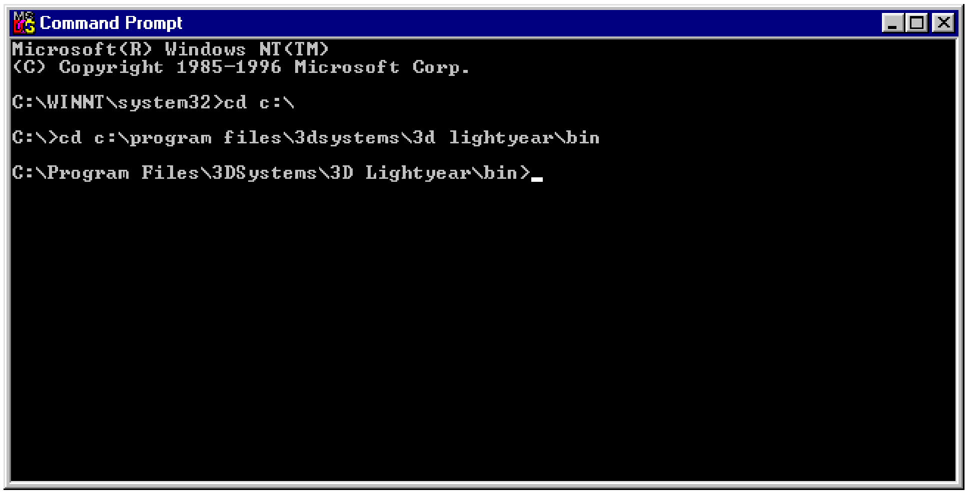


Figure 12. Using the "cd" command to change directories to "bin".

3. Once in the "`bin`" sub-directory, at the prompt, type:

"`lmutil lmhostid`"

(See Figure 13). The utility will prompt your system for its unique host identification code.

4. RECORD THE CODE. Make a note of the code somewhere so that you will be able to find it later.

NOTE!

License files are machine-specific. You should take steps to be able to identify your machine later on by its unique host identification code.

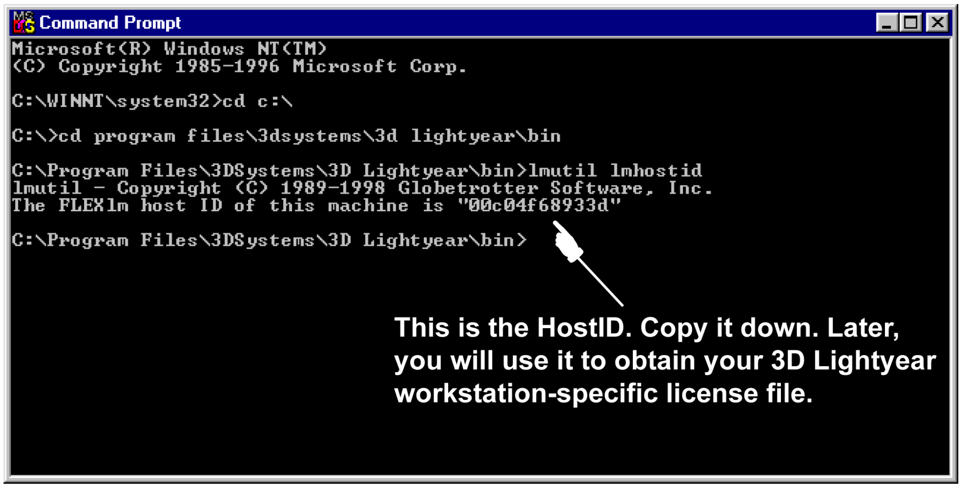


Figure 13. The "lmutil lmhostid" command queries your PC for an identification code.

5. **REPEAT Steps 1 through 4 of this procedure for each machine that will be running the 3D Lightyear program (make a list of all the host identification codes and which machine they refer to).**
6. **LOG ON to 3D Systems' website on the World-Wide Web. You can find us at:**

   `www.3dsystems.com`
7. **Follow the instructions for licensing your software under "Customer Services", "Software Licenses." See Figure 14.**

   The first step is to enter the License Authorization Code to gain access to the web-based license generator. This code is imprinted on the License Authorization Card that came with your 3D Lightyear software.

   Once you gain access to the license generator, you input the HostID you obtained from Step 3 earlier, and the license generator displays the text for your license file.
8. **Cut and paste the license file text from the web display into a text file using Notepad, and save it with the name "License.dat".**

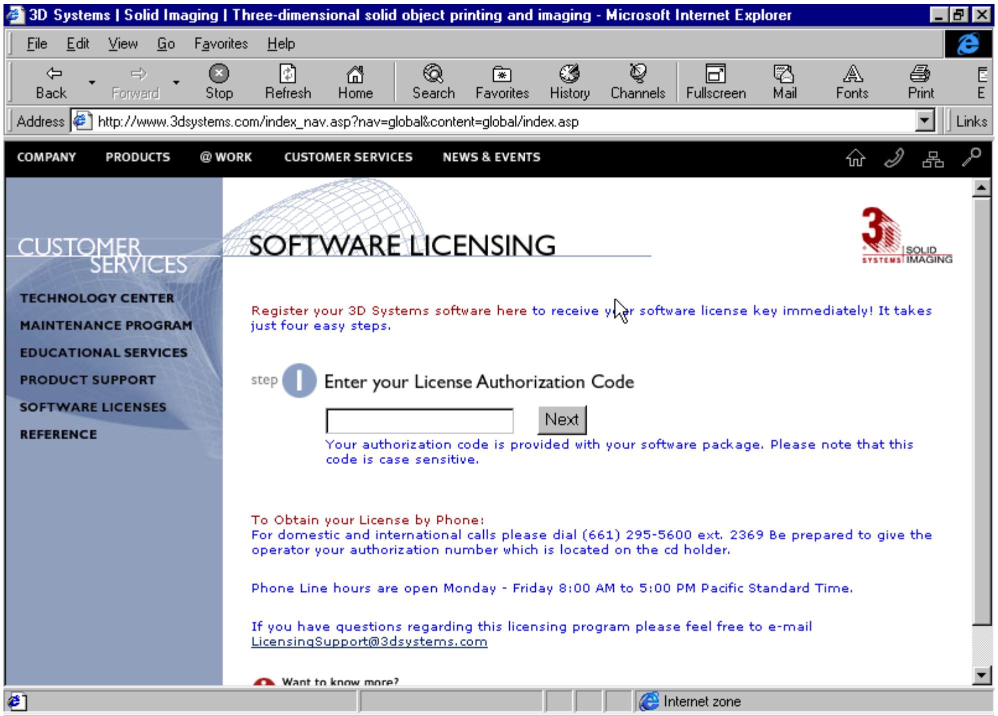


Figure 14. You obtain your software license on line via 3D Systems' Corporate Website.

NOTE!
ALTERNATIVELY (if you do not have access to the "web") you can telephone:

3D Systems' Contracts Administration Offices at 1-661-295-5600, extension 2369, Monday through Friday, between the hours of 8:00 a.m. and 5:00 p.m., Pacific Standard Time. You will need to provide the Licensing Specialist with the Licensing Authorization Code shipped with the software package, and the host IDs you generated in Step 3 of this procedure for each of the workstations upon which you wish to run the 3D Lightyear program.

9. Once you have your license file(s), carefully match them to the correct machine by the HostID code.

Remember, licenses are machine-specific and will only enable the 3D Lightyear software to run on the machine whose identification code (HostID) matches a specific parameter in the license file.

10. Copy the appropriate license file into the "bin" sub-directory where you installed the 3D Lightyear program on your machine and name the file "`license.dat`".

NOTE!
Your software is now licensed and ready to run.

Testing the Installation—Running the 3D Lightyear Program for the First Time

When you first launch ***3D Lightyear*** software, the program's license manager will prompt you for the location of the license file for your workstation. Once you have located it, you can save its location so that you will not be asked to locate it again.

To Launch the Program:

1. Click on Windows' "Start" bar, and locate the *3D Lightyear* program shortcut.

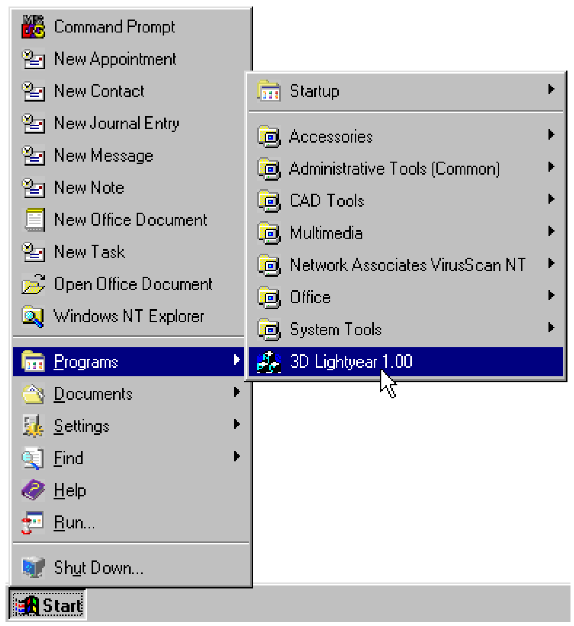


*Figure 15. Starting the **3D Lightyear** program.*

You are prompted to locate the license file manually by the screen illustrated in Figure 16.

*Figure 16. The **3D Lightyear** License Manager prompts you to locate the License file for your workstation.*

2. Click the "Specify the License File" radio button.

3. Click the "Next" button to begin the process of locating your license file.

You are presented with the dialog illustrated in Figure 17.

Figure 17. Use your system's browser to locate your license file.

4. Use the "Browse" function to open a Windows Explorer-type dialog with which you can locate your file. Double-click the filename of the license file.

With the "License.dat" filename displayed in the "Browse" box, click the... Next >> **button to continue.**

The next dialog prompts you to save its location. Click the "Save Setting" radio button as illustrated in Figure 18.

Figure 18. Save the location of your License File.

Saving the setting allows you to subsequently launch the program without having to specify its license location.

NOTE!
When you see the *3D Lightyear* program's "splash screen", followed by entrance to the program's Main workspace, you will know that you have successfully identified the correct license file for you workstation. (See Figure 19.)

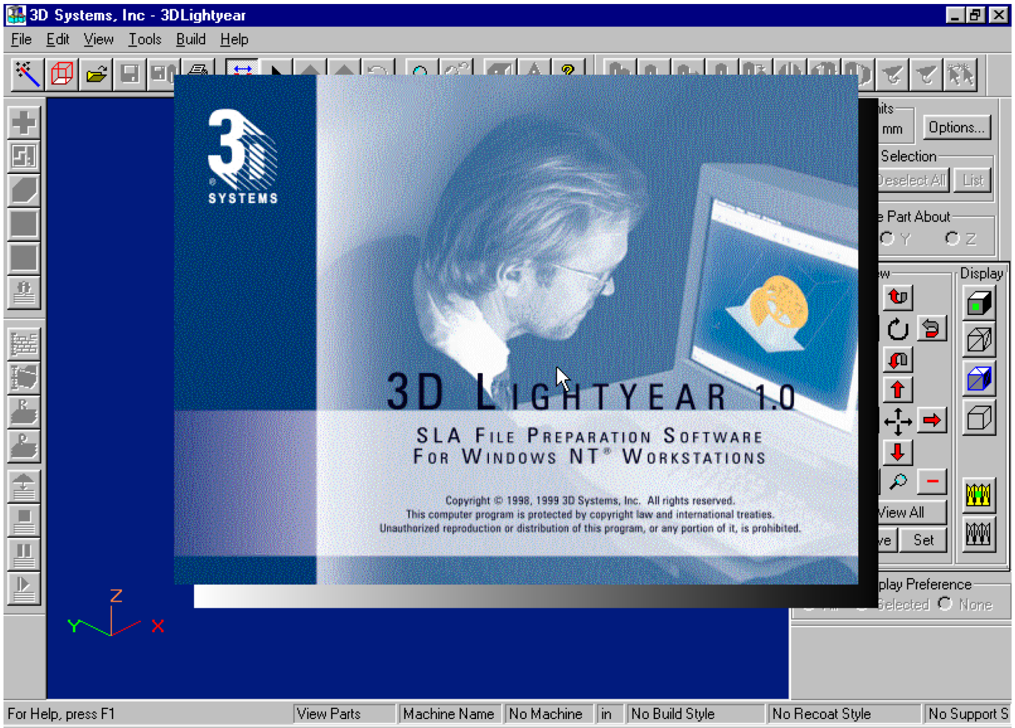


Figure 19. Following a momentary display of the program's "Splash Screen", the software opens into the main program workspace.

Getting Help

The user interface of ***3D Lightyear*** software is designed to allow you to learn by doing. We have tried, where we can, to provide answers to any questions you may have about the use of the program *while you are actually using it.*

The ***3D Lightyear*** *Online Users' Guide*, installed as part of the "Typical" *3D Lightyear software* setup routine, allows you to get instructions and information on many aspects of the product's use from within the program itself.

To use the Online Users' Guide, simply press **<**F1**>** at any time while using *3D Lightyear software*. The Windows' standard help system that you will be presented with includes a plain-text search facility, an index, a table of contents, and animated demonstrations that should help you find the information you are looking for with just a few clicks of your mouse.

Getting Help Directly from 3D Systems

The real strength and utility of 3D Systems' methods for Rapid Prototyping and Manufacturing comes from the ongoing commitment of our people to develop and support the software and hardware we sell, even after you take delivery. We stand with pride behind everything we make, and are determined to deliver *solutions* rather than simply *products.*

We are here to help you design better, to make it possible to bring your products to market faster, and to find new ways for you to complete the design-to-production cycle at a significantly lowered cost. Our products are only the beginning.

Aside from continuing focus on research and development, a major part of our efforts to meet our corporate goals is our Customer Service and Education departments. Our Field and Applications Engineers are ready to supply you with practical tips, technical information, software updates and training.

3D Systems' Customer Service – USA
805 Falcon Way
Grand Junction, Colorado 81506
USA
Telephone Toll-free Hotline (in the US): 1.800.793.3669
Fax: 970.257.4601
Email: moreinfo@3dsystems.com

3D Systems' Customer Service – Europe
Röntgenstrasse 41
D-64291 Darmstadt
GERMANY
Telephone: +49.6151.357.357
Fax: +49 6151.357.222
Email: moreinfo@3dsystems.com

3D Systems' Customer Service – United Kingdom
Unit 7 The Progression Centre
Mark Road
Hemel Hempstead, Herts, HP2 7DW
ENGLAND
Telephone: +44.14.42.282.666
Fax: +44.14.42.282.667

Turn to 3D Systems' Education Department for even more help...

3D Systems maintains an extensive and dynamic program to educate and train customers and researchers on SLA systems, software, and the latest developments in Rapid Manufacturing, Tooling, and Prototyping techniques. The wealth of real-world experience that our education professionals apply in teaching our classes provides you with insight into far more than simply the workings of the machinery or software.

Ask your local 3D Systems' representative, or call the company directly for information on attending a class, or having 3D Systems Education personnel come to your facility for hands-on training. They can be reached by calling 3D Systems' Corporate Headquarters at 1.661.295.5600, and asking for extension 2248 or 2192.

3D Lightyear Software Workspace Overview

When you launch the 3D Lightyear program, a title screen showing the program version number and copyright date "flashes" briefly on your workstation screen as the program loads. When you see an empty workspace similar to the one shown in Figure 20, you are ready to begin.

The Main Workspace

The main workspace of ***3D Lightyear*** software, as illustrated in Figure 20, is where you will perform the bulk of the work necessary for preparing your parts. With the exception of the facility to optimize and draw custom supports, all the tools you need to prepare your files for building on an SLA solid imaging system are accessed through the icons and menus on this screen.

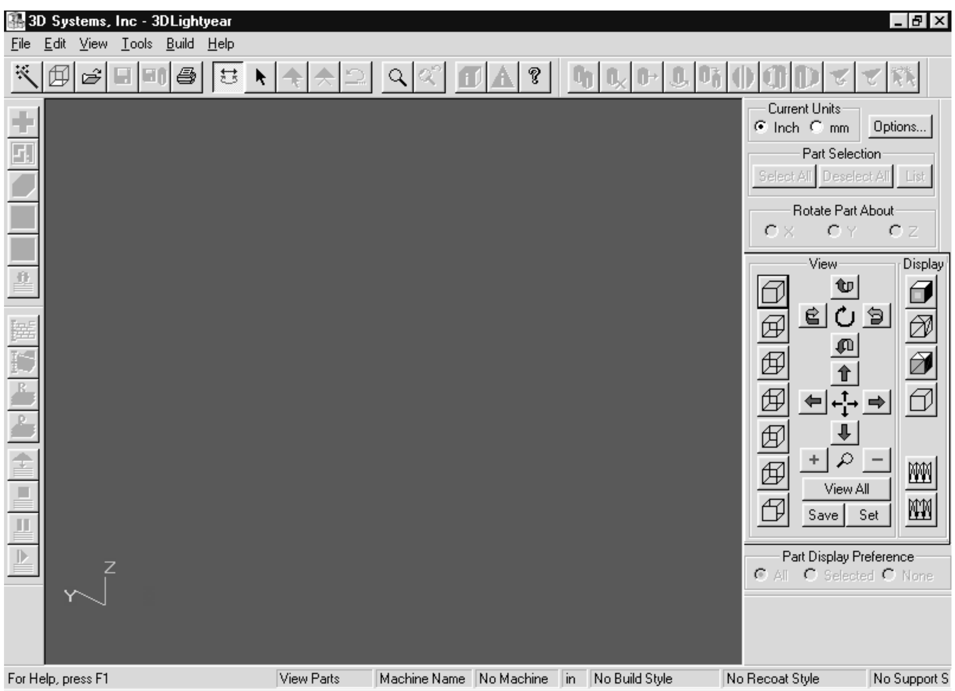


Figure 20. An example of 3D Lightyear's Main Workspace upon launching the Program

Figure 21 “maps out” the various graphical elements that comprise the interface of the main workspace. An explanation of each of these elements can be found in the subsections that follow.

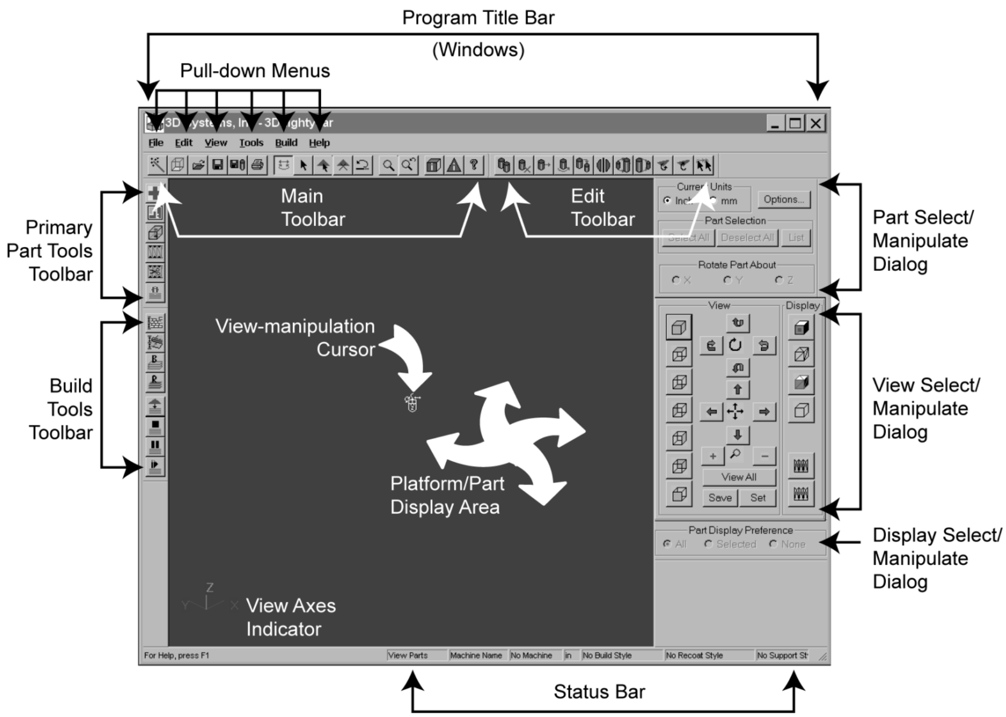


Figure 21. The 3D Lightyear Software Graphical Overview

Program Title Bar

Just as in all Windows applications, the Program Title Bar (Figure 22) displays the name of the application running in that window, and provides the minimize, iconize, and close program buttons.

Figure 22. Program Title Bar

Pull-Down Menus

All functions in the 3D Lightyear program are available from one of the six pull-down menus: **"File"**, **"Edit"**, **"View"**, **"Tools"**, **"Build"**, and **"Help"** as illustrated in Figure 23. Most menu functions also are available by clicking an icon on one of the 3D Lightyear tool bars. First we present the menus, then we will explore the toolbars.

Figure 23. Pull-Down Menus

The File Menu

As illustrated in Figure 24, the **"File"** menu houses the setup, loading, saving, printing, and program exit functions.

Figure 24. The File Menu

The Edit Menu

As illustrated in Figure 25, the **"Edit"** menu houses all the part copying, deleting, transforming, selecting, and conversion functions.

Figure 25. The Edit Menu

The View Menu

As illustrated in Figure 26, the **"View"** menu houses the functions that control the way parts are seen on the screen, including shading, lighting, coloring, view orientation and zoom level. It also controls which of the various toolbars and tool dialogs are displayed.

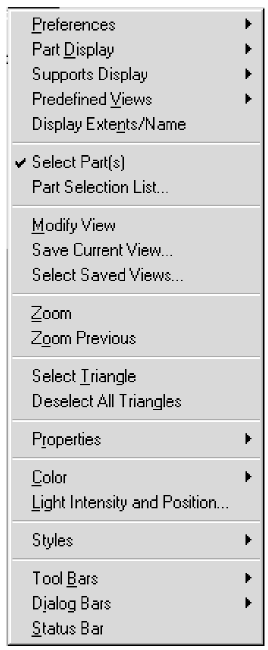


Figure 26. The View Menu

The Tools Menu

As illustrated in Figure 27, the **"Tools"** menu provides tools for verifying and repairing damaged STL files, combining STL files into a single file, automatically placing STL files on a platform, and creating and editing support structures. Additionally, tools are provided for creating and editing vents and drains for builds using the QuickCast style. Finally, this menu houses the **"Reference Plane**" tool and provides access to the **"Options"** dialog where you can manipulate many aspects of the workspace.

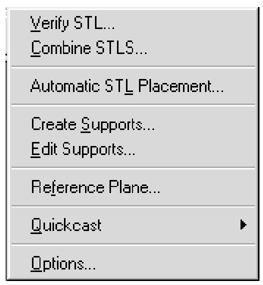


Figure 27. The Tools Menu

The Build Menu

As illustrated in Figure 28, the **"Build"** menu houses tools for modifying the default platform styles for changing the build and recoat parameters to accommodate special circumstances. This menu also houses the Prepare functionality which transforms the platform data into the build file(s) needed to actually build the parts on the SLA machine.

Figure 28. The Build Menu

The Help Menu

As illustrated in Figure 29, the **"Help"** menu provides access to the on-line help system, and the 3D Lightyear software version and licensing information.

Figure 29. The Help Menu

Toolbars and Dialog Bars

Following is a tour of the toolbars available in the 3D Lightyear software. Figures 30 through 36 show the icons on each of the toolbars and dialog bars that provide easy-access alternatives to the pull-down menus for most of the 3D Lightyear software functions. Using the Toolbar and Dialog Bar icons can helps increase your productivity. Note that when you "hover" the mouse cursor over an icon, you get a short description of the icon's function in a call-out box near the cursor. The icon's function is also displayed on the left side of the status bar in the lowermost area of your workspace.

Each Toolbar and Dialog Bar is illustrated with a short description of each icon on the toolbar.

Main Toolbar

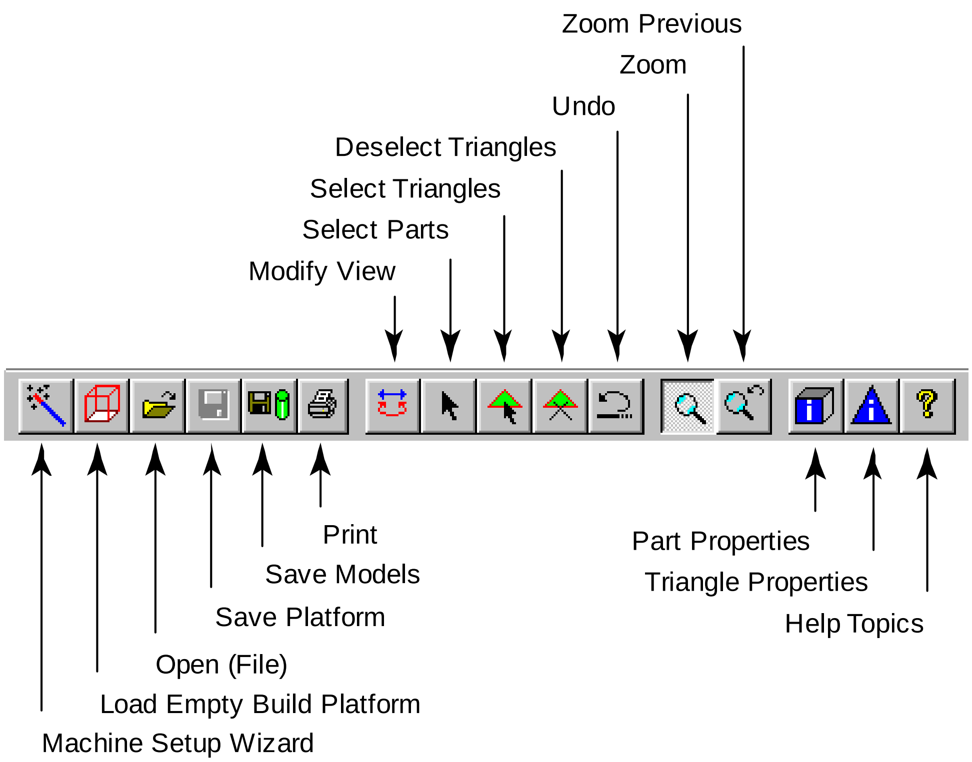


Figure 30. Main Toolbar

Edit Toolbar

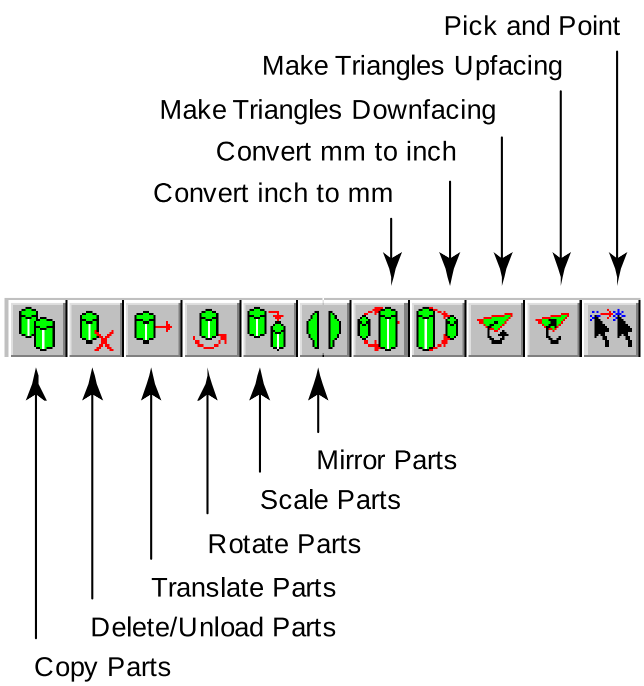


Figure 31. Edit Toolbar

Tools Toolbar

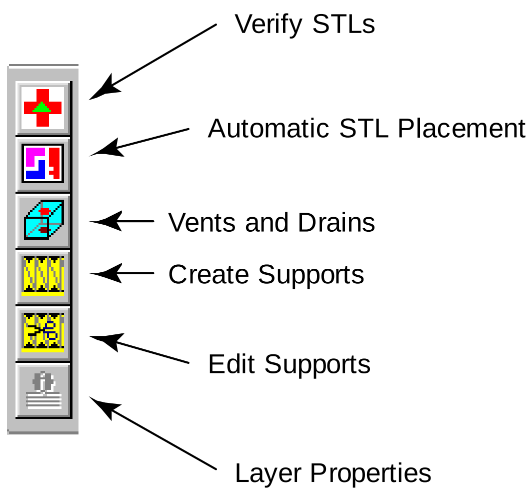


Figure 32. Tools Toolbar

Build Toolbar

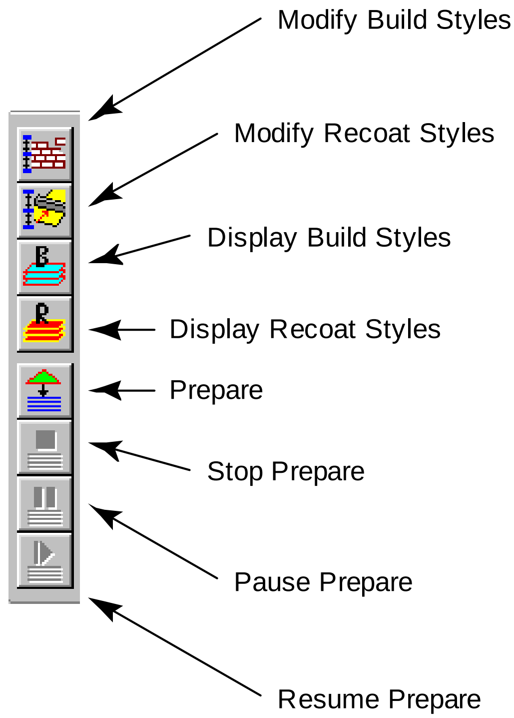


Figure 33. Build Toolbar

Selection Dialog Bar

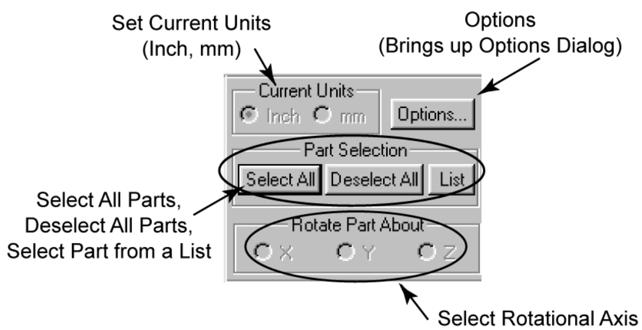


Figure 34. Selection Dialog Bar

View Dialog Bar

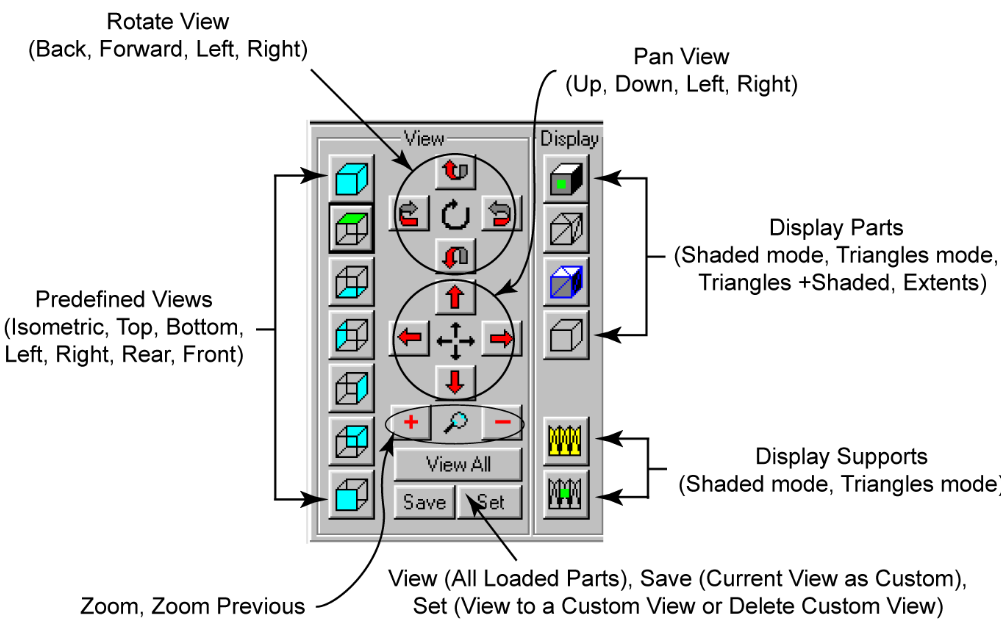


Figure 35. View Dialog Bar

Display Dialog Bar

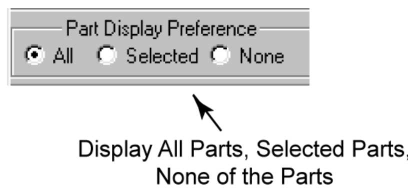


Figure 36. Display Dialog Bar

Status Bar

The Status Bar (Figure 37) displays information about the operation mode, platform configuration, machine type, units, part build style and part recoat style for the components being displayed in the display area.

Figure 37. Status Bar

Platform/Part Display Area

Finally, the last remaining, and largest, area of the program's viewing area, displays the platform and parts you have loaded.

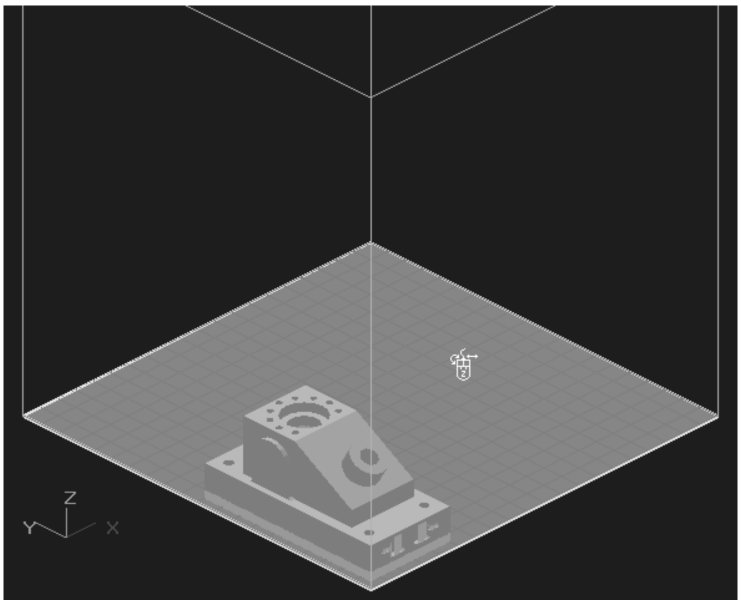


Figure 38. 3D Lightyear Software Part Viewing and Display Area

Quick Start: Step-by-Step

The easiest way to learn the basic functions of the 3D Lightyear software is to actually use it to go through the steps of preparing your part for building on an SLA machine. This section serves as a VERY basic tutorial. First, it gives you some familiarity with the 3D Lightyear STL viewing capabilities,

- LOAD AND VIEW an STL file
- CHANGE THE VIEW of the workspace

then It leads you step-by-step through the processes necessary to:

- SET UP a new platform
- CHANGE THE ORIENTATION of the part
- VERIFY the part
- CREATE Supports for the part
- SAVE your work
- PREPARE (slice and merge) the build file

Loading and Viewing an STL File

First, we will load and view an STL file, and explore some of the ways to change the view settings.

1. **Launch the 3D Lightyear software program, just as you would any other Windows program, by clicking the...** 

icon, positioning the cursor over the "Programs" menu, then clicking the "3D Lightyear 1.00" menu item, as illustrated in Figure 39.

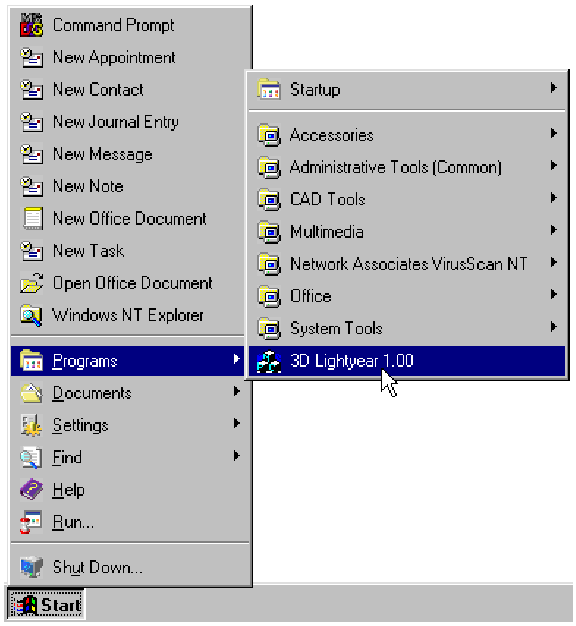


Figure 39. 3D Lightyear 1.00 Menu

2. Click the "Open"...  **icon on the Main Toolbar (or pull down the "File" menu and choose "Open..."), to bring up the "Open File" dialog as illustrated in Figure 40.**

NOTE!

To save space, during these exercises we will dispense with the parenthetical instruction, as in the above step, about the availability of functions from the pull-down menus. Just be aware that there is usually a pull-down menu alternative to access 3D Lighyear software functions.

The folder...

`"c:\program files\3DSystems\3D Lightyear\STLs"`

should be displayed. If it isn't, use the standard Windows tools to navigate to the above-named folder.

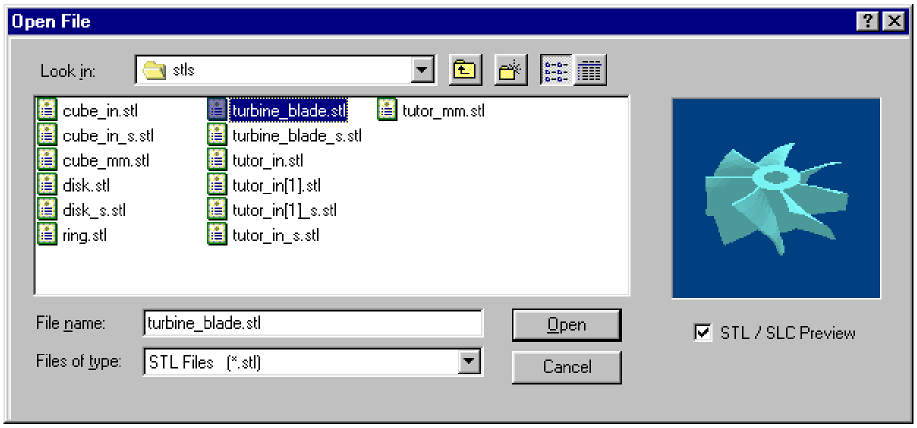


Figure 40. Open File Dialog

3. **In the lower-right portion of the dialog, look at the "STL / SLC Preview" checkbox. If it isn't checked, click on the box. Position the pointer over the filename, for example, "turbine_blade", then click. Notice that a preview of the part is shown in the window.**

   Click the... Open **button. (Alternatively, you can double-click the filename "turbine_blade" which automatically "opens" the file.)**

   The workspace will look something like that shown in Figure 41.

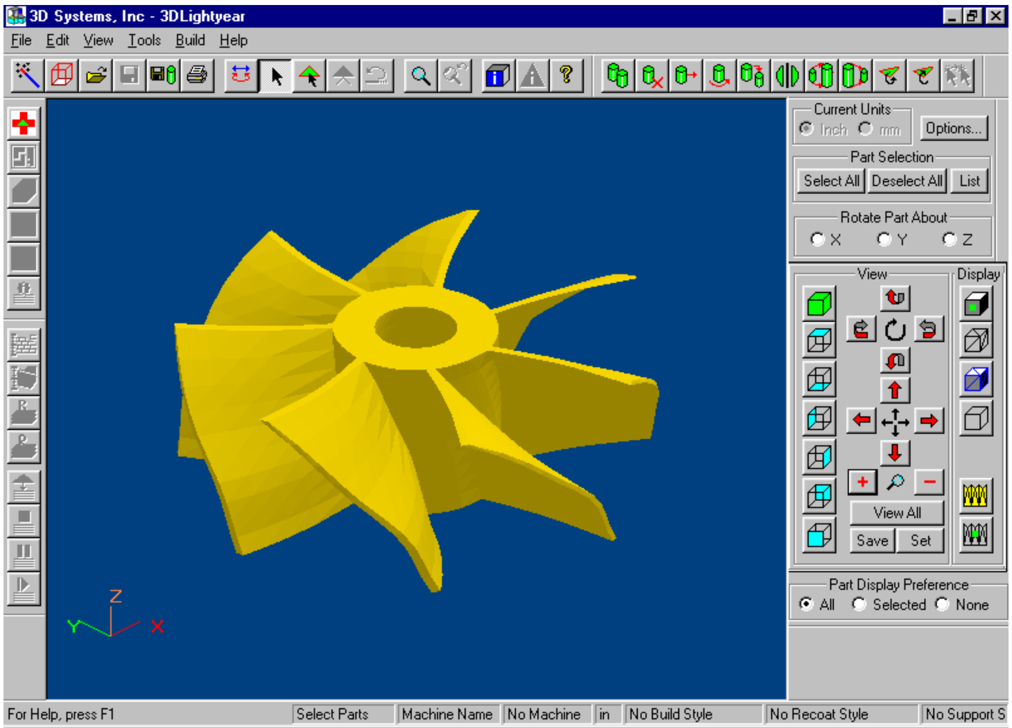


Figure 41. 3D Lightyear Workspace with Turbine Part

4. Notice that the mouse cursor looks like... **. Whenever this cursor is active, you are working in the "Modify View (Trackball)" mode. Click and hold the left mouse button, and drag the mouse across your mousepad.**

That's how you "rotate" the view.

5. Click and hold the right mouse button, and drag the mouse across the mousepad.

That's how you "pan" the view.

6. Click and hold both mouse buttons, and drag the mouse across the mousepad.

That's how you "zoom" the view.

Of course, as in all other Windows programs, there's more than one way to do anything.

7. **Experiment with clicking the "Rotate"... , "Pan"... , and the "Zoom"... icons on the "View Dialog Bar" at the right side of the workspace. Notice the rotating, panning and zooming functions are also available here.**

And there's even another way to zoom into a particular section of the part.

8. **Click the "Zoom"... icon on the Main.**

   Notice that the cursor changes to... . Position the cursor just to the top left of the part. Click and hold the left mouse button and drag the cursor down and to the right. As you do, you will see a rectangle being formed. When the rectangle encompasses the part, let your finger off the left mouse button. See how it zooms in to the bounded area. Do it again. The feature allows you to zoom into very small areas of the part.

9. **Now click the "Zoom Previous"... icon on the Main Toolbar. This is the "Zoom Previous" function. It steps you back through the previous zoom levels; it's kind of like "zoom undo."**
10. **Now let's learn about the "Pre-defined" views. Click the "Isometric View"... icon on the "View Dialog Bar".**

    Now, click the "Top View"... icon, and finally the "Left View"... icon.

See how the view changes? Again, you can always find another way to do the same thing.

11. **Click the "View" pull-down menu. You will see a "Pre-defined Views" sub-menu that allows you to select these same views.**

So far, we have seen the "turbine_blade" part in shaded view. STL files are really comprised of triangles, right? What if we want to view the triangles? Let's do it.

12. Click the "Triangles"... icon on the View Dialog Bar.

Now, click the "Triangles + Shaded"... icon. It's the Shaded Triangle view. And finally, if you just want to view the extents of the part, click the "Extents"... icon.

NOTE!
The Extents view is helpful when viewing a highly-tesselated (many triangles) parts. The more highly tesselated a part is, the longer it takes the software to render a new view. The problem with the extents view, though, is that it does not give you a sense of the part geometry. A compromise between the slow rendering of a highly tesselated part while maintaining the geometry, is to render the part with "points" during any manipulation. Try this.

13. Change back to the "Shaded Mode" view by clicking the "Shaded View"... icon. Click the "Tools" pull-down menu, then click "Options" menu item. This opens the "Options Dialog" as illustrated in Figure 42. Click the "Show Points" radio button, then click the... OK button. Change back to the "Modify View" mode by clicking the "Modify View (Trackball)"... icon. Now, try rotating and panning the part.

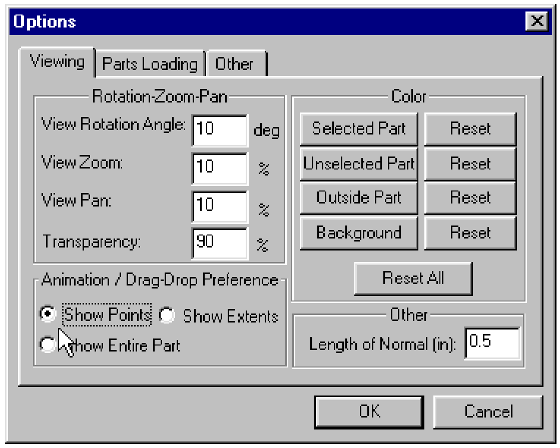
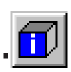


Figure 42. Options Menu, Show Points

See how the rendering changes to display the vertex points of the triangles during the "movement" of the part? This allows you to see the part's geometry without slowing down the system trying to render a shaded part. If you use the "Show Entire Part" from the "Tools", "Options" dialog, the part will remain rendered in shaded mode. Depending on how highly tesselated the part is, you may see a significant slowing of your system as it tries to render intermediate views while rotating, panning, or zooming. Note, however, that the turbine_blade part only has 2,750 triangles; hardly a difficult part to render quickly.

How do we know how many triangles are in this part? It's easy.

14. Click the "Part Properties"...  **icon which opens the dialog illustrated in Figure 43.**

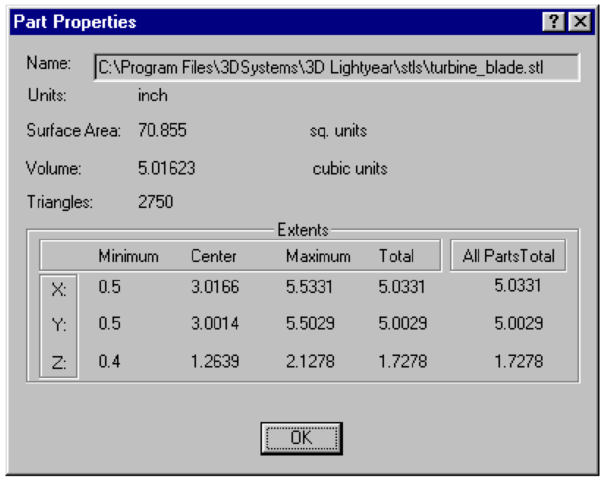


Figure 43. Part Properties Dialog

Along with the number of triangles, this dialog gives you information about the surface area, volume, and position in CAD space of your part.

Speaking of CAD space. Notice that in the preceding exercises, we were only changing the view of the 3D Lightyear software's workspace. Nothing we did changed the orientation, position or size of the part itself. Also, there was no connection between this STL file and any SLA machine configuration or build and recoat styles. We simply were viewing an STL file.

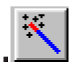
In the next section, you will learn how to designate a platform that carries the machine type, resin and build parameter information, and applies that information to the STL files to prepare the build file(s).

Setting Up a New Platform

Before you can associate STL files with a specific SLA machine, resin, and build and recoat styles, you must set up a "machine" to house this information. The 3D Lightyear software provides an easy way to input this information through the "New Machine Setup Wizard."

A “wizard” is a kind of electronic questionnaire. Based on the “answers” you enter in the blanks of this questionnaire, 3D Lightyear's New Machine Setup Wizard creates a Platform Configuration. The Platform Configuration contains all the information you will need to load, create supports for, and prepare parts for building on your SLA.

Use the New Machine Setup Wizard as follows:

1. **Click the "Machine Setup Wizard"...**  **icon to start the wizard. The first dialog looks something like the one in Figure 44.**

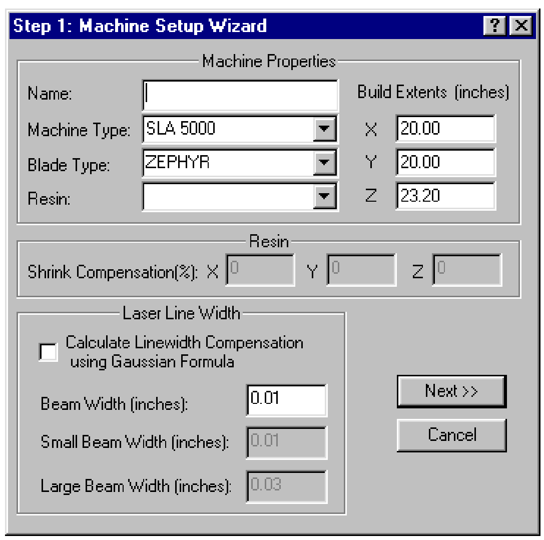


Figure 44. Step 1: Machine Setup Wizard Dialog

2. **Fill out this dialog entering the following information:**

Machine Name

The Machine Name is a convenient means of identifying this machine configuration later on. It is saved with your Build Platform file, so that you can “re-call” a set of parameters to the 3D Lightyear software workspace easily.

You may find it handy, particularly in situations where a facility has more than one SLA system, to devise a system by which you can identify particular SLA setups by their name.

For example, an SLA 5000 loaded with SL 5510 Resin that is to be used to build parts dimensioned in millimeters with the QuickCast Build Style might be given a name such as:

```
5000_5510_mm_QC
```

NOTE!

Machine names are limited to 128 alpha-numeric characters. No spaces or special characters are permitted. You will be prompted to change your machine name if these "rules" are broken.

If your facility has more than one SLA 5000 be operating with similar parameters, you can add more identifiers to differentiate between machines…

```
5000_alpha_5510_in_Qcast

5000_bravo_5510_in_Fast

5000_charlie_5510_in_Tooling
```

…for example.

For this example, type "5000_5510_in_Exact" for the machine name.

Machine Type

This field in Step 1 of the **"Machine Setup Wizard"** is a pull-down list with selections for the SLA model (SLA 7000, SLA 3500, etc.) for which you will be preparing parts.

NOTE!

A platform file that is setup and prepared for an SLA 5000 in the 3D Lightyear software CANNOT be built on an SLA 7000 in Buildstation. A file prepared for an SLA 190 CANNOT be built on an SLA 250, etc. The machine type selected here must match the machine type on which the parts will be built.

For this example, use the pull-down selection box to select the "SLA 5000" as your machine type.

Blade Type

This field allows you to set the type of recoating blade that is installed on your SLA system. Because all SLA 5000s have “Zephyr” recoating blades, that is the only choice offered for this machine.

For those machines that have either "Zephyr™" or "regular" blades, (SLA 250s and SLA 500s) you would need to select which blade your machine has. All other large machines default to "Zephyr" and the SLA 190 defaults to "NONE".

Resin

This pull-down list shows you the available CibaTool Resins for the type of machine you selected. Later in this guide we will explain what to do if you are not using a CibaTool resin.

For now, just select SL5510.

Build Extents

These fields show the default maximum extents for the type of machine you have selected. These are editable fields within very narrow limits. When you have gained some experience with your particular machine, you may find it possible to increase the extents and build slightly-larger-than-default-sized parts.

For now, just accept the default values.

Shrink Compensation (only for 190/250 users)

These fields show the default Shrink Compensation values. All UV-photosensitive resins shrink when cured. In this example, because we have chosen the SLA 5000 where the shrink values are entered at the build station, these values are zero, and non-editable. If you had chosen an SLA 190 or SLA 250 machine, you would be able to enter the shrink values you desire.

Because we are setting up an SLA 5000, you cannot edit the shrink values.

Laser Line Width/Beam Width

This section of Step 1 of the New Machine Setup Wizard prompts you for values from your SLA machine that the 3D Lightyear software uses when preparing your parts and creating the build files.

Notice that the entry field is for the ***"Beam Width"*** (or "***Beam Widths***" when setting up a platform for the SLA 7000) of the laser beam at the vat.

The ***"Beam Width"*** value(s) is/are used to *calculate* the *cured line width* value that 3D Lightyear software uses for line width compensation.

The values for the ***"Beam Width"*** fields are set to known defaults by 3D Lightyear software based on the selection you make for Machine Type. If you know the actual beam width, you can enter it here so that the calculations for cured linewidth are of the highest accuracy. If you do not know the actual beam width, just accept the default value(s).

You can also click the check box to cause 3D Lightyear software to use the **"Gaussian Formula"** to calculate the linewidth compensation. Without using the formula, the calculation for linewidth compensation is simply one-half the beam width. With the formula, the calculation takes other factors into account when determining linewidth compensation.

3. **Click the... Next >> button to continue to Step 2 of the wizard.**

The next screen you see will look something like Figure 45.

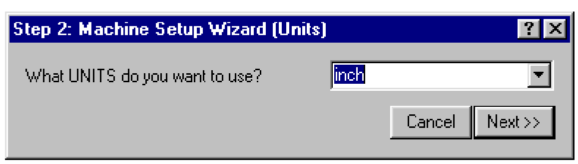


Figure 45. Machine Setup Wizard, Units

Units

This screen prompts you for the unit of measure that will be in effect on the Build Platform during this work session.

For now, choose "`inch`".

4. When you have chosen the unit of measure to use during this session, click the... Next >> button to continue with Step 3 of the wizard.

The next screen you see will look something like Figure 46.

Build Style

This step of the wizard allows you to specify the Build Style in effect as you load parts into the workspace and onto your Build Platform. There are four Build Styles available. Not all Build Styles are available for every Machine Type/Resin combination.

- FAST
- EXACT
- TOOLING
- QuickCast

Figure 46. Step 3: Machine Setup Wizard, Build Styles

Later, you can change Build Styles, change the parameters of existing styles, and apply styles to a specific range of a part or supports. The name of the style showing in the selection field of this dialog, however, will serve as the default Build Style for the Build Platform.

In our example here, select the "Exact" style.

5. When you have chosen the Build Style, click the... Next >> button to continue with Step 4 of the wizard.

The next screen you see will look something like Figure 47.

Layer Thickness

This dialog allows you to choose the Z-axis increment the 3D Lightyear software uses when slicing the parts during the Prepare process.

Figure 47. Step 4: Machine Setup Wizard, Layer Thickness

The values that appear on the pull-down list in this dialog represent default build styles that have been developed by 3D Systems Process group. They are determined by the type of SLA, the type of resin, and the type of recoating blade chosen in the earlier steps of the setup wizard.

Select "0.0040 in" for our exercise.

5. **When you have chosen the appropriate "Layer Thickness", click the...** 

button to continue to the last step in setting up a new machine platform.

The next screen you see will look something like Figure 48.

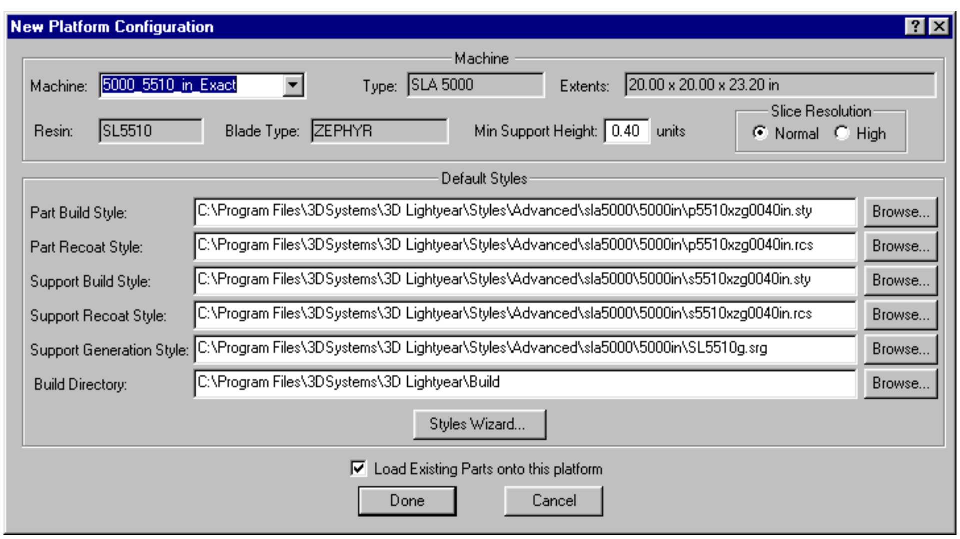


Figure 48. New Platform Configuration Dialog

This dialog summarizes all of the choices you have made using the wizard. You can use this dialog to “change your mind” about Build Styles, Recoating Styles, the destination directory for your BFFs, etc.

If you wanted to change to other or special build styles (for example, custom styles you have previously saved), you could use the... Browse... buttons to display the Windows Explorer facility that allows you to change the style files showing in the various fields.

For now, just click the... Done button.

Note that now the part/platform viewing space displays a representation of the platform and build envelope for the target machine as illustrated in Figure 49.

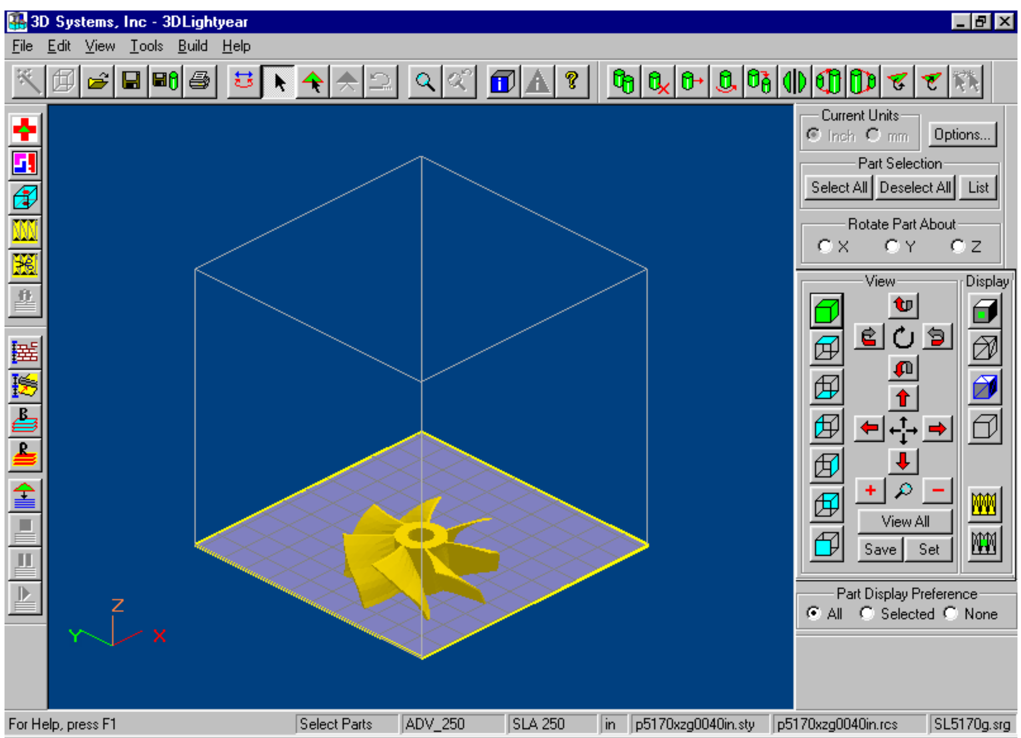


Figure 49. 3D Lightyear Workspace with Platform

If you have been following the procedures up to this point, you should see the "turbine_blade" part on the platform. If you do not see the part, use the "Open"... icon and the "Open File" dialog to locate and load this file for the next part of our tour.

Now that we have a platform open, our first step toward preparing our parts for building is to orient them within the confines of the platform envelope.

Orienting Parts on the Platform: Translation and Rotation

Why Orient Parts?

Parts must be oriented so that they will build properly. That means that all parts should be contained within the positive octant of CAD space and within the Platform extents. Parts outside this octant or outside the platform extents, cannot be prepared or built at all.

In addition, the bottom surface of each part must be at the proper distance from the platform so that the part can be recoated safely and that adequate support structures can be built. We cover support creation in a later section.

Also, we (usually) do not want parts to overlap with one another.

And finally, we want parts oriented to account for trade-offs in the building process: that is, we can orient the parts to build them faster, to give a certain surface, minimize support removal effort, or to obtain the highest accuracy.

We will save the details on these trade-offs for the Advanced section of this guide. Here, we will just illustrate some of the ways to translate and rotate parts on the platform.

Before we go further, let's load a second part on the platform. Use the **"Open File"** command to load the "tutor_in", or some other, part.

Selecting Parts

When using certain 3D Lightyear functions such as translation and rotation, we want to operate on a single part at a time. To do this, we must first select the part we want to work with. As usual with 3D Lightyear software, there are many ways to select and deselect parts.

1. **Alternately click the... Select All and... Deselect All buttons on the "Selection Dialog Bar".**

As you click these buttons, notice how the color of the parts change. The default color for Selected parts is yellow; for Unselected parts, it is light blue. (Although we will not explore this aspect of 3D Lightyear software here, be aware that these default colors can be changed using the **"Tools" > "Options"** dialog.)

That's fine, but how can you select an individual part?

2. **Click the... Deselect All button. Now click the... List button.**

You will see the **"Select Parts"** dialog as illustrated in Figure 50.

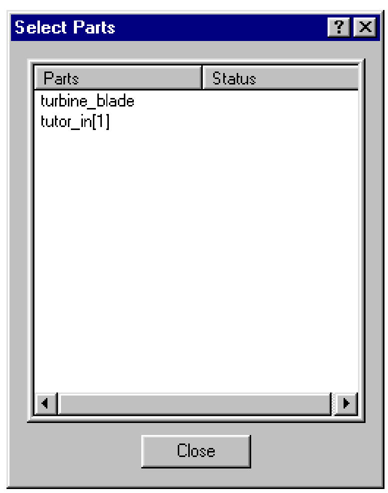


Figure 50. Select Parts Dialog

Notice the dialog lists the loaded parts with nothing in the status column. That is because there are no parts selected.

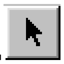
3. Click the "turbine_blade" file name.

Notice the word "Selected" appears now in the Status column.

4. Click the... 

button.

Notice now, the "turbine_blade" part is yellow indicating that it is selected. Here's another, more direct, way to select a part.

5. Click the "Select Parts"...  **icon on the Main Toolbar.**

Notice the cursor changes to... . While this cursor is active, you are in the **"Select Parts"** mode.

6. Click on the Unselected part.

Notice the part turns yellow indicating it is now selected. But, now both parts are selected. Is there a direct way to deselect parts? Of course there is.

7. Press and hold the <Ctrl> key on the keyboard. Now click on a part.

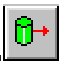
The part is deselected.

All right, now we know how to Select and Deselect parts. Let's learn how to position (translate) parts on a platform.

Translating Parts

Translating a part is simply moving it with respect to the platform. The platform exists with one of its corners at the 0,0,0 point in CAD space, and extends into positive CAD space to the extents of the SLA build envelope. Our parts must be within this area before we can prepare them for building.

One way of translating a selected part is to use the "Translate Selected Parts" dialog.

1. Click the "Translate"...  **icon on the Edit Toolbar.**

This brings up the **"Translate Selected Parts"** dialog as illustrated in Figure 51.

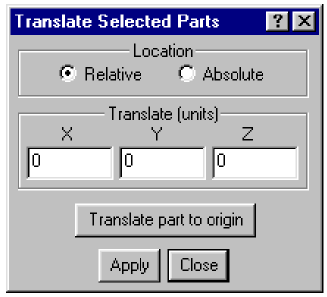


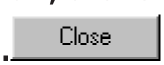
Figure 51. Translate Selected Parts dialog

In this dialog you specify the X, Y, and Z values for the translation. Notice that the translation can be **"Relative"** or **"Absolute"**.

Relative translation positions the part X, Y, and Z units from where the part is currently located. Absolute translation positions the part X, Y, and Z units from the origin (which is X=0, Y=0, Z=0).

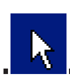
Notice also that there is a special button you can use to translate your part to the origin. Sometimes this is handy when a part exists so far out in CAD space that you can't even see it. This is a great way to get your part to a known location quickly.

2. For now, click the... 

button and then the... 

button.

As you would expect by now, there are easier, more direct ways to position parts. Try this.

3. Click the "Top View"...  **icon on the View Dialog Bar. Make sure you are in the "Part Selection" mode, that is the cursor looks like...** **.**

Now, position the cursor over a selected part, click and hold the left mouse button, and drag the mouse and the part across the platform. When you get the part positioned where you want it, lift your finger off the mouse button.

This is called **"Drag and Drop"** translation. As you can see, it allows you to visually position the part where you want it.

There are other ways to translate parts with the 3D Lightyear software, however we are only going to explore one more here. It's called **"Automatic Part Placement"**. First, let's move both the parts to the origin.

4. **Click the... Select All button. Then click the "Translate"... icon to bring up the "Translate Selected Parts" dialog, and click the.... Translate part to origin and then the... Close buttons to translate both parts to the origin.**

5. **Now, click the "Automatic STL Placement"... icon on the "Tools Toolbar".**

Often when you load a large number of parts, they will overlap. **"Automatic Part Placement"** is a fast way to separate them so you can easily make fine placement adjustments.

All right, now we have the parts separated, in the positive octant, and all within the build platform extents. What if we want to build the part with a different side parallel to the X axis, or build it on its side? To do this we need to rotate the part.

Rotating a Part

As with the other functions, there are a number of ways to rotate a part. We will explore just one of them here.

Select a single part on the platform. If you have been following these exercises, deselect the "turbine_blade" part and select the "tutor_in" part.

1. **Click the "Rotate"... icon on the Edit Toolbar.**

This brings up the **"Rotate Selected Parts"** dialog as illustrated in Figure 52.

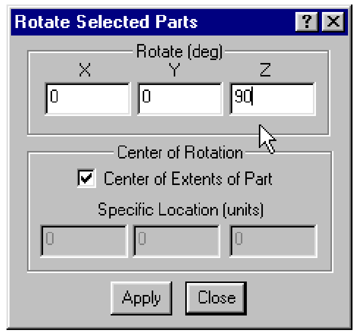


Figure 52. Rotate Selected Parts dialog

2. Type "`90`" into the Z entry box, then click the... Apply button.

You see the part rotates 90 degrees. Also notice that it rotated about the center of its extents. That is because the **"Center of Extents of Part"** box is checked. Most of the time that's what you will want. To rotate the part about a specific coordinate, uncheck the box and enter the coordinate values.

3. Now, click the... Close button to close the dialog.

4. Click the... Deselect All button on the "View Dialog Bar".

Notice the part is now rendered in red, indicating that it is not fully on the platform. Let's leave it that way for a moment, and explore a very handy function.

If you have been following these exercises, the last operation rotated the part partially off the platform as illustrated in Figure 53.

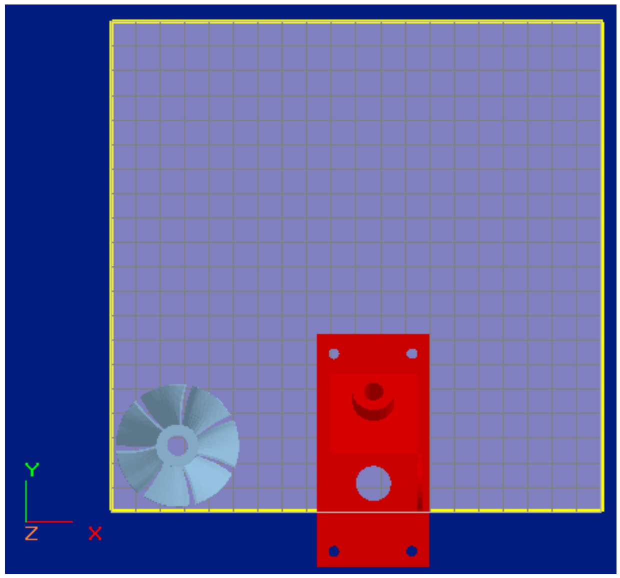
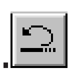


Figure 53. Part Rotated Off Platform, rendered in Red

The Undo Function

Some times as you are moving and changing things on your platform, you will want to revert back to a previous state. The 3D Lightyear software has a quick way to get you back, step-by-step.

1. Click the "Undo"...  **icon on the "Main Toolbar".**

This is the "Undo" function. Notice that the rotation that we last applied to our part, which put it off the platform, has been "undone" and the part is back to the way it was before we rotated it.

That's it for part positioning. There are other functions, such as **"Copy"**, **"Scale"**, and **"Mirror"** that allow you to change the parts on your platform, but we will leave those for later sections. Now, we want to go to the next stage in the preparation process: verification of the STL files.

Verifying the Integrity of STL Files

3D Lightyear software's **"Verify"** tool "finds and "fixes" problems with your STL files. It is always advisable to check the validity of your STL files.

The Verify function in the 3D Lightyear software is greatly improved over the previous version in that it works about 150 times faster. This improvement allows you to check every STL file without degrading your part preparation productivity.

We will leave the explanation of the various problems an STL file can have and how the Verify function works until later in this guide; here we will just take you through the steps of verifying an STL file.

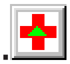
To use ***"Verify"***, you must have already loaded parts into your workspace.

NOTE!
Do not Verify parts for which supports have been generated, unless you intend to delete and re-generate the supports.

Verify eliminates the necessary part STL-to-Supports association created when supports are generated. Supports, if they exist, will be invalidated if Verify is executed on a part after they are generated.

NOTE!
Unlike earlier versions of 3D Systems' part preparation software, the 3D Lightyear software Verify function *DOES NOT* require that parts reside in positive CAD space (the positive octant, where all triangle vertices are non-zero and non-negative numbers).

You *WILL*, however, have to translate and otherwise orient all parts in the positive octant before executing Support Generation and/or Prepare (slice).

1. Click the "Verify STL"...  **icon.**

The "Verify STL" dialog (Figure 54) opens.

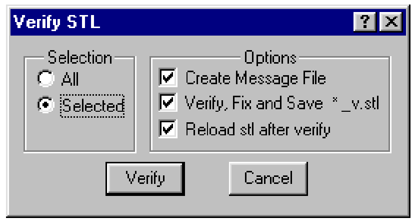


Figure 54. Verify STL Dialog

2. Check the options you wish to invoke for the verification of the STLs in your workspace, and click the... 

button.

If the "Create Message File" option is enabled, the Information Dialog Bar appears at the bottom of the workspace and displays a running list of messages detailing status of Verify's analysis of the parts being verified.

The information in the Information Dialog Bar is written to your PC's hard disk as an ASCII text file with the name "[stlfilename].vmf", where "stlfilename" is the name of the first STL file chosen to be verified.

Figure 55 illustrates an example of the text from a typical verification executed on an STL file named "cube_in.stl".

```
Part Extents:
0.5 <= x <= 1.5
0.5 <= y <= 1.5
0.3 <= z <= 1.3
12 output triangles
12 input triangles
0 degenerate sided triangles removed
0 narrow-gap filling triangles created
0 wide-gap filling triangles created
0 triangles reoriented
0 unmatched triangle sides
1 distinct shell:
Shell volume: 1   (num triangles: 12)
0.5 <= x <= 1.5
0.5 <= y <= 1.5
0.3 <= z <= 1.3
C:\3D Systems Programs\Lightyear\stls\cube in.stl was GOOD
```

Figure 55.   Example of Verification

NOTE!
By default, the VERIFY function creates a new STL file for each STL you choose. This new file is given a "_v.stl" suffix, and written to the same directory as the original STL file, unless you specify otherwise.

If you selected "Reload STL after Verify" in the "Options" section of the dialog, your workspace will now display the verified STLs.

If you did not choose to replace your existing files, you will have to unload the parts you currently show in your workspace and load/open the newly-created, verified files.

Now that we have STLs that are known to be good, let's go on the next phase of the preparation process: creating supports.

Creating Supports

What are "Supports"?

The grid-like structures that are generated by 3D Lightyear and attached to the downfacing regions of your parts are called "Supports".

There are three phenomena that occur during the SLA build process that make it necessary to create supports for your parts.

First, supports provide a small, easy-to-remove, break-away region between the SLA build platform and your parts. If an object were built without supports, as the bottom-most layers of that object were cured by the SLA, solidified resin would become enmeshed in the openings of the SLA's platform. This condition would make it difficult—if not impossible—to remove finished parts without damaging them in the process. See the illustration in Figure 56.

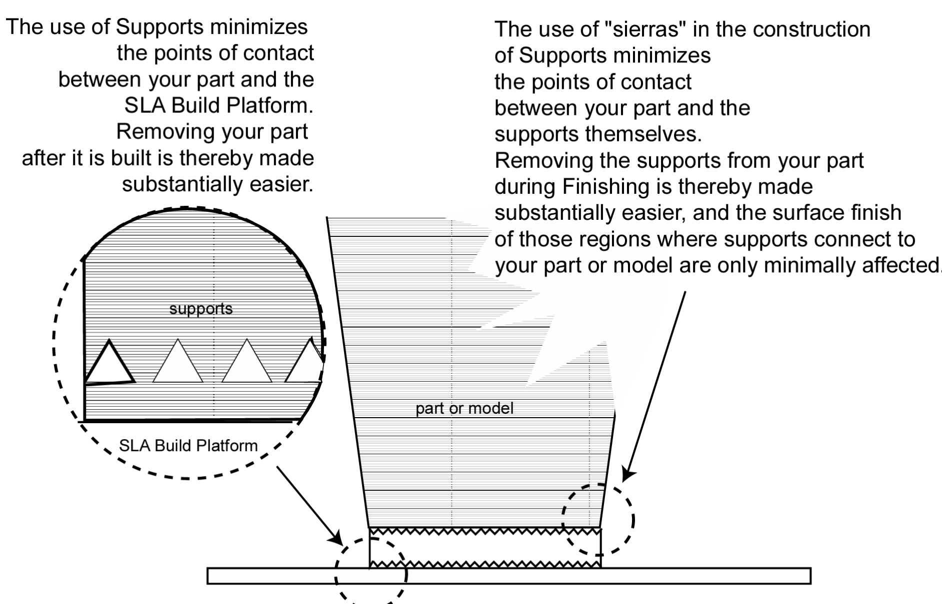


Figure 56. Supports

Another reason for supports is that they provide a safeguard for those areas of your parts that left unattached would tend to drift in the liquid resin due to the action of the SLA Recoating System. Supports “anchor” your parts to the SLA build platform so that, as the recoating blade sweeps over the vat, recoating the just-cured top layer of the object(s) that is being fabricated, the forces of surface tension do not move or carry any portions of the (object) layer with it. Such an occurrence would distort part geometry and cause a build “crash”. See the illustration in Figure 57.

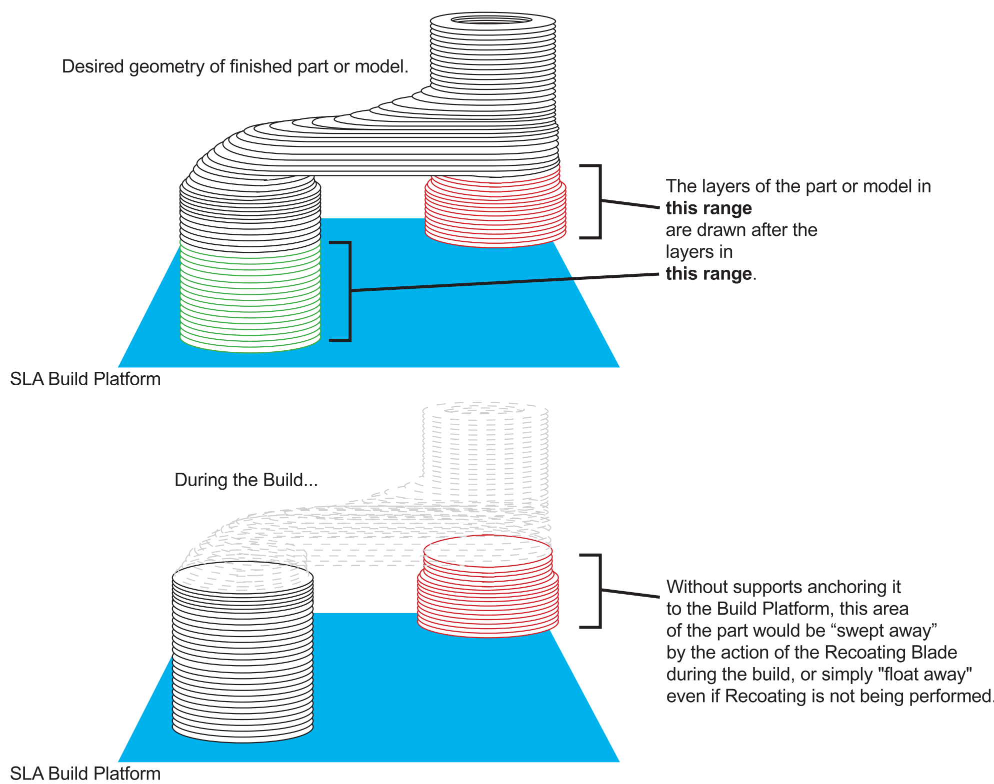


Figure 57. Supports and Anchoring

Finally, as their name implies, supports provide a “buttressing” of those areas of your parts that, in a less-than-fully-cured state, would otherwise “sag”, distort, and/or separate due to gravity…as illustrated in Figure 58.

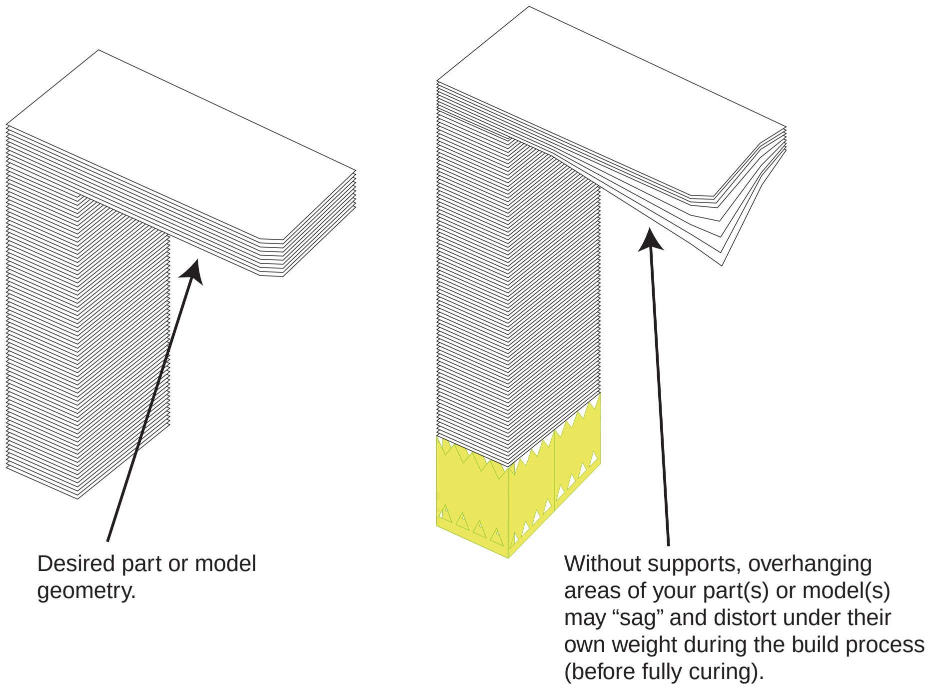


Figure 58. Overhangs

NOTE!
3D Lightyear *DOES NOT* create supports for SLC files. These files should already have support structures attached to them when they are loaded on to the Build Platform in your workspace.

Generating and attaching supports to your STL files is one of the principle functions of the 3D Lightyear software. Generating them is one of the necessary steps for preparing STL files for building on your SLA. Once generated and “optimized”, they are Prepared (sliced) along with the other objects on the 3D Lightyear Build Platform, incorporated into the build file(s), and built as part of the SLA job that fabricates your parts.

What are "Support-Generating Styles"?

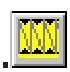
Do not confuse Support ***Build*** Styles with Support ***Generation*** Styles. In addition to Build Style files, which comprise the parameters used by the SLA software for ***building*** your parts and their supports, there are also styles that govern the manner in which 3D Lightyear software ***generates*** supports.

A file comprising support-generating parameters is called a "**S**upport a**RG**ument" or *"**SRG**"* file. 3D Lightyear distinguishes these files from others by their *"**.srg**"* filename suffix.

Generating the Supports

Before you generate supports for your parts, make sure you have:

- created or loaded the appropriate Build Platform (specifically the SLA type) in your workspace.
- Verified all the STL files
- oriented your parts in the positive octant of your workspace, and inside the "legal" areas of the build envelope with enough room for supports.

1. Click the "Create Supports"...  **icon on the "Tools Toolbar".**

The **"Create Supports"** dialog similar to the one shown in Figure 59 opens.

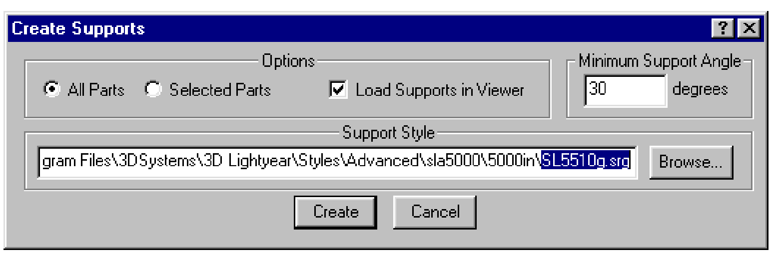


Figure 59. Create Supports Dialog

2. Click the... 

button to begin the support generation process.

During support generation, you will see a series of messages flash across your workspace as the 3D Lightyear software Support Generator examines the geometry of your parts, determines how best to support it (them), and creates the supporting structures based on the Support Style selected when you set up your Build Platform (Machine).

As part of the supports generation process, a separate "support" STL file is generated and saved in the same directory as the part STL file. This subsidiary STL consists of the supports for the part to which it is attached. Each support STL file is given the same name as the part to which it is physically attached on the Build Platform, with an additional “.s” before the STL suffix; “turbine_blade_s.stl”, for example.

NOTE!
In addition to a file named “[filename]_s.stl” (where "[filename]” is the name of the STL file for which supports are created) 3D Lightyear also creates “[filename].ODF” and “[filename].CTL”. The purpose of these and other files created during the build file preparation process are explained in subsequent sections of this guide.

NOTE!
If you create supports for Verified STLs—which is what you’re supposed to do—the “_s” addition to the support STL filenames is immediately preceded by “_v”, yielding the following, for example: “Dolphin_v_s.stl”, “turbine_v_s.stl”, or “manifold_v_s.stl”.

Assuming you have selected the option to display the supports in the workspace, when the process of generating supports is complete, the view of your parts in the workspace will now include their newly created and attached support structures.

Figure 60 shows two typical parts on a Build Platform. The parts differ only in that one of the parts has had supports generated for it by 3D Lightyear, the other has not.

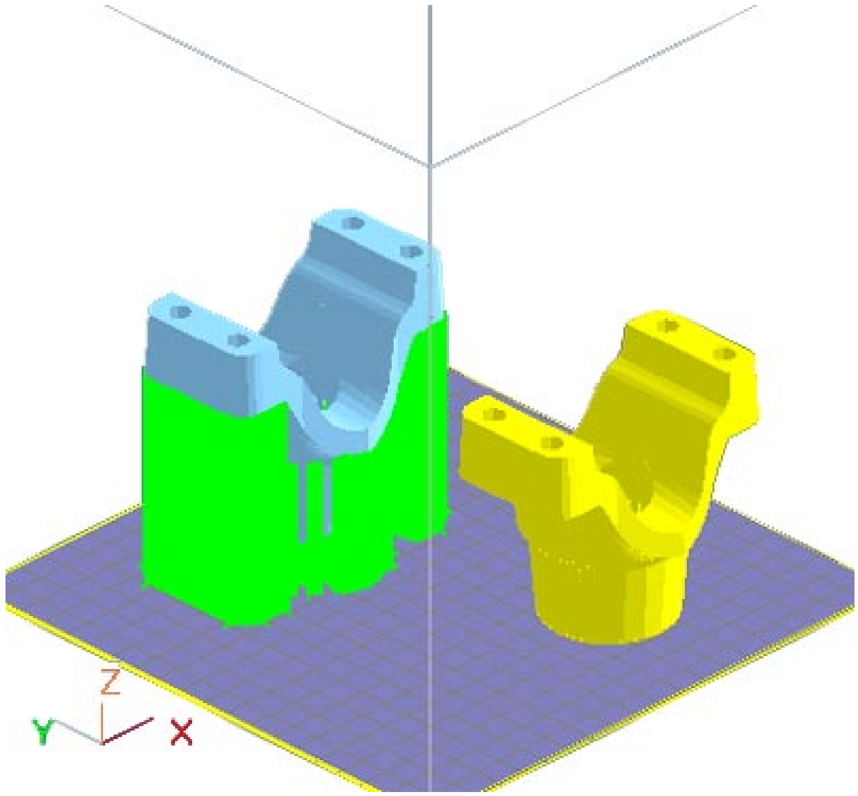


Figure 60. Build Platform (one part with Supports, and one without)

NOTE!
Even if you decide not to enable the display of supports in your workspace, *they are still created,* and the file "filename]_s.stl" is still written to your disk.

NOTE!
Once you have created supports for a part, *DO NOT TRANSLATE IT, SCALE IT, MIRROR IT, OR OTHERWISE CHANGE ITS ORIENTATION in any way* in your workspace. If you do, you will not be able to edit the supports. Support editing is detailed in the Advanced section of this guide.

Now we are ready for the final part of the platform preparation process, Prepare. But before we do that, it is a good idea to save your work.

Saving Your Work

The following **"Save"** options are available from the **"File"** menu.

Selecting **"Save[d]"** allows you to save all of the selected and modified STL and SLC parts to their default file names.

Selecting **"Save All"** allows you save all of the modified STL and SLC parts to their default file names.

Selecting **"Save As..."** allows you to save all of the selected STL and SLC parts with the option of changing the file name.

Selecting **"Save Build Platform"** allows you to save a new platform file or overwrite an existing platform file.

Selecting **"Save Build Platform As..."** allows you to save a new or existing platform file with a different name.

"Preparing" the Build File(s)

The Prepare Function

The final task you need to perform in 3D Lightyear to get your files ready for transferring and subsequently fabricating on an SLA system is to run "Prepare". Often referred to as "Slicing", or "the Slicing Function", this last step actually involves both the conversion of the parts on the Build Platform into a series of stacked, cross-sectional layers ***and*** the combining (converging) of all the objects into a single, optimized build format—the BFF if you are preparing files for building on SLA 3500s, 500s, 5000s, and 7000s; or the ".v", ".r", ".l", and ".prm" file suite if you are preparing for building on SLA 190s and 250s.

Saving the prepared platform also creates a Platform File (distinguished by its ".pla" filename suffix). The Platform file saves all the information about the objects on the Build Platform, their orientation, the Build Styles applied, any scaling, etc. Later, you can recall an entire 3D Lightyear software work session by opening the Platform File.

NOTE!
Prior to executing the Prepare function, make sure that all the objects on the Build Platform have the appropriate supports attached to them, and that both the supports and all of the parts are oriented correctly, i.e., completely on the platform and within the allowable Build Extents for the type of SLA on which you intend to build them.

There are two means of carrying out the "Prepare" function:

- **"Prepare All…"**, which you can only start by choosing it from the "Build" pull-down menu, executes the "slice" and "converge" operations on all SLC and STL files on the Build Platform.

- **"Prepare…"**, which you can start by clicking the **"Prepare"**... icon on the Build Toolbar, performs the "slice" and "converge" operations only on those parts on the Build Platform whose associated SLI files (if they exist) have been changed since the last prepare function.

NOTE!

The "Prepare..." function (as opposed to "Prepare All...") can save you processing time, since it only processes newly-changed files, "ignoring" any files that might have been successfully sliced and built previously.

To **"Prepare"** your file or files:

1. **Click the "Prepare"... icon, or pull down the "Build" menu and choose "Prepare..."**

   OR...

   Pull down the "Build" menu and choose "Prepare All..."

You are presented with the message box illustrated in Figure 61.

Figure 61. All modifications done to parts will be saved

This message informs you that, by default, the **"Prepare"** function overwrites the STL and SLC files that are on the Build Platform—if you have changed them.

NOTE!

If you have verified your STL files, Prepare overwrites the [filename]_v.STL for each file it slices with the associated information on sizing (scaling), and orientation (make up- or down-facing, translation, etc.), effectively creating a new STL.

This means that, assuming you performed "Verify" on your original STL, then moved it around on your Build Platform, and changed its size, the next time you loaded that verified STL, you would be loading that changed version, rather than the STL you originally brought in and verified.

NOTE!
If you *have not* performed Verify on the STLs on your Build Platform and you execute Prepare, *your original STL files will be overwritten* with any associated, scaling, and orientation information you have effected since loading them.

To preserve your original STL and/or SLC part files, save the individual parts under a new name before executing Prepare or any Platform Saving operation.

2. Click the... 

button to continue the Prepare process, or click the... 

to stop the process.

Selecting **"OK"** brings up the **"Save As..."** dialog (Figure 62) which allows you to specify the name and directory or sub-directory where you wish to save the Platform File about to be created.

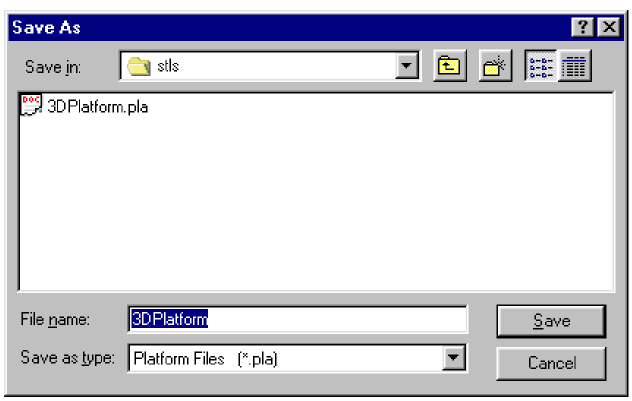


Figure 62. Save As (Platform Files) Dialog

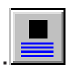
3. **Notice that this is a standard Windows save dialog and that the default name for the PLA file is "3DPlatform". Before saving the file, you may want to type a different name, or specify (or create) a different folder on your hard drive.**

4. **When ready, click the... Save button to begin the "Prepare" process.**

The Information Dialog Bar appears at the bottom of your workspace, and immediately begins to scroll downward as messages are added to the file that keeps track of the status of the slice and converge processes that occur during the Prepare function.

Stop, Pause, Resume Prepare

During the **"Prepare"** process, you can **Stop** the process, **Pause** the process, and **Resume** a paused process using the following tools:

- **"Stop Prepare"**... 
- **"Pause Prepare"**... 
- **"Resume Prepare"**... 

The Prepare function is processor intensive which, when running, does not allow other programs much CPU time. Pause/Resume Prepare comes in handy if you want to use the computer for another task temporarily.

Completing the Prepare Process

Assuming everything is set properly on the Build Platform, and that all styles and supports have been assigned and edited as appropriate, when the process of slicing and converging your parts is complete, you see a message in the Information Dialog Bar as illustrated in Figure 63.

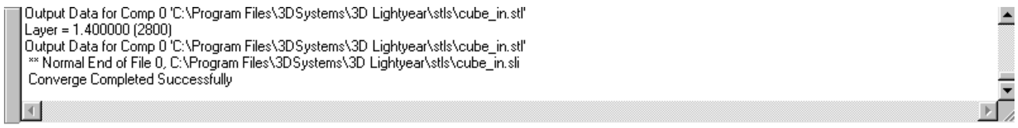


Figure 63. Information Dialog Bar (Prepare Completed Successfully)

…and be presented with the notification message shown in Figure 64.

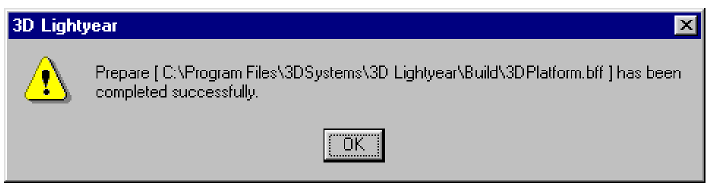


Figure 64. Prepare has been completed successfully

5. Click the... 

button to complete the Prepare process.

Well, that about does it for this section. You have learned the basics of the entire build file preparation process from loading STL files to preparing them for building. The next sections will take you on to Advanced concepts of the 3D Lightyear software.

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Advanced Preparation Concepts and Techniques

Modifying the Build Parameters

Styles, or more accurately, “style files”, are parameter groups that control the slicing 3D Lightyear software does to your parts. Style files consist of information on the type of SLA system upon which you intend to build your parts, and the style of build you will be executing (FAST, EXACT, TOOLING, or QuickCast) and the best parameters for successful part building..

Style files are assigned to the entire Build Platform during the configuration of a New Machine (using the New Machine Setup Wizard). Once assigned, you can edit the build parameters.

Why Change Parameters?

Parameter editing may be deemed necessary to accommodate a specific combination of part geometry, resin, and buildstyle. Veteran users of 3D Systems’ stereolithography systems will encounter two levels of access to build parameter editing; Standard and Advanced.

In an effort to provide our users with a system that helps direct success for novice users, while simultaneously providing operational flexibility for advanced users, we have designed 3D Lightyear software with many of the known “safe” parameters for building high-quality parts “built in”. We have provided a collection of Build Style files for every system/resin combination currently available, and have instituted a system of keeping our user base updated on an ongoing basis. Our team of veteran process development engineers have devised and extensively tested all the defaults and allowable edit ranges in each style file to assure a high rate of build success and quality.

Modifying Build Styles

To modify a build style, the first thing you need to do is:

1. **Open a build platform and load at least one part.**
2. **Select only one part in the view area.**
3. **Click the "Modify Build Styles"... icon on the "Build Toolbar". See Figure 65.**

The Modify Build Styles dialog is the same for Standard and Advanced users, and with only minor differences is the same for all machine types. (The differences occur in the SLA 7000 and the SLA 190/250 dialogs and are covered later in this chapter.)

The "Modify Build Styles" dialog shows the styles assigned to the selected part, as well as the Build Parameters for the part. You use this dialog to Add, Delete, Edit, Copy, Paste, and Save build styles.

You find the name of the part at the top of the styles window. The styles window list the styles and start/stop range for each style.

To perform any of the button functions, you must first select the style to which you want to apply the function. You can select only one style at a time. The dialog in Figure 65 shows only one build style assigned to the part. This means that the entire part will use the same build style from start to finish. After selecting the style, you can perform the **"Add"**, **"Delete"**, **"Edit"**, **"Copy"**, **"Paste"**, and **"Paste on All Selected Parts"** functions, each of which is explained below.

NOTE!
When you hover the mouse pointer over a parameter input box in the "Build Parameters" section, the allowable range of parameters and the default value for that parameter appear. You must stay within this range when modifying build parameters.

Add

Clicking the... Add button, allows you to change the build style or assign additional build styles to the part. The dialog, illustrated in Figure 66, opens showing the default **"Start Z:"** and **"Stop Z:"** Range.

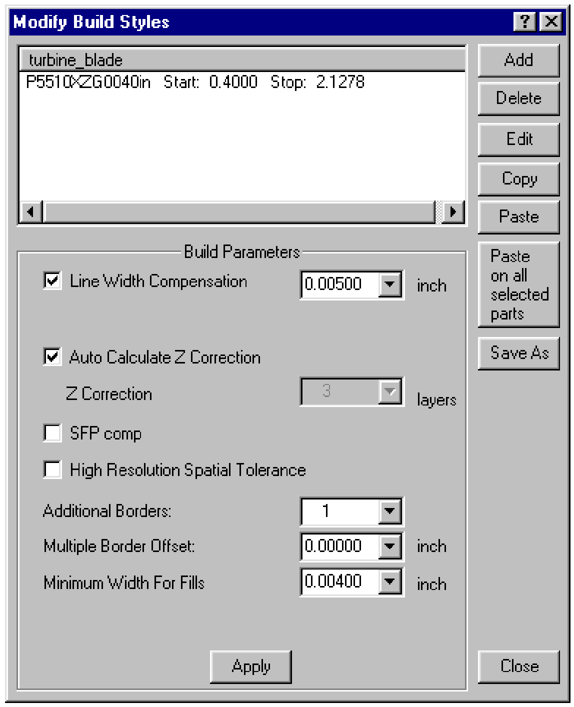


Figure 65. Modify Build Styles Dialog (SLA 5000)

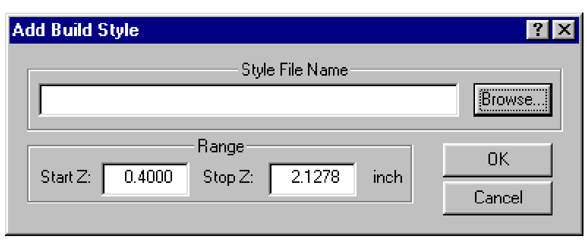


Figure 66. Add Build Style Dialog.

1. Click the... Browse... button to open the "Select Part Build Style" window (Figure 67).

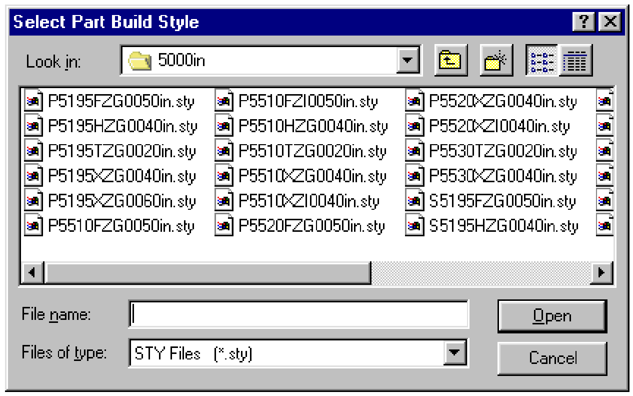


Figure 67. Select Part Build Style Window

2. Navigate to the correct directory (i.e., the one that matches your user level, machine type and units) and select a build style from the list.

3. Click the...  **button.**

The build style appears in the top text box of the "Add Build Style" dialog (Figure 68).

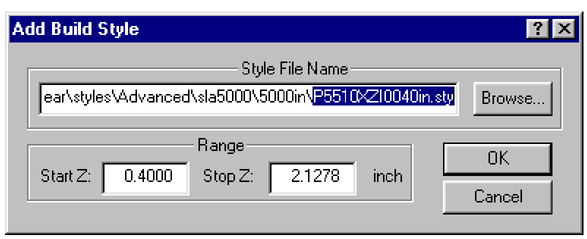


Figure 68. Add Build Style Dialog Box With Added Build Style

4. Type the desired "Start Z" and/or desired "Stop Z" range for the new build style into the "Range" boxes (Figure 69).

Figure 69. "Start Z:" / "Stop Z:" Range

The "added" build style will only apply to this Z Range.

5. **Click the... OK button to add the selected build style to the "Modify Build Styles" dialog (Figure 70).**

6. **Click the... Apply button to apply the added build style to the selected part.**

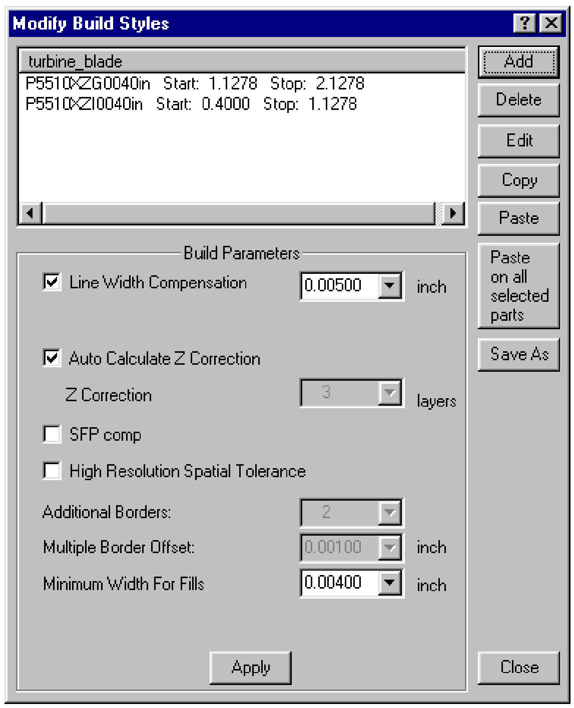


Figure 70. Modify Build Styles Dialog with Added Build Style

Delete

Clicking the... Delete button allows you to delete a selected (highlighted) build style from the "Modify Build Styles" dialog if there is more than one build style present. The remaining ranges are extended to cover the entire range of the part.

Edit

Clicking the... Edit button opens a dialog that allows you to edit the parameters of a previously assigned (and selected) build style.

Because there are many **"Edit"** sub-menus that vary with Standard and Advanced, and by machine type, the discussion of these functions will follow the discussion of the rest of the functions on the **"Modify Build Styles"** dialog.

Copy

Clicking the... Copy button allows you to copy a selected build style that you wish to paste to a different part.

Paste

Clicking the... Paste button allows you to paste the previously copied build style to one newly selected part.

Paste on all selected parts

Clicking the... Paste on all selected parts button allows you to paste the previously copied build style to all selected parts.

Save As

Clicking the... Save As button allows you to save the modified build style under a new name and/or in a different folder.

Linewidth Compensation

Clicking the **"Linewidth Compensation"** box instructs the software to apply linewidth compensation during the Prepare process. Linewidth compensation improves part accuracy. For an explanation of linewidth compensation, see the section "What are 'Laser Beam Width' and 'Linewidth Compensation'?" later in this chapter.

Auto Calculate Z Correction

Auto Calculate Z Correction when activated, calculates the **layers** parameter. When **Auto Calculate Z Correction** is on, the user is not permitted to modify the **layers** parameter. To modify the **layers** parameter, uncheck the **Auto Calculate Z Correction** check box.

Layers

The **layers** parameter is the number of layers of Z correction. For example, if the component layer thickness is 0.15 mm (0.006 in) and the amount of error to correct is 0.30 mm (0.012 in), the number of layers to correct is 2 [0.30 mm/0.15 mm = 2 (or 0.012 in/0.006 in = 2)]. The **layers** parameter is calculated using D_p, E_c, layer thickness, Hatch vector overcure values, and Fill vector cure depths. In this calculation, Z-directional error is calculated by determining the cure depth (influenced by Overcure Error and Print-through) and subtracting the intended layer thickness. The Z-directional error is then divided by the layer thickness and rounded to the next whole number for slicing. You may change the **layers** parameter as desired.

SFP comp

SFP Comp (Small Feature Preservation Compensation) when checked, provides linewidth compensation without eliminating small part features.

High Resolution Spatial Tolerance

This version of 3D Lightyear software adds a new feature that helps maintain part accuracy in highly tessellated parts. You enable the feature by clicking the check box in the **“Modify Build Styles”** dialog next to the function "High Resolution Spatial Tolerance." This feature should be used only when you notice "notching" in a surface (especially a curved surface) on a highly tessellated part where you expect the surface to be smooth.

Additional Borders

Additional borders can be added to create a thicker and stronger vertical sidewall. You can select 0 (zero) or more additional borders. The SLA 7000 must have at least one additional border to build correctly.

Multiple Border Offset

When additional borders are drawn, they are offset towards the center based on this value.

Minimum Width for Fills

Minimum Width for Fills uses the X/Y directional minimum width of a geometry to eliminate vectors from the .sli file.

SLA 7000 and SLA 190/250: Differences in the Modify Build Styles Dialog

For the most part, the parameters in the **Modify Build Styles** dialog are consistent for all machine types. There are, however, slight differences in the dialogs for SLA 7000 and SLA 190/250.

The SLA 7000 **Modify Build Styles** dialog contains both Small and Large spot Linewidth Compensation parameters as illustrated in Figure 71.

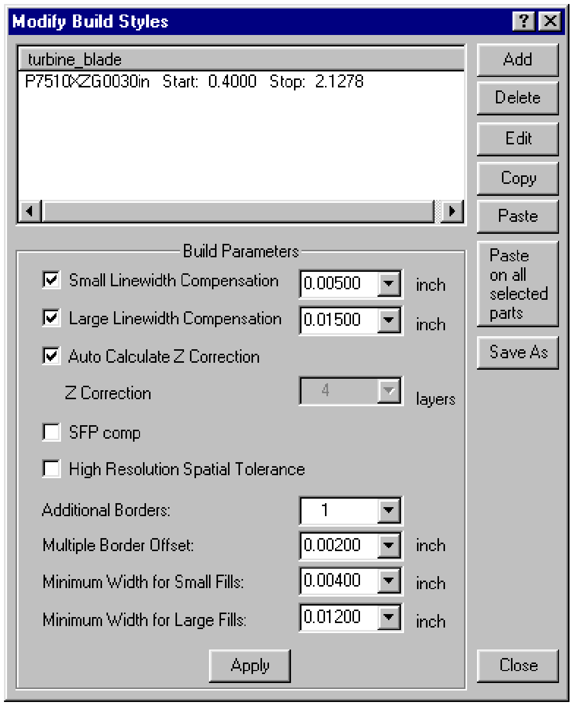


Figure 71. Modify Build Styles Dialog, SLA 7000 only

The SLA 190/250 **"Modify Build Styles"** dialog contains two additional parameters: **"DH Flag"** and **"UH Flag"** as illustrated in Figure 72. By default, the SLA 190/250 does not hatch areas that have fill. Checking these boxes force the system to hatch, as well as fill, these areas.

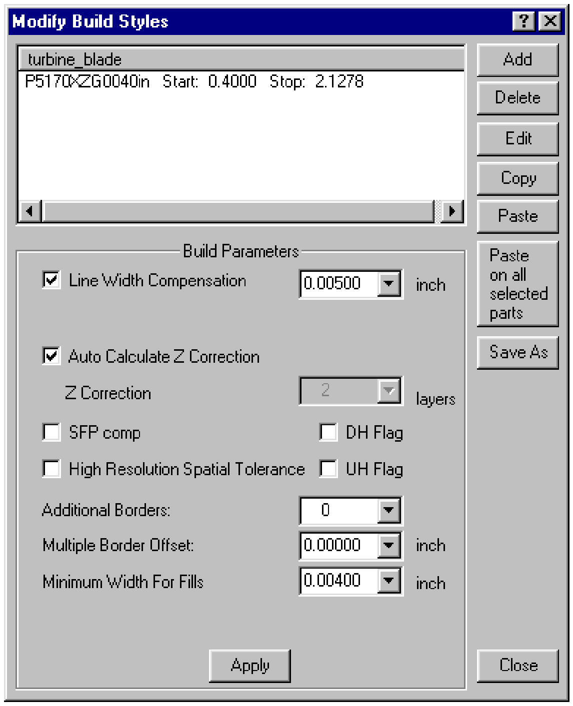


Figure 72. Modify Build Styles Dialog, SLA 190/250 only

Edit Parameters

The **"Build Parameters"** in the **"Modify Build Styles"** dialog described above are applied to the entire part regardless of the number of style ranges within the part. To change parameters for individual ranges and style within the part, click the... Edit button.

This opens the **"Style Parameters"** dialog. There are two different forms of this dialog; one for Standard users and another for Advanced. Also, the dialog for SLA 7000 users is somewhat different from users of the other SLA systems due to the dual spot size of the SLA 7000 and the inherent complexity of some of its build styles. Figures 73 through 77 illustrate the **"Build Style Parameters"** dialog for various SLA systems and user status.

The common elements on all the variations of this dialog are:

- **Style:** displays the filename of the selected build style.
- **Description:** displays a short description of the selected build style.
- **Layer Thickness:** displays the layer thickness of the selected build style. This field may or may not be editable, depending on the machine and build style. Some newer build styles are “cyclic” in the sense that bordering, hatching and filling are performed in cycles (e.g. border every layer, hatch every three layers, etc.) Generally, the layer thickness of cyclic styles are not editable.
- **Z Start:** displays the Z-height at which this build style begins.
- **Z Stop:** displays the Z-height at which this build style ends.

Any of the areas in the following dialogs that are "grayed out", means that you cannot edit that parameter. **Z Start** and **Z Stop** can only be adjusted within the current size of the part.

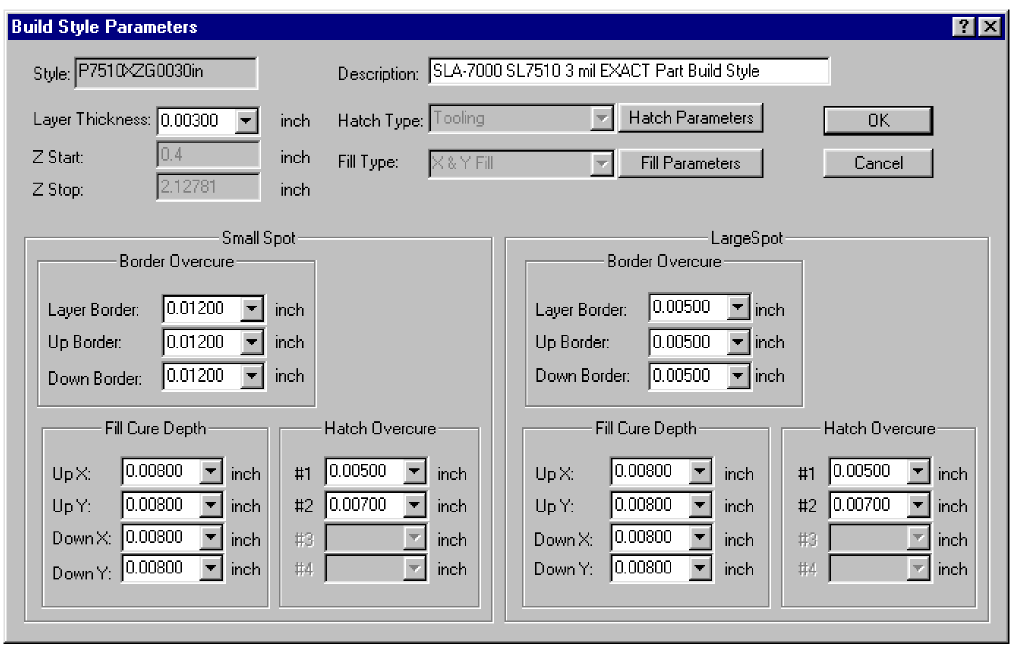


Figure 73. Build Style Parameters Dialog, Standard SLA 7000 users only)

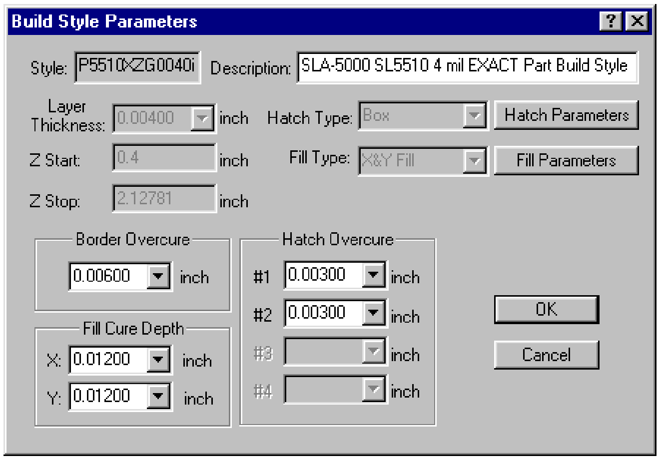


Figure 74. Build Style Parameters Dialog, Standard SLA 350, 500, 3500, and 5000 users

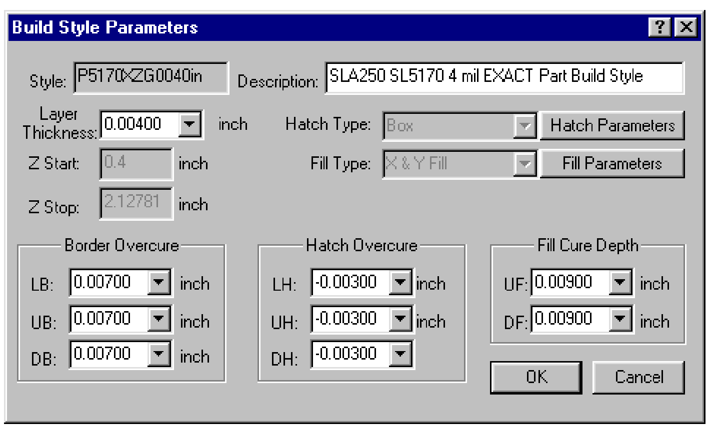


Figure 75. Build Style Parameters Dialog, Standard SLA 190 and 250 users

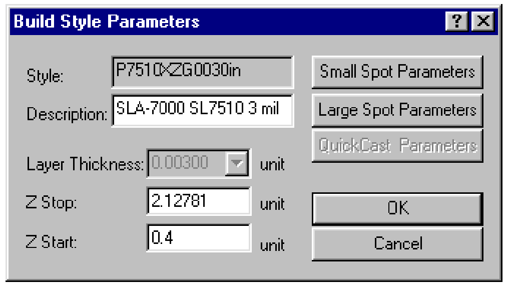


Figure 76. Build Style Parameters Dialog, Advanced SLA 7000 users

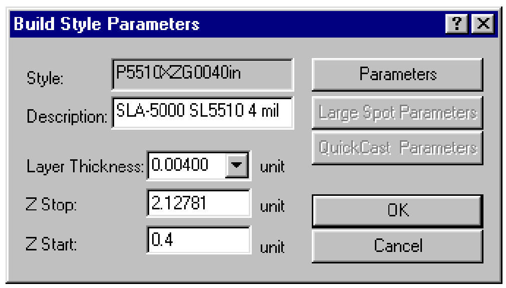


Figure 77. Build Style Parameters Dialog, Advanced SLA 190, 250, 350, 500, 3500, and 5000 users

Clicking the... OK button applies any changes made to the **Layer Thickness**, **Z Stop**, and **Z Start** parameters.

Standard users edit the **Border Overcure**, **Hatch Overcure**, and **Fill Cure Depth** parameters directly from the **Build Style Parameters** dialog. Standard users access the **Hatch Spacing**, **Start/End Retraction**, **Fill Spacing**, and **QuickCast** parameters by clicking the... Hatch Parameters and... Fill Parameters buttons.

Examples of these dialogs are illustrated in Figures 78 through 81.

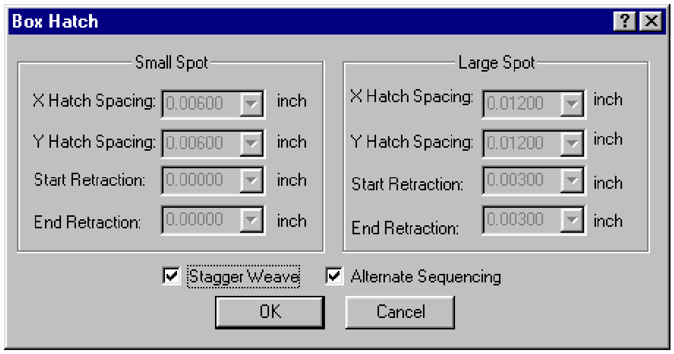


Figure 78. Hatch Parameters, Standard SLA 7000 users

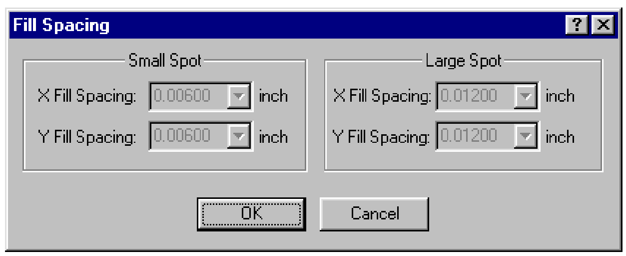


Figure 79. Fill Spacing Parameters, Standard SLA 7000 users

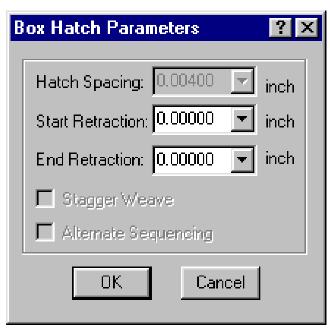


Figure 80. Hatch Parameters, Standard SLA 190, 250, 350, 500, 3500, and 5000 users

Figure 81. Fill Spacing Parameters, Standard SLA 190, 250, 350, 500, 3500, and 5000 users

Advanced users access the **Border**, **Hatch**, and **Fill** parameters by clicking the... Small Spot Parameters or Large Spot Parameters buttons for SLA 7000 systems, or the... Parameters button for all other SLA systems as appropriate.

Advanced users access the QuickCast-specific parameters by clicking the... QuickCast Parameters button. Except for QuickCast-specific parameters, examples of these dialogs are illustrated in Figures 82 through 84.

A discussion of the QuickCast-specific parameters can be found in the QuickCast chapter later in this guide.

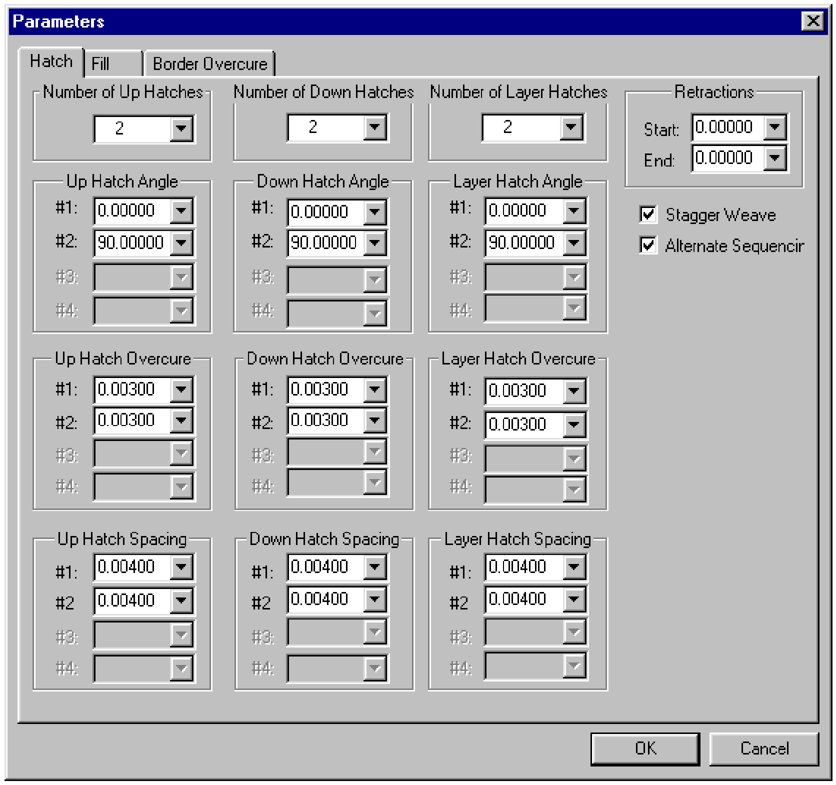


Figure 82. Hatch Parameters, all Advanced users

Hatch Parameters

The internal grid work of vectors drawn by the laser beam within the border vectors are called Hatches. Hatching is used to solidify the internal areas of the part. Hatching parameters define the number of hatching passes, hatch spacing, hatch overcure, and the angle of each pass.

Retractions - When a hatch vector is drawn, it can either start at a point on the border vector and end at a point on the other border vector on the opposite side, or it can start at some distance from a point on the border vector and end at some distance from a point on the border vector on the opposite side. The Start and End Retraction parameters specify the distance of the Start and End points of the hatch vector and the points on the border vectors.

Stagger Weave: This variable is applied to X and Y hatches only. If this option is ON, the positions of the hatch vectors change from layer to layer so that the hatch vectors of two consecutive layers are interlaced. If the option is OFF, the individual hatch vectors of a layer are drawn directly on the top the individual hatch vectors of the previous layer. Sometimes when this option is ON, it forces the hatch vectors to become X and Y hatch.

Alternate Sequencing: If this option is OFF, the hatch vector is drawn in the same sequence on every layer. If it is ON, although the hatch pattern is not changed, the sequence of drawing the hatch vector changes from layer to layer. With two hatch (X and Y) and four propagation (Right, Left, Front and Back) directions, there are eight drawing sequences. This option is used to reduce curl on the bottom of the part.

Hatch Type: Displays the cross hatching types for each layer.

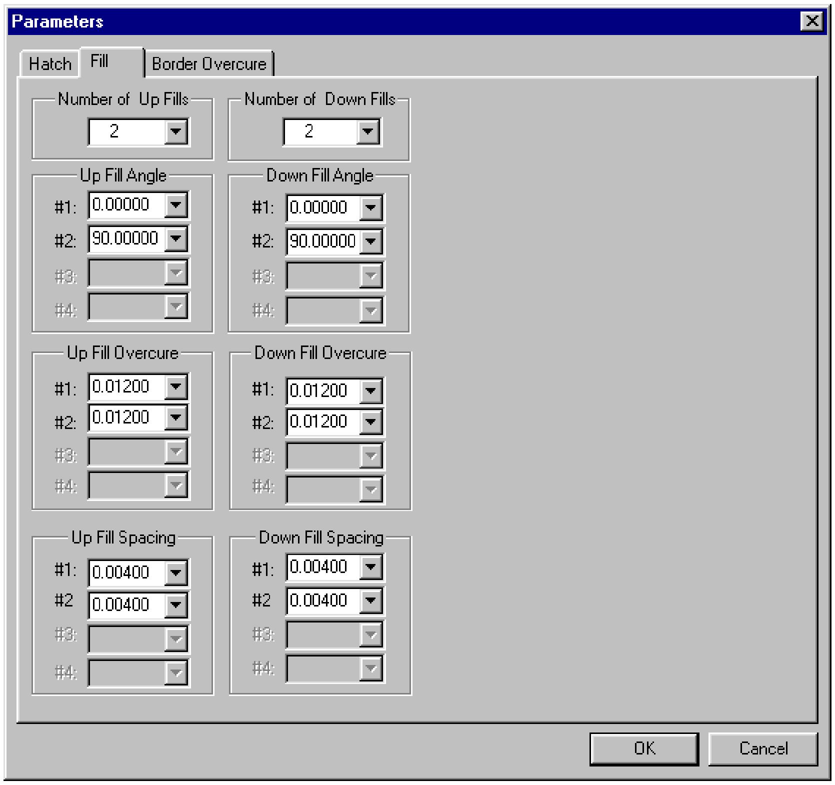


Figure 83. Fill Spacing Parameters, all Advanced users

Fill Parameters

Fills are a tightly spaced vectors drawn on the layers representing the part surfaces. Fills ensure a smooth finish to the surfaces of the part and are always drawn parallel to the X and Y axes. You to edit the number of upfacing and downfacing Fills, and also the value of up and downfacing angles, overcure depths, and spacings.

Fill Type: displays the direction of the fill vectors.

Fill Cure Depth: determines the absolute depth of curing for the fill vectors.

Fill Spacing: determines the spacing between the X and Y fill vectors.

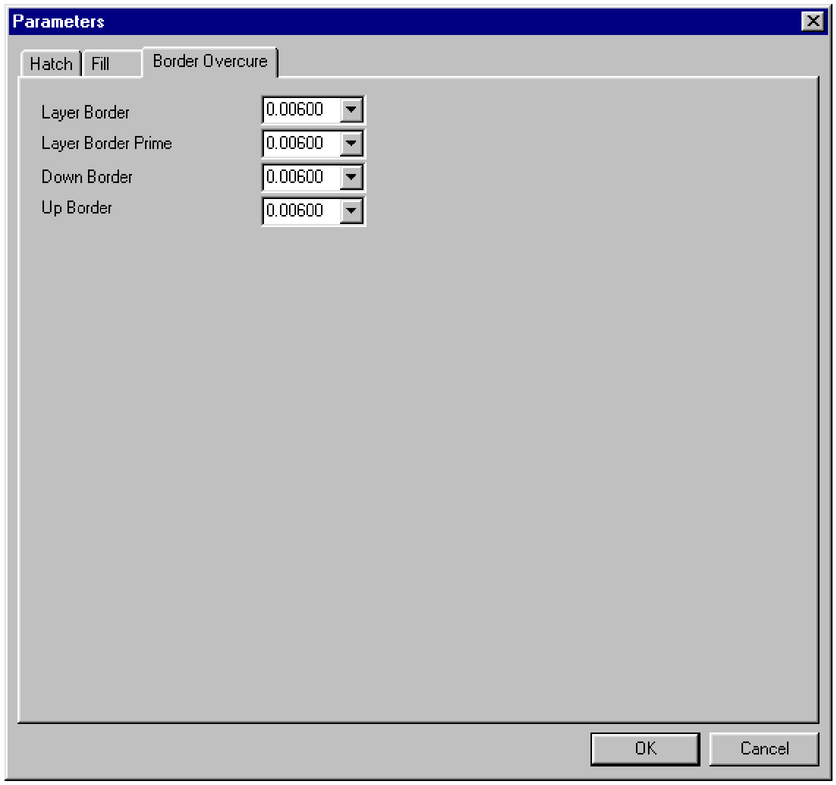


Figure 84. Border Overcure Parameters, all Advanced users

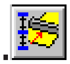
Border Parameters

Border Overcure is the depth beyond the slice layer thickness that the borders will be cured.

Modifying Recoat Styles

The first thing you need to do, is to open the "**Modify Recoat Styles**" dialog. To do this:

1. **Open a build platform and load at least one part.**

2. **Click the "Modify Recoat Styles"...**  **icon from the "Build Toolbar". This brings up the "Modify Recoat Styles" dialog as shown in Figure 85.**

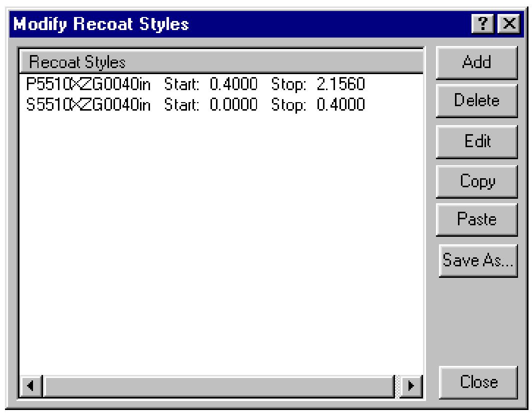


Figure 85. Modify Recoat Styles Dialog

The **"Modify Recoat Styles"** dialog lists all the recoat styles assigned to the selected platform. From this dialog, you can **Add**, **Delete**, **Edit**, **Copy**, **Paste**, and **Save** recoat styles.

Add

To Add an additional recoat range, click the...  button. The Add Recoat Style dialog appears as in Figure 86 showing the current **Start Z:** and **Stop Z:** range.

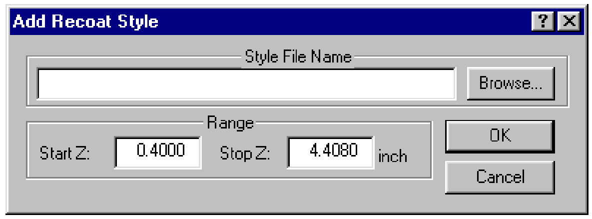


Figure 86. Add Recoat Style Dialog Box

1. Click the... 

button to open the "Select Part Recoat Style" window (Figure 87).

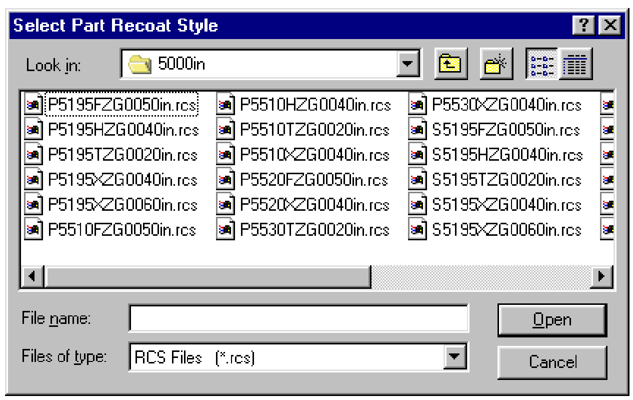


Figure 87. Select Part Recoat Style Window

2. Navigate to the correct directory (i.e., the one that matches your user level, machine type and units) and select a recoat style from the list.

3. Click the... 

button.

The recoat style appears in the top text box of the "Add Recoat Style" dialog (Figure 88).

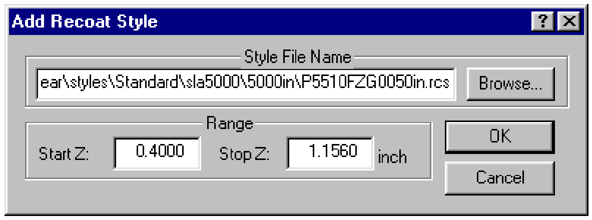


Figure 88. Add Recoat Style Dialog with Added Recoat Style

4. Type in the desired "Start Z" and/or desired "Stop Z" range in the "Range" boxes.

Figure 89. ***"Start Z:"*** */* ***"Stop Z:"*** *Recoat Range*

The "added" recoat style is applied to this Z Range.

5. Click the.. 

button to add the recoat style into the "Modify Recoat Styles" dialog (Figure 90).

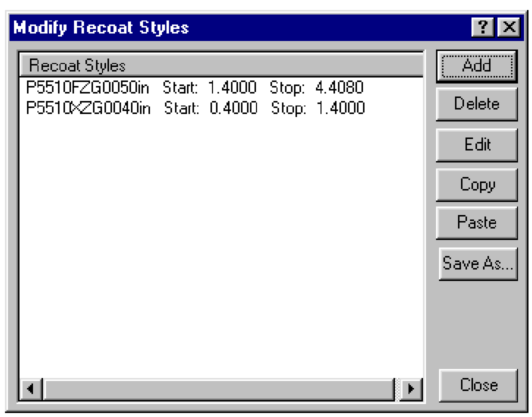


Figure 90. Modify Recoat Styles Dialog with Added Recoat Style

Delete

Clicking the... 

button allows you to delete a selected (highlighted) recoat style from the **"Modify Recoat Styles"** dialog.

Edit

Clicking the... Edit button opens the **"Recoat Style Parameters"** dialog as illustrated in Figures 91 and 92. This dialog allows you to edit the parameters and ranges of the platform's recoat style. The following parameters of the selected style can be edited: **"Number of Sweeps"**, **"Blade Gap Percentage"**, **"Velocity/Period"**, **"Z Wait/Z Level Wait"**, **"Pre-dip delay"**, **"Z Dip Velocity"**, and **"Z Dip Distance"**.

"Grayed out" areas in the following dialogs are non-editable.

NOTE!
Placing the mouse pointer over a text box, shows the default values and the allowable value range.

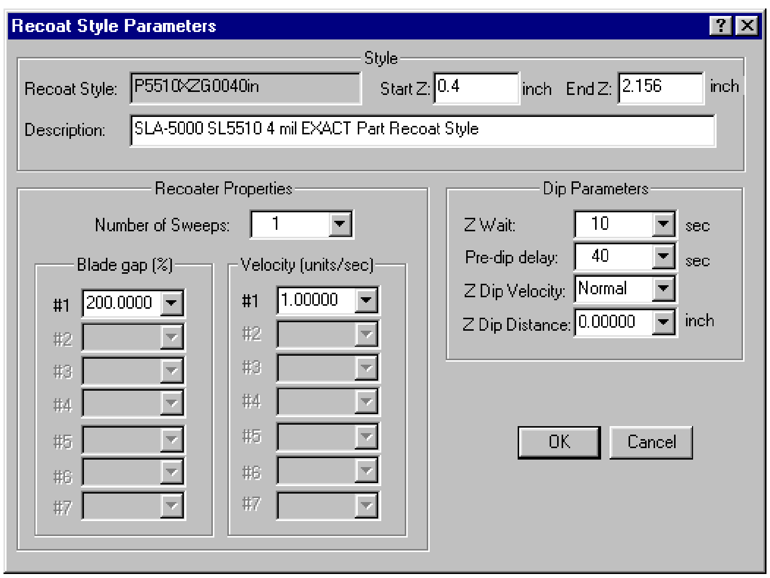


Figure 91. Recoat Style Parameters Dialog, SLA 350, 500, 3500, 5000, and 7000 users

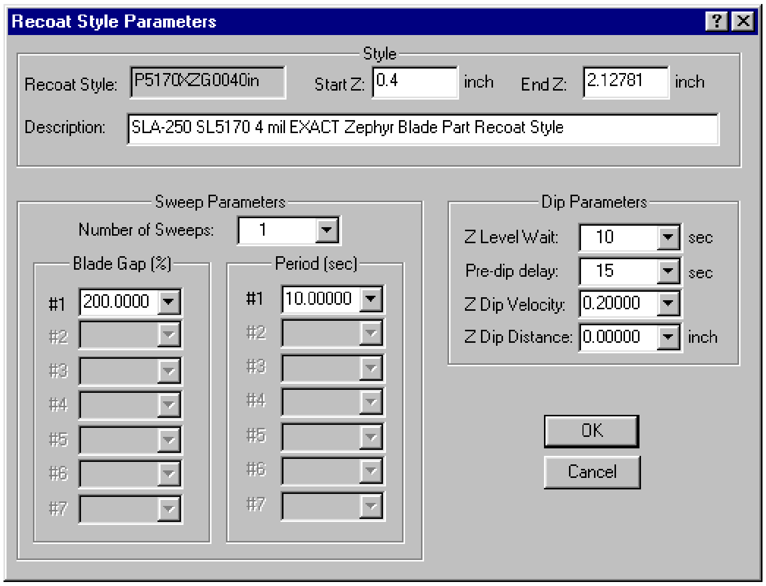


Figure 92. Recoat Style Parameters Dialog, SLA 250 users

Start Z: displays the Z height at which this recoat style begins. You can type in a different value within the allowable range.

End Z: displays the Z Height at which this recoat style ends. You can type in a different value within the allowable range.

Recoat Style: displays the filename of the selected recoat style.

Description: displays a short description of the recoat style.

Number of Sweeps: displays the number of sweeps for this style. A recoat style may use up to seven sweeps, each with a separately defined **Blade Gap Percentage** and **Velocity**.

Blade Gap percentage: is used to assign the clearance (or distance between the bottom of the recoater and last layer of the part) at time of sweeping

Velocity (SLA system 350/3500/500/5000/7000 only): displays the velocity of the blade when it sweeps.

Period (SLA system 250 only): displays the time required for a sweep from front to back or back to front.

Z Wait: displays the number of seconds allowed for the resin surface to stabilize after recoating and before the laser begins to draw the next layer. Large-platform machines require a minimum Z Wait of five seconds to accommodate beam profiling.

Pre-dip Delay: displays the number of seconds the elevator pauses before a new layer of liquid resin is applied. Used with certain resins, this pause allows the part to more fully cure before the next layer is built.

Z Dip Velocity (SLA system 350/3500/500/5000/7000 only): displays the velocity (Normal, Medium or Slow) at which the elevator moves between layers. Normal velocity is 2.54 mm/sec (0.1 in/sec), Medium is 1.52 mm/sec (0.06 in/sec) and Slow is 0.76 mm/sec (0.03 in/sec). This option affects elevator velocity only during the build program. Resin level check and elevator drain use a single set value of 2.54 mm/sec (0.1 in/sec).

Z Dip Velocity (SLA system-190/250 only): displays the elevator velocity in revolutions per second (rps). This refers to the rotation of the ball screw to which the platform is mounted.

Z Dip Distance: displays the distance the elevator "dips" during the recoating process.

Copy

Clicking the... Copy button allows you to copy a selected recoat style.

Paste

Clicking the... Paste button allows you to paste the previously copied recoat style.

Save As

Clicking the... Save As button allows you to save the modified recoat style under a new name and/or in a different folder.

Creating Custom Build Styles

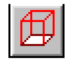
Some SLA system users want to apply custom styles (STY or RCS) to their parts and in some cases want to apply this style as a “default” (e.g. users who build with non-CIBA resins.)

1. **From the general build styles, find a supplied style that is similar to the one you want. It must be from the same SLA system machine type, (however SLA 350 and SLA 3500 styles are interchangeable), and the same CAD units. 3D Lightyear software will not allow a style from one machine or unit to be applied to a different platform. For Build Styles, the “donor” style must also be of the same type - e.g. to create a QuickCast Box style, you must start with another QuickCast Box style, you cannot start with QuickCast Hex for example.**
2. **Set up a “dummy” platform using the donor style or styles. This is done in the regular way using the Setup interface giving the platform an appropriate name. Once the platform has been created, load any STL file. (At this point the new platform will have all the donor styles applied).**
3. **Now open the “Modify Build Styles” window and make the required changes. Do the same for “Modify Recoat Styles”. From within these windows, the new style can be created by using the “Save As” button and given a unique name.**
4. **When new styles have been saved, close the build platform, then use “Load Empty Build Platform” to re-open it. When the “New Platform Configuration” window opens, the “Browse” buttons can be used to select the newly created style(s). Once the user clicks “Done”, these styles are applied to that platform configuration every time it is opened. The operation is now complete and can be repeated for other build styles & configurations.**

Using the “Styles Wizard” to Select Style Files

The **"Styles Wizard"** allows you to easily change from the default styles shown in the **"New Platform Configuration"** dialog, to one of the other styles, listed in the "Styles" directory. You do this by clicking the **"Styles Wizard"...** Styles Wizard... button, and selecting the desired parameters.

To open the **"New Platform Configuration"** dialog from an empty viewer:

1. **Click the "Load Empty Platform"...**  **icon from the "Main Toolbar". This brings up the "New Platform Configuration" dialog as shown in Figure 93.**

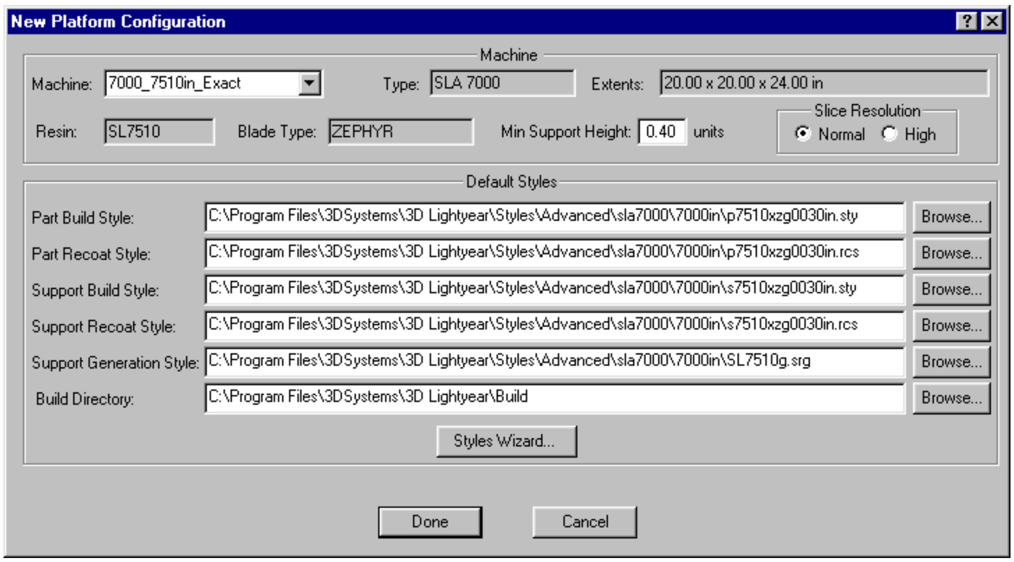


Figure 93. New Platform Configuration Dialog

2. **Select the desired machine name from the "Machine:" pull-down menu.**
3. **Click the...** Styles Wizard... **button.**
4. **Select the desired "Units", "Build Style" and "Layer Thickness" as each box appears.**
5. **Click the...** Done **button when finished.**

Editing Supports

Why Should I Edit Supports?

Once you have created the supports for your parts, there are several aspects of their construction that you can—and may very well ***want*** to—change.

It is important to understand that 3D Lightyear software's Supports Generating algorithm is not "perfect". Its relative effectiveness and thoroughness depends upon a logical, but relatively ***unqualified*** examination of the geometry of your parts. Depending upon this "analysis", the results of which can vary significantly according to object orientation relative to the horizontal plane of the Build Platform, 3D Lightyear software can occasionally produce less-than-optimal supports for the purposes of some applications.

Anatomy of a Support

Regions

When 3D Lightyear software analyzes the geometry of your parts, it makes a determination of the number of distinct surfaces (adjacent or not) to which to attach them. These distinct surfaces are called ***"Regions"***, and are shown in the Regions List in the Edit Supports dialog.

Sierras and Separators

By default, the top and bottom edges of supports generated by 3D Lightyear software are shaped like tiny, two-dimensional mountain tops. These mountain tops, or sierras are designed to minimize the contact area between a part and its supports. This minimization is effected because the points of sierras take the place of what would otherwise be solid, planar edges. See the illustration in Figure 94.

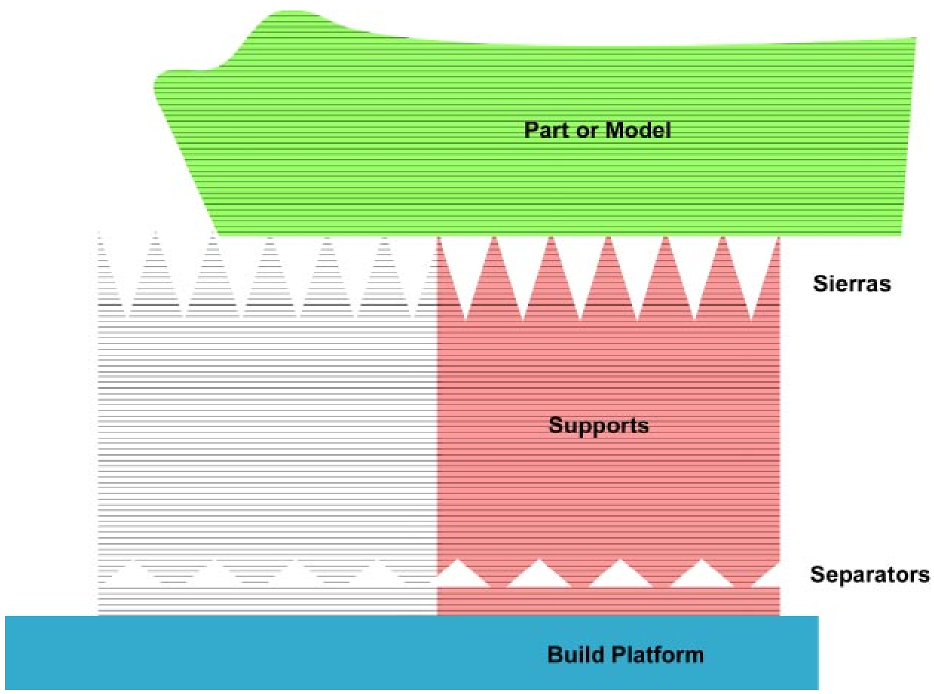


Figure 94. Sierras and Separators

In most cases, cured sierras do not impugn the vertical strength of supports. By virtue of their pointed structure, however, they tend to be relatively more brittle than contiguous curtain-like support edges leading up to them. A similar structure, the separator, can be built near the platform. These structures form a “break away” zone, similar to the perforations on a tear-off section of a form or card. The effect substantially improves the ease with which you can remove your from the Build Platform.

In order to effect the anchoring function for the layers to which they are attached during the build of your part, the points of sierras penetrate the surfaces of the objects they support. Again, though, since this penetration is in the form of points as opposed to edges, the remnants of support attachment will be much less in evidence and easier to finish.

NOTE!
Separators only occur between the Build Platform and the bottom-most surfaces of your part. If a region of supports attached to a part is both attached to the part *AND* the Build Platform, only the section of the support region attached to the Build Platform will incorporate separators.

Braces

The stabilizing structures 3D Lightyear software's Support Generator creates and attaches to supports are called ***Braces***. They provide an extra measure of support ***for the supports*** where geometric characteristics indicate that areas of supports are susceptible to breaking or distorting during the Build process.

There are two types of braces created in 3D Lightyear software: ***Delta Braces*** and ***Solid Braces***.

Delta Braces

Delta braces are the default type of brace. They are given this name because of their shape; they resemble isosceletic trapezoids as illustrated in Figure 95.

Delta braces, in turn, come in two varieties, ***Build Platform deltas*** and ***Up-facing surface deltas***. Braces can stabilize supports (depending upon the support and brace parameter settings) in any area of an object's geometry, including both the Build Platform ***and*** any down-facing surfaces that "overhang" other, opposing up-facing surfaces.

The graphic on the previous page illustrates the kind of braces that are attached to the supports between the bottom surfaces of a part and the Build Platform; they are fabricated with their bottom opening "blocked in" by an additional triangular structure. Delta Braces of this type are referred to as ***Build Platform Braces***.

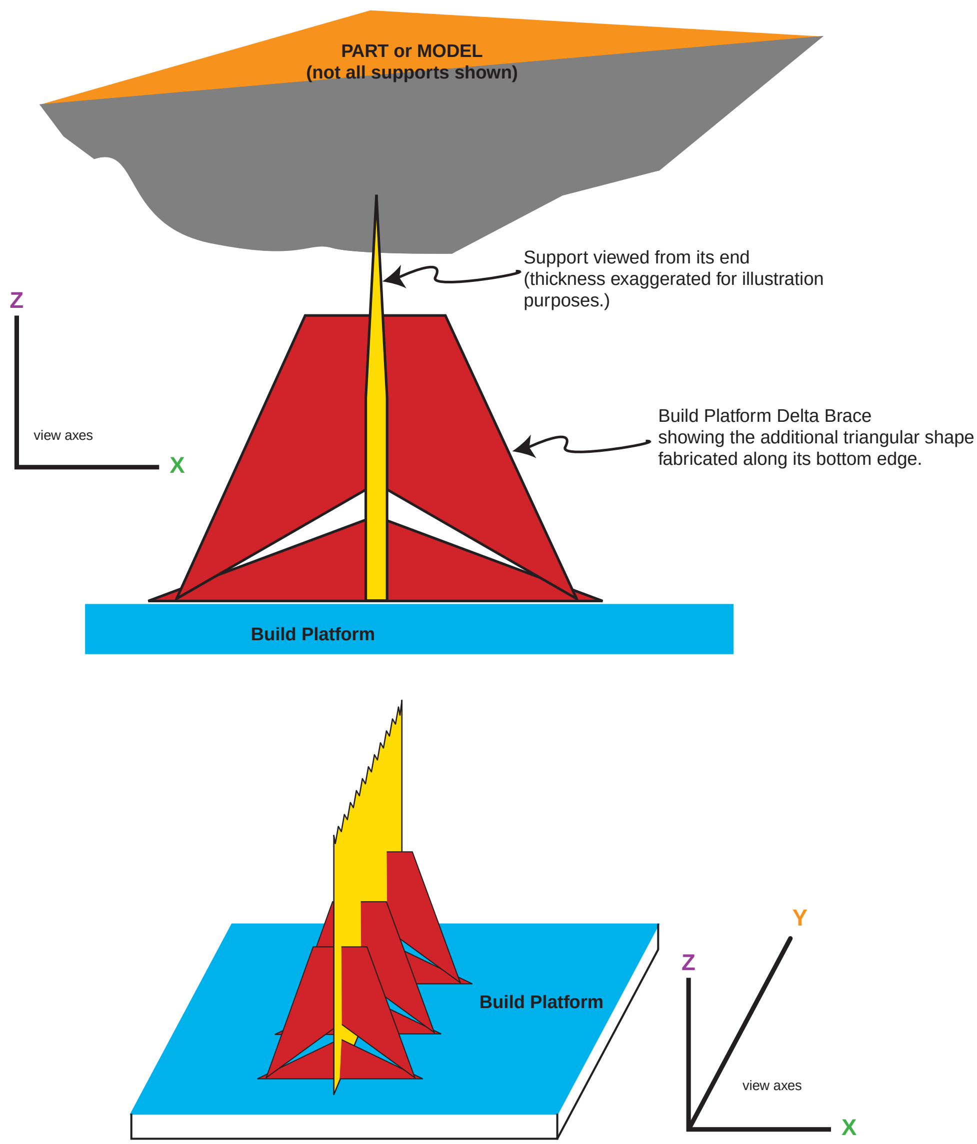


Figure 95. Support Braces

When delta braces are attached to supports that provide buttressing between opposing surfaces of a part (i.e., supports that rest on an up-facing part surface and support a down-facing surface), they are called ***Up-facing Braces***. Up-facing delta braces do not contain the additional triangle used in Build Platform braces; the intent being, as in the case of the supports themselves, to both preserve as much of the surface finish as possible, and to maximize the ease with which you can remove the bracing structures.

Solid Braces:

As their name implies, *Solid Braces* are devoid of any openings at all along their bottom edges. This is the "strongest" type of brace, offering increased lateral buttressing capabilities.

NOTE!
Solid braces are, by default, used sparingly. They can make post-build support and part removal comparatively more tedious.

Scaffolds

3D Lightyear software can be directed to construct three-dimensional rectangles attached to the Build Platform and interconnected around the base of otherwise standard supports. Scaffolds provide additional stabilization of certain types of part geometry and/or supports. To combat the instability on the Build Platform of inherently ***un***stable part, and/or support structures, you can add ***scaffolding*** to your support.

From time to time—usually because a particular surface must be built with an orientation that enhances its surface finish, for example—you may have to prepare and build parts in awkward positions on the Build Platform. A relatively "tall" part with hyperbolic-shaped "legs", for example, may require building with those legs in an ungainly position that is susceptible to crashing during early stages of the build.

Scaffolds, as their name suggests, consist of a series of boxes that define a perimeter around the base of all supports and braces attached to a region of a part. The following graphic illustrates the idea of scaffolding added to the supports on a Build Platform.

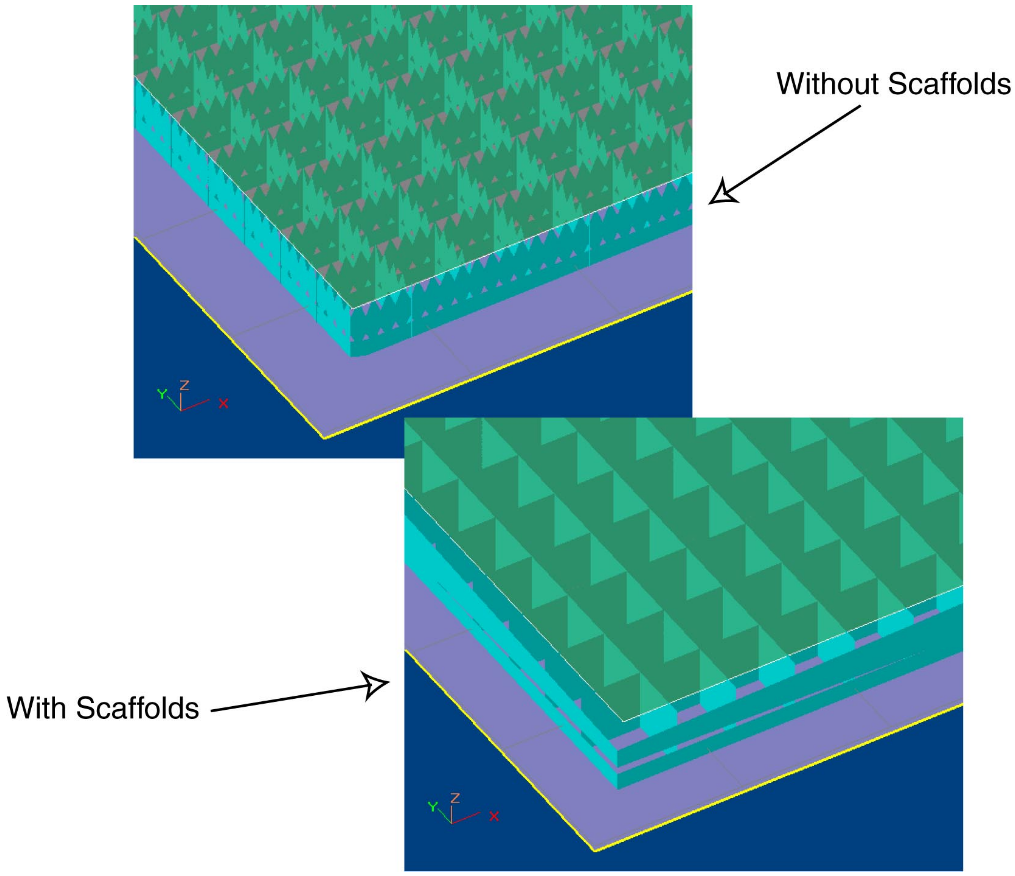


Figure 96. Cube Part, with and without Scaffold Supports

Gussets

In order to save time and resin in supporting overhanging geometries that are significantly above the level of the Build Platform (or up-facing surfaces of the part itself), gussets can be substituted for traditional supports and braces.

Gussets are special supports attached to the underside of an overhang and a neighboring “side-wall” of the part. (“Side-walls” are vertical or near-vertical facets of the finished object.)

Figure 97 illustrates the gusset support.

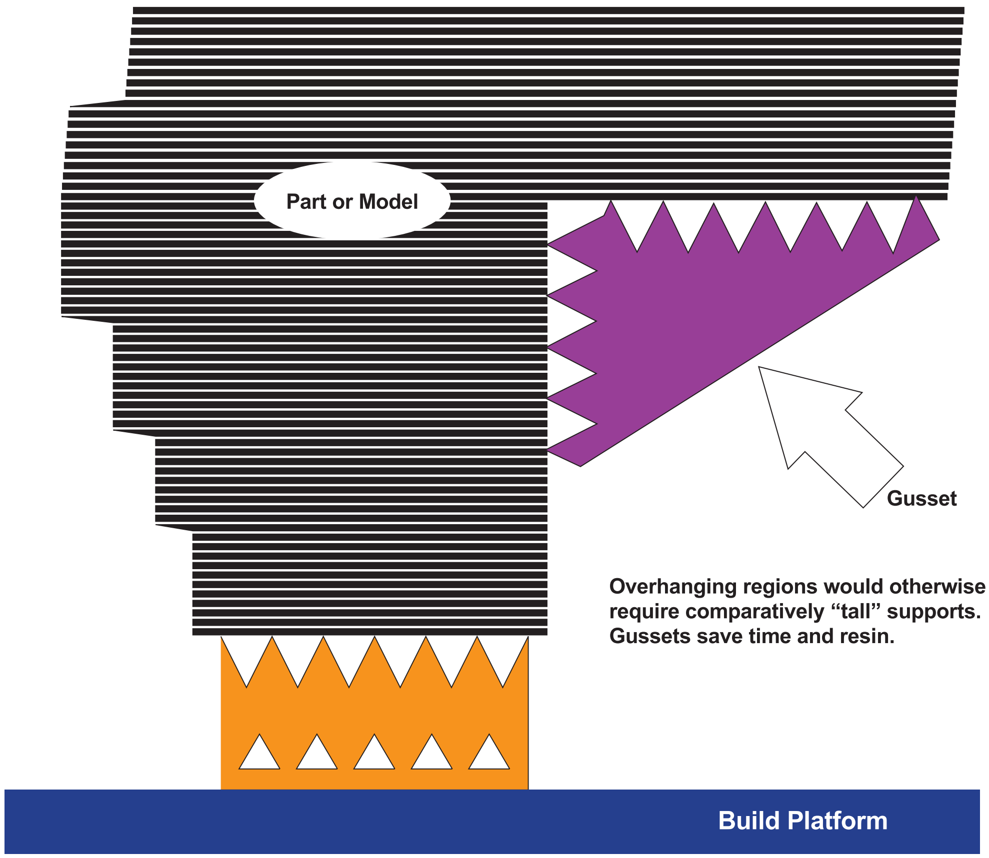


Figure 97. Gusset Supports

Flag Supports

This is a reference to a specialized type of gusset support.

When an overhanging feature in the geometry of a part requires supports and the feature is too “high” (in the Z axis) above the Build Platform for the use of “standard” support structures, Gussets are the typical alternative. However, the use of Gussets should be carefully evaluated, since by the nature of their attachment to part, vertical (or near-vertical) walls they can adversely effect the quality of that surface’s finish.

Flag supports are the alternative to Gussets. Flag supports are formed by constructing a vertical “pole” structure from the Build Platform up to the bottom-most vertex of the triangular lamina that makes up what would otherwise be a Gusset. Since this pole is positioned incrementally away from sidewalls, surface finish quality is “left intact”.

Deciphering SRG file names

The factory default Support Generation Style file names consist of the name of the stereolithography resin, followed by a feature block mnemonic, and the “**.srg**” suffix. Figure 98 illustrates the naming convention.

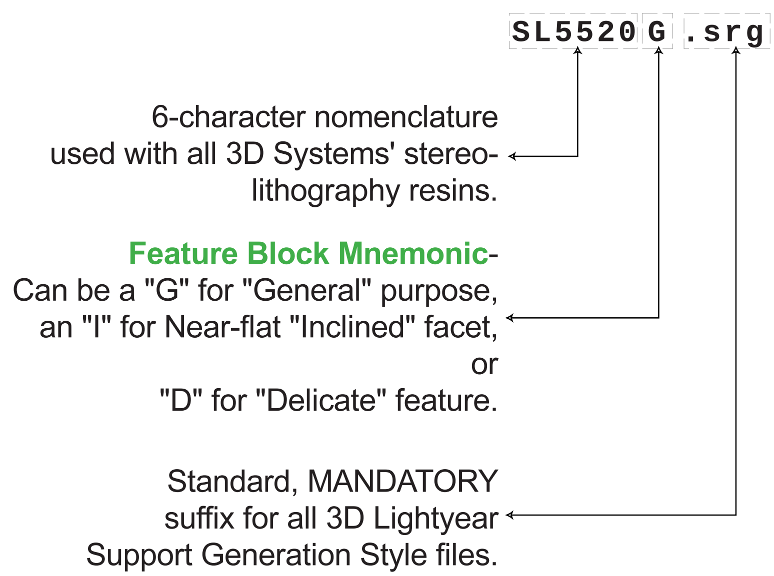


Figure 98. Deciphering SRG File Names

Determining Whether Supports Need Editing

NOTE!
Exercise caution and restraint in deleting automatically-generated supports or changing any of their default parameters. Faulty "customized" supports are frequently the root cause of failed builds.

Editing supports is a skill that usually requires an amount of stereolithographic part building experience to master. A great deal of time and 3D Systems' research has been, and continues to be expended on the science of generating ***just enough*** but ***not too much*** support for parts.

If you are contemplating deleting supports, lessening the depth of their sierra penetration into your part, changing the size of support braces, removing gussets, etc., we strongly recommend build experimentation with your particular object's geometry before attempting the SLA system fabrication of your "final" part.

Two relatively common examples of conditions in which supports can (and should) be edited are:

- Arches and/or horizontally-oriented tubular areas of a part often have supports generated for them by 3D Lightyear software. Typically, features of this type are self-supporting—the physics of their shape inherently resists collapse during the build process on the SLA system Supports can be turned off or minimized in these regions.

- Down-facing conical- or tetrahedral-shaped points on a part usually do not have supports created for them at their very tips. This is because, logically, a down-facing point would not otherwise require supports, since all the layers above it would be inherently larger in area. However, during the build, these and similar geometric aspects would "float away" in the vat unless properly anchored by supports. If your part has this type of geometry, make sure to add supports to any down-facing points so that they are properly anchored to the Build Platform.

Getting a Better Look at the Supports While Editing

When you begin the process of editing Supports in 3D Lightyear software, you will notice that the display of your workspace changes to "Zoom in" on the supports you will be editing. Depending upon the settings you have instituted for the way objects are colored, you might also be able to see:

- The regions of Supports available for editing
- The Separators, Sierras, Braces, Gussets, or Flags attached to your part
- The areas of your part that have too many or too few Supports

By default, the display of the part is transparent. This is to allow you to better scrutinize the number, structure, and relative orientation of the structures you intend to edit. Figure 99 shows a typical 3D Lightyear software workspace display during the initial phases of a support editing session.

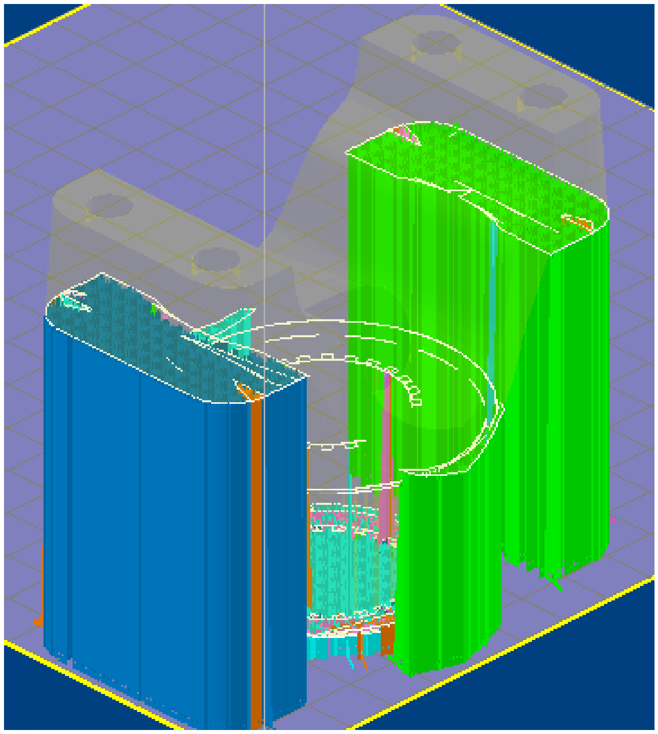


Figure 99. Getting a Better Look at Supports

You can control several aspects of the workspace display, according to your preferences, to enable you to work with the editing tools.

Use the settings illustrated in Figure 100 in concert with the Regions list in the **"Edit Supports"** dialog to show the aspects of the Supports, Regions, and your part in the Supports Editing workspace that are most useful.

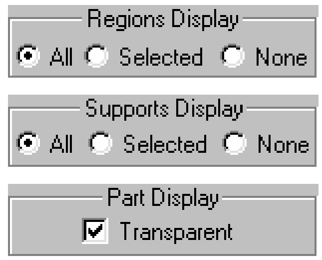


Figure 100. Regions, Supports, and Part Display Settings

To control the degree of transparency with which your part is displayed in the Supports Editing workspace:

1. **Click the... Options... button in the upper-right corner of the "Selection Dialog Bar".**

   You will see the dialog illustrated in Figure 101.

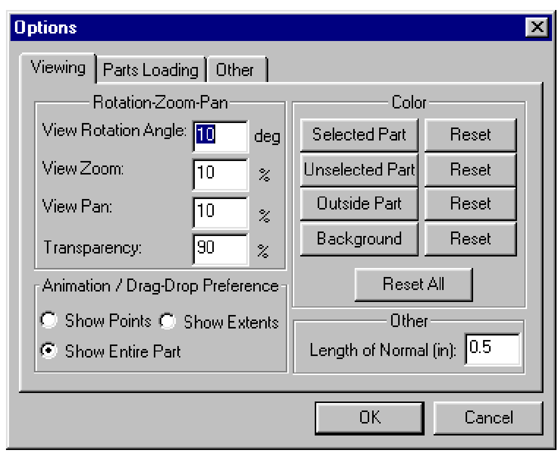


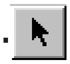
Figure 101. Options Dialog (Viewing Tab)

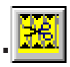
2. **Change the value in the "Transparent:" field of the dialog to change how well you can "see through" your part.**

   The higher the value entered, the more transparent the display of your part will be in the Supports Editing workspace. Depending upon your view perspective, having your part more transparent can help to scrutinize things such as attachment parameters, Sierras, Gussets, Flags, etc.

Lower the value to make the display of the part more opaque.

Changing and Saving the Construction of "Supports"

1. **Assuming you have created the Supports you wish to edit, click on either a part, or the supports for a part using the "Select Parts"...**  **tool.**

2. **Click the "Edit Supports"...**  **icon on the "Tools Toolbar".**

NOTES!

You *CANNOT edit supports:*

- If they are part of an SLC file
- If they are part of an object in a BFF
- If they are part of an SLI file
- If they have been created using any application ***other than*** 3D Lightyear software
- If you are missing the ODF file

Also...**you can only edit the Supports of one part at a time.**

You will see the notification displayed in Figure 102.

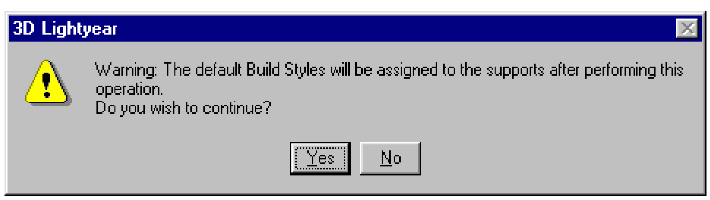


Figure 102. Build Style Warning

3. **Click "Yes" to continue ("No" to quit the Supports Editing process).**

Notice that (if you click "Yes") the view of your workspace changes to help you scrutinize the supports that 3D Lightyear software has created. The Edit Supports dialog (Figure 103) appears as well.

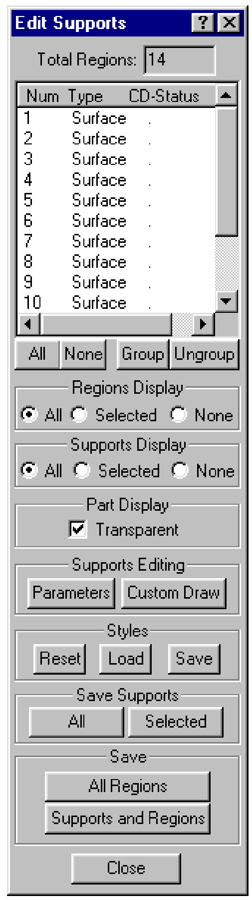


Figure 103. Edit Supports Dialog

NOTE!
You can execute the remaining operations in this procedure in a sequence different from the one in which they are listed here, omitting some steps altogether, if they are not applicable to your needs.

For Example:
You may wish *only* to add or delete Supports from the selected object, or to use Custom Draw before or without Selecting Regions. You may have a need to edit Supports Parameters without performing Custom Draw at all. etc.

4. Click on one of the Regions in the Edit Supports dialog list box to highlight the Supports you wish to edit,

OR…

Use the Select Parts tool in the main workspace to select the region of Supports you wish to edit.

The part or supports you choose will change color, according to the display preferences you have set.

5. Click on the… [Parameters] button to open the "Edit Support Parameters" dialog which allows you to change the characteristics of the Supports you selected in the preceding step.

The "Edit Support Parameters" dialog has four tabs as shown in Figures 104, 107, 108, and 109. The allowable ranges for each of the parameters is shown.

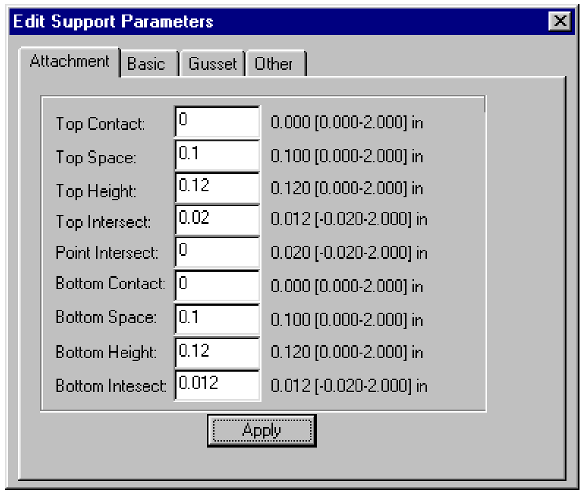


Figure 104. Edit Support Parameters Dialog Box (Attachment Tab)

The parameters available in the **"Attachment"** tab of the **"Edit Support Parameters"** dialog (Figure 104), are listed below. Figures 105 and 106 illustrate these parameters.

Top Contact: width of the sierra in contact with the part.

Top Space: distance from the center of one sierra to the center of the next.

Top Height: height of the sierra from its valley to its peak.

Top Intersect: distance the sierra penetrates into the part.

Point Intersect: distance by which supports for point type regions overlap into the region.

Bottom Contact: width of the down-facing sierra in contact with the part.

Bottom Space: distance from the center of one down-facing sierra to the center of the next down-facing sierra.

Bottom Height: height of the down-facing sierra from its valley to its peak.

Bottom Intersect: distance the sierra penetrates into the part.

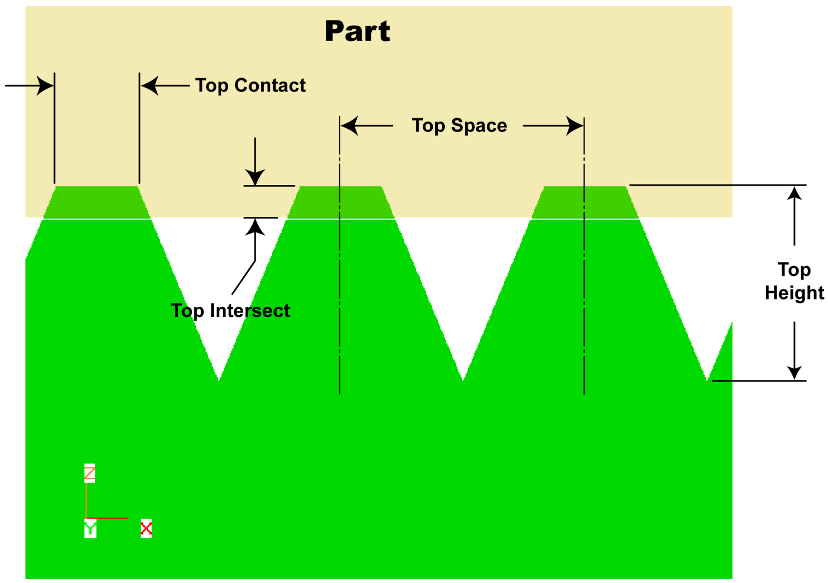


Figure 105. Edit Support Top Parameters

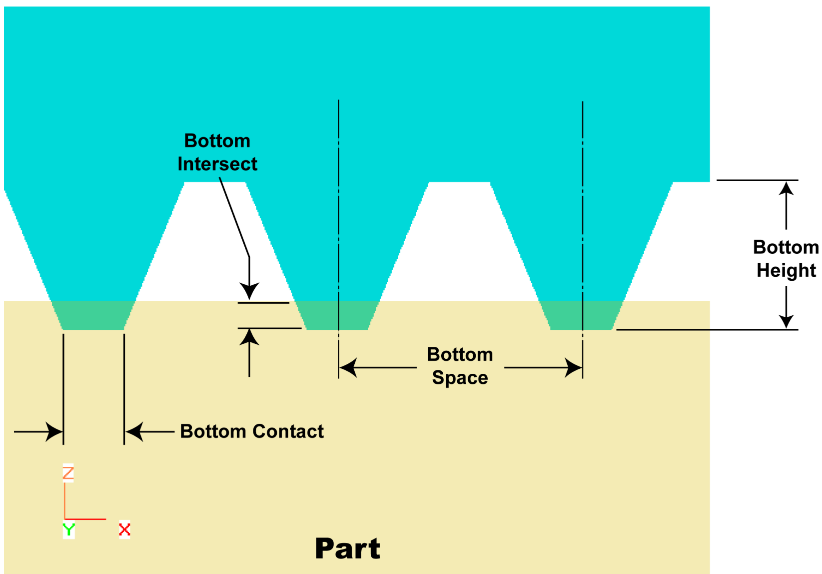


Figure 106. Edit Support Bottom Parameters

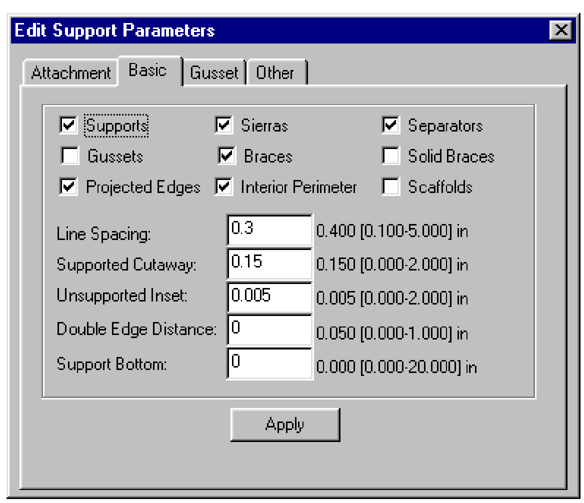


Figure 107. Edit Support Parameters Dialog (Basic Tab)

The parameters available in the **“Basic”** tab of the **“Edit Support Parameters”** dialog (Figure 107), are listed below.

Supports: if checked, allows **Supports** to be created for the selected regions.

Gussets: if checked, allows **Gussets** to be used in the selected region where gussets are possible. Gussets attach to the part along both the horizontal and vertical wall.

Projected Edges: if checked, allows the creation of **Projected Edges** to the outer edge of a region. A projected edge is a support that is created as an inset copy to the outer edge of a region.

Sierras: if checked, allows the creation of **Sierras** where the supports contact the part. Sierras allow the supports to be removed from the part with less force by only contacting the part at intermittent locations.

Braces: if checked, allows the creation of **Braces**. Braces are cross trapezoidal shaped supports created on the supports under the Sierra line. They stabilize the support.

Interior Perimeter: if checked allows the creation of **Projected Edges** for the interior holes within a region, otherwise, supports will be created right up to the inner edge.

Separators: if checked allows for the creation of **Separators** where the supports attach to the platform. Separators aid in detaching the supports from the build platform.

Solid Braces: if checked allows the creation of **Solid Braces**. Solid Braces makes it harder to detach the brace from the platform.

Scaffolds: if checked allows the creation of **Scaffolds** for a selected region. A scaffold provides a stable structure for a part that must be built in an unstable orientation.

Line Spacing: displays the **Line Spacing** basic support parameter value. Line Spacing is the spacing between the individual support lines in the grid work of the supports..

Supported Cutaway: displays the **Supported Cutaway** basic support parameter value. Supported Cutaway refers to the amount of a part area that should be self-supporting.

Unsupported Inset: displays the **Unsupported Inset** basic support parameter value. Unsupported Inset should be used in conjunction with the **Projected Edges** option. The inset is used to protect the edges of the part from damage when the support is removed.

Double Edge Distance: displays the **Double Edge Distance** basic support parameter value. Double Edge Distance refers to how close two support lines can come together before one line is eliminated.

Support Bottom: displays the **Support Bottom** basic support parameter value. Support Bottom allows the modification of a support bottom in its relation to the platform. By entering a positive value, the bottom of the support moves up in the Z dimension.

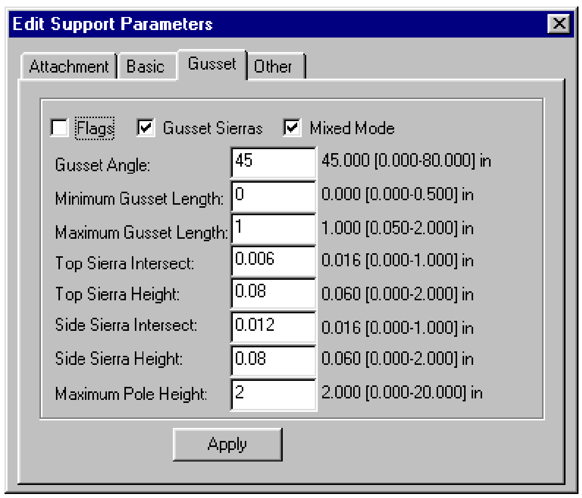


Figure 108. Edit Support Parameters Dialog Box (Gusset Tab)

The parameters available in the **"Gusset"** tab of the **"Edit Support Parameters"** dialog (Figure 108), are listed below.

Flags: if checked, allows **Flag** supports to be substituted for gusset supports in qualified regions. Flag supports do not touch the vertical wall so as not to leave marks on the wall as gusset supports do.

Gusset Sierras: if checked, allows the creation of **side** and **top** sierras in a gusset support, and **top** sierras of a flag support.

Mixed Mode: if checked, allows the creation of **regular** supports in areas that require additional support but which the gussets cannot reach.

Gusset Angle: displays the **Gusset Angle** parameter value which is the angle at which the gusset will be created.

Minimum Gusset Length: displays the **Minimum Gusset Length** parameter value which specifies the shortest possible length for a gusset in the Z-axis.

Maximum Gusset Length: displays the **Maximum Gusset Length** parameter value which specifies the longest possible length for a gusset in the Z-axis.

Top Sierra Intersect: displays the **Top Sierra Intersect** parameter value which specifies the vertical height of that portion of the top sierras which penetrates into the downfacing region of the part it is supporting.

Top Sierra Height: displays the **Top Sierra Height** parameter value which specifies the vertical height of each of the top sierras on triangular gusset lamina.

Side Sierra Intersect: displays the **Side Sierra Intersect** parameter value which specifies the length of the portion of the side sierras which penetrates the vertical wall of the part.

Side Sierra Height: displays the **Side Sierra Height** parameter value which specifies the height of each vertical row of sierras.

Maximum Pole Height: displays the **Maximum Pole Height** parameter value which specifies the maximum allowable vertical distance between the downfacing region and the closest upfacing region or the platform beneath the downfacing region, so as to qualify the region to be supported by flag supports.

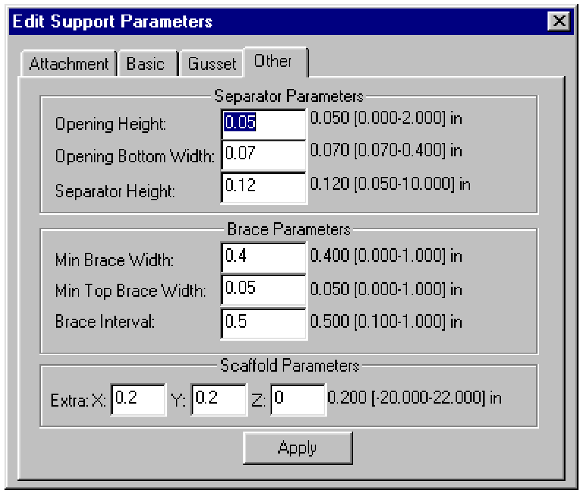


Figure 109. Edit Support Parameters Dialog Box (Other Tab)

The parameters available in the **"Other"** tab of the **"Edit Support Parameters"** dialog (Figure 109), are listed below.

Opening Height: displays the **Opening Height** parameter value which is the vertical height of each of the triangular or trapezoidal holes of a separator.

Opening Bottom Width: displays the **Opening Bottom Width** parameter value which represents the bottom width of the triangular or trapezoidal holes of the separators.

Separator Height: displays the **Separator Height** parameter value which is the vertical distance from the platform to the bottom of the separator holes.

Min Brace Width: displays the **Min Brace Width** parameter value which is the minimum value for the bottom width of a brace.

Min Top Brace Width: displays the **Min Top Brace Width** parameter value which is the minimum value for the top width of a brace.

Brace Interval: displays the **Brace Interval** parameter value which refers to the spacing between braces along a single support line.

Extra X: displays the **Extra X** parameter value which allows the **X** dimension of the scaffold to be modified. By changing the parameter with a positive value, the scaffold will increase size within the **X** dimension.

Extra Y: displays the **Extra Y** parameter value which allows the **Y** dimension of the scaffold to be modified. By changing the parameter with a positive value, the scaffold will increase size within the **Y** dimension.

Extra Z: displays the **Extra Z** parameter value which allows the **Z** dimension of the scaffold to be modified. By changing the parameter with a positive value, the scaffold will increase size within the **Z** dimension.

6. **Click the... [Apply] button to see the effect of your changes on the Supports showing in the workspace.**
7. **If desired, select a Region from the list (see Step 3, above) and click the... [Load] button to change the Support Generation Style file for the selected Supports Region.**
8. **Repeat the preceding step, as desired. Click on the "Reset" button if you make a mistake.**
9. **Click the... [Save] button to write any changes you made to the Supports Generation Style(s) to a custom SRG file.**
10. **Click the... [All] button to write to disk all of the changes you may have made to the Supports for the part showing in the main workspace,**

    OR...

    Click the... [Selected] button to write to disk any changes you may have made exclusively to one Supports Region.

NOTE!
Clicking the "All" button saves any changes made to the *original* Supports STL file, effectively "overwriting" the file that was generated by 3D Lightyear software.

Clicking on the "Selected" button gives you the opportunity to name a different file for the changed Supports STL, leaving the original file intact.

11. Click the... [All Regions] button to save any changes you may have made to the ODF file for the Supports you are editing (not the Supports STL),

OR...

Click the... [Supports and Regions] button to save any changes to the ODF and to the Supports STL.

12. Click the... [Close] button to exit the Supports Editor and load the edited Supports (if any changes were made) back into the main workspace.

13. Repeat this procedure, starting with Step 2, as necessary, for the Supports of each part on the Build Platform.

What is Meant by the "Default Build Styles will be Assigned" Warning?

When you edit supports generated with 3D Lightyear software, the first thing you will see is a dialog similar to one in Figure 110.

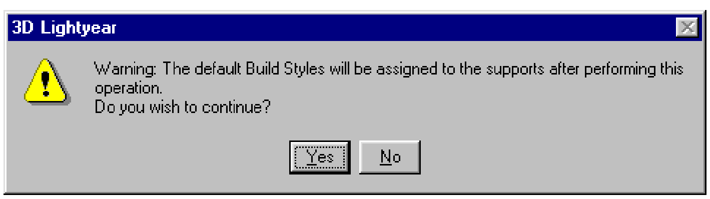


Figure 110. 3D Lightyear software (Warning)

3D Lightyear software includes a set of "default" styles, developed, through extensive research by our Process Engineers, to serve as a “Safe Starting Point” for building your parts and their supports. If you use the provided default styles, we estimate that 95-99% of the build jobs you prepare will execute successfully on your SLA system Buildstation.

Selecting the **"Yes"** button will assign the default build style to your supports.

Generally, the order in which you use 3D Lightyear software is as follows:

1. **Open or set up a Platform.**
2. **Load parts.**
3. **Verify.**
4. **Make copies, scale, etc.**
5. **AutoPlace (if necessary).**
6. **Modify part build styles**
7. **Create Supports.**
8. **Edit Supports.**

Adding and Deleting Supports—Custom Draw

Custom Draw is a kind of “sub-application”; a set of tools within the 3D Lightyear software application that run within that program. Using Custom Draw, you can:

- “Draw in” additional supports for regions of your parts you think will need reinforcing during the Build process
- Remove supports where they are not needed, thus reducing both the time it takes to complete the build process and the amount of time needed to finish your parts
- Edit existing supports to optimize their use in preserving your parts geometries

When you click the… [Custom Draw] button in the **"Edit Supports"** dialog, a separate window opens over the main, 3D Lightyear software workspace. The illustration in Figure 111, represents a typical Custom Draw workspace with an example support region already loaded.

The Main Custom Draw Workspace

This screen displays the selected support regions, region by region, of the part whose supports you are currently editing. This is the interface for all the tools you can use to add, delete, or change the shape of the supports for your parts—region by region.

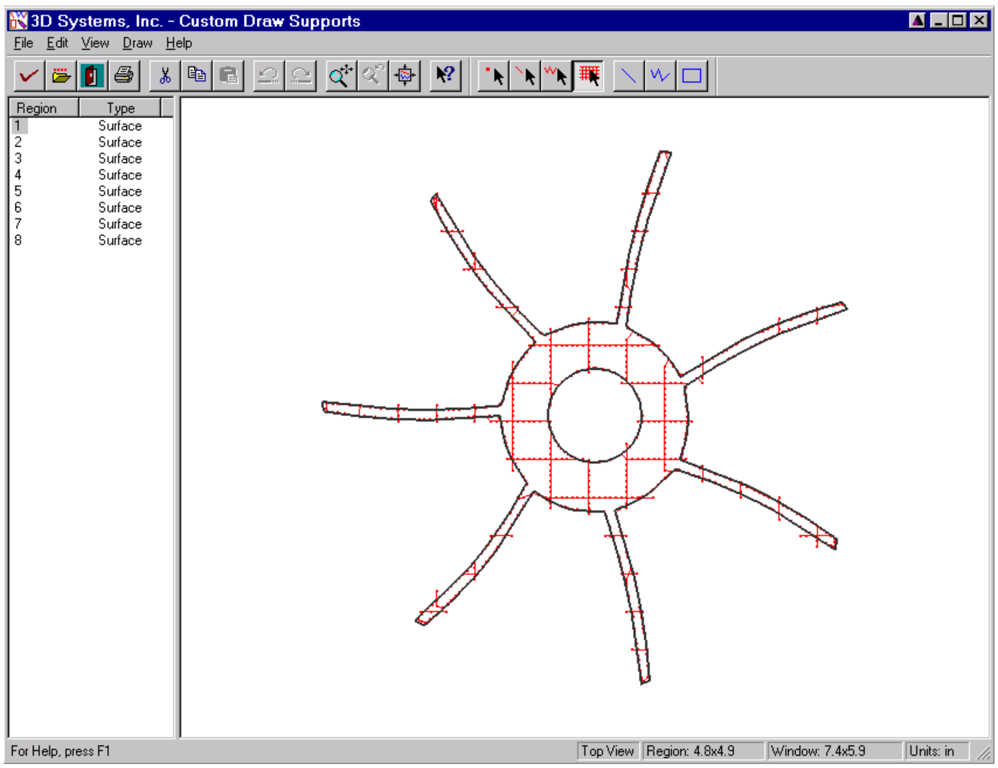


Figure 111. Custom Draw Interface and Workspace

Using the Custom Draw Interface

The shape of the current region shown in the workspace (its exterior and any interior perimeters) is represented as a SOLID BLACK LINE called the “Boundary Line”. (See Figure 112.)

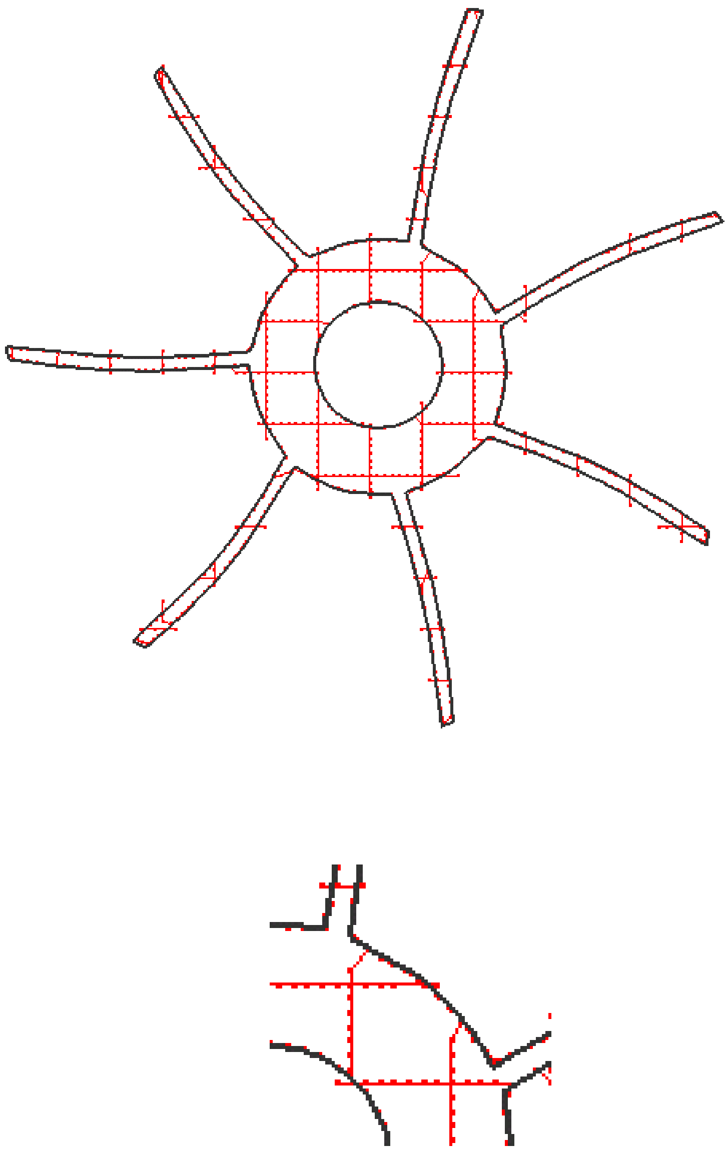


Figure 112. Boundary Lines

The supports generated by 3D Lightyear software associated with the selected region are represented as a series of colored (blue by default) lines connecting a series of points as illustrated in Figure 113.

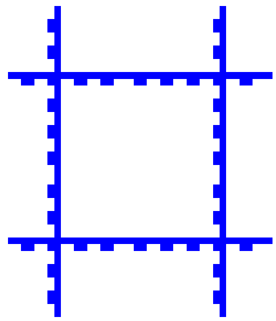


Figure 113. Support Points

Any braces attached to the currently displayed region are represented as pink line segments with discernible endpoints.

Gussets are represented as green line segments with discernible endpoints.

When you add supports to the region, the addition is represented as a dashed line/polyline/rectangle until you complete the action by releasing the mouse button.

Any time you select a feature, it changes color to show that it is selected (from its default color to **red**, the default for a selected element).

Loading Regions into the Custom Draw Workspace

When Custom Draw is opened, the default-selected region is the one which was selected in the “Edit Supports” dialog in 3D Lightyear software. You can load a region into the Custom Draw workspace by selecting one of the regions in the list. The region index number of the region in the workspace is always highlighted.

Alternatively, you can specify current region by one of the following methods:

- Left mouse clicking the index number in the Region Column
- Pressing the Up-arrow Key
- Pressing the Down-arrow Key
- Pressing the Page-up Key
- Pressing the Page-down Key

Using the Region List in Custom Draw

Figure 114 illustrate what the Region List box might look like in your Custom Draw session…

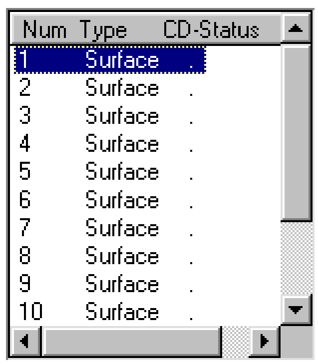


Figure 114. Region List Box in Custom Draw

This List Box displays all the “Regions” identified by the support generation routines as an area that may required supporting. Based on the type of region, its size, angle with respect to horizontal, and other factors, supports may or may not be created in a particular region. Therefore, it is possible that an identified region will not contain any automatically-created supports.

The three types of regions defined are **Surface**, **Line** and **Point** regions. Surface regions are supported with a grid-like support structure and are usually the large regions. 3D Lightyear software organizes the surface regions first in the Region List box. Line regions are the second priority. Line regions are supported by a single line of supports with cross-braces that only provide bracing for the support and do not intersect with the part. The last regions in the Region List box are the point regions. Point regions are generally the smallest regions and are supported with a single cross-web.

NOTE!
The order of the regions in the Edit Supports dialog is determined by region size. The numbers assigned are from largest region to smallest.

Changing the View of the Workspace in Custom Draw

This **"Zoom/Pan"**... tool is used to change the appearance of your workspace. It functions in a slightly different manner than the Zoom tool in the main workspace of 3D Lightyear software.

To magnify the view of the workspace to fill a defined area ("Rubber-band box" zoom IN):

1. **Click the "Zoom/Pan"... icon, then click, hold, and drag the mouse in the workspace to define a rectangular area you want to magnify.**

   You will see a dashed-line rectangle drawn.

   Release the mouse button to zoom IN so that the area you defined fills the workspace.

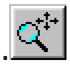
To interactively zoom IN/OUT:

1. **Click the "Zoom/Pan"... icon, then click, hold both mouse buttons anywhere in the workspace.**

   Drag the mouse upward (toward the top of the workspace) to zoom OUT.

Drag the mouse downward (toward the bottom of the workspace) to zoom IN.

To pan the view of the workspace:

1. **Click the "Zoom/Pan"...**  **icon, then click, hold the right mouse button anywhere in the workspace.**

   Drag the mouse in any direction to move the viewed area.

Drawing Functions

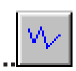
Three kinds of curves can be drawn into a support region. They are **Line**, **Polyline**, and **Rectangle**. The newly drawn lines or polylines are interpreted as support lines.

Draw a Line

To draw a line, the mode must be set to Line Drawing Mode. This can be done by clicking the **"Line"...**  tool in the Drawing Toolbar or through the pull-down menu **Draw-Line.**

In the Line Drawing Mode, move the mouse cursor to a location in the drawing area for the start point; press and hold left mouse button; drag the mouse to a location for the end point; release the mouse button. A line (Support) is drawn between the start point and end point.

Draw a Polyline

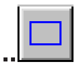
Set the mode to Polyline Drawing Mode by clicking the **"Polyline"...**  tool in the Drawing Toolbar or through the pull down menu **Draw-Polyline.**

In the Polyline Drawing Mode, move the mouse cursor to a location in the drawing area for the start point; press and hold the left mouse button; drag the mouse to a new location; release the mouse button. The point where the mouse button is released becomes the end point of the previous segment and the start of the next segment.

To draw the next segment, press and hold the left mouse button; drag the mouse to the desired location, and release the mouse button.

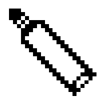
You can end drawing a polyline either by clicking the right mouse button to end the polyline and leave it open, or by double clicking the left mouse button to close it. The polyline represents the new supports.

Draw a Rectangle

Set the mode to Rectangle Drawing Mode by clicking the **“Rectangle”...**  tool in the Drawing Toolbar or through the pull-down menu **Draw-Rectangle.**

In the Rectangle Drawing Mode, move the mouse cursor to a location in the drawing area for one of the corner points; press and hold the left mouse button; drag the mouse to a location for the diagonal point; release the mouse button.

Using the Drawing tool in Custom Draw



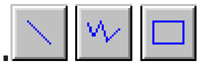
Drawing tool

This tool allows you to create your own supports and associate them with the region showing in the Custom Draw workspace.

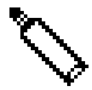
NOTE!
Supports you create will not actually be added to the displayed region until you click the region apply icon...

or pull down the “File” menu and select “Region Apply...”, or have “Auto Apply” selected in the “File” menu and change active regions by clicking on another in the list box.

To use this tool:

1. **Click one of the "Draw"...**  **icons.**

   The pointer in the Custom Draw workspace will change to...

   Click (and release the mouse button) in the workspace at the point you wish to begin drawing the line that will constitute the supports you are adding.

2. **Drag the drawing tool to the next intended point in your support structure, and click. The drawing tool uses a temporary dashed line to represent the new support. Once you click, the temporary dashed line becomes a solid line, signifying that you have drawn the support.**

3. **Repeat Steps 2 and 3 until you have drawn all the supports you wish to add.**

4. **If you are drawing a polygon, you can close the polygon, either by:**

   Double-clicking the starting point

   OR...

   Double-clicking an arbitrary point outside the area you wish to have enclosed by your polygon.

NOTE!
The drawing tool automatically closes the polygon constituting the supports you create. Unless you double-click on the starting point, it removes the last drawn side of the polygon and “snaps” to the first point you created.

This means that you must either double-click the starting point of your polygon, or draw one extra, temporary side, double-clicking at an arbitrary endpoint outside the area you wish to have enclosed by the finished polygon.

In order to fashion a triangle-shaped support, for example, you need to draw a four-sided polygon, double-clicking at a temporary, arbitrary fourth point somewhere outside the area you want enclosed by the triangle.

5. **Click the "Apply"... icon**

   OR...

   Pull down the "File" menu and select "Region Apply...",

   OR...

   Make sure that "Auto Apply" is selected (checked) in the "File" menu and change active regions by clicking on another in the list box.

Selection Functions

Vertices, line segments, and polylines of Support Lines or Brace Lines can be selected for copy, delete, or move. The selected entities are highlighted in red.

Select a Point

Set the mode to Select Point mode by clicking the **"Select and move a point"...** tool in the Drawing Toolbar or through pull down menu **Edit-Select Point.**

Under Select Point mode, left clicking a point selects it and deselects all the other entities. For multiple entity selection, hold down the **<Ctrl>** key while left clicking. Left clicking a selected point while holding down the **<Ctrl>** key deselects it.

Select a Line

Set the mode to Select Line mode by clicking the **"Select Line \ Move Entity"...** tool in the Drawing Toolbar or through pull down menu **Edit-Select Line.**

Left clicking a line segment selects this line and deselects all the other entities. For multiple entity selection, hold down the **<Ctrl>** key while left clicking. Left clicking a selected line while holding down the **<Ctrl>** key deselects it.

Select a Polyline

Set the mode to Select Polyline mode by clicking the **"Select Polyline \ Move Entity"...** tool in the Drawing Toolbar or through pull down menu **Edit-Select Polyline.**

Left clicking a polyline selects this polyline and deselects all the other entities. For multiple entity selection, hold down the **<Ctrl>** key while left clicking. Left clicking a selected polyline while holding down the **<Ctrl>** key deselects it.

Select All

Select all lines and points by clicking the **"Select All Lines \ Move Entity"...** tool in the Drawing Toolbar or through pull down menu **Edit-Select All.**

Left clicking anywhere in the viewer deselects all lines and points.

Editing Functions

The editing functions include Cut, Copy, Paste and Move. You make changes to the existing Support Lines or Brace Lines using these functions.

Cut Entities

Select lines and/or polylines to be cut; click the **"Cut"...** tool in the Main Toolbar or the **Edit-Cut** menu to delete the selected entities. You can also use the **<Delete>** key or **<Ctrl>+"X"** keys to delete the selected entities.

Copy Entities

Select lines and/or polylines to be copied; click the **"Copy"...** tool in the Main Toolbar, or the **Edit-Copy** menu to copy the selected entities into the *Copy Buffer*. You can also use the **<Ctrl>+"C"** keys to copy the selected entities.

Paste Copied Entities

With entities copied in the copy buffer, click the **"Paste"**... tool in the Main Toolbar or the **Edit-Paste** menu to paste the copied entities into the current region. You can also use the **<Ctrl>+"V"** keys to paste the copied entities.

Copy Entities between Regions

The Copy Buffer is global within the Custom Draw application. You can copy entities from one region, make another region as current and paste the copied entities into that region.

Move Selected Entities

Under either **“Select Line \ Entity Move”** mode or **“Select Polyline \ Entity Move”** mode, you can move the selected entities around. The **“Select Line \ Entity Move”** is a combined mode. So is **“Select Polyline \ Entity Move”**. Under either of the two modes, holding down the left mouse button and dragging the mouse for a certain distance switches the Select mode into Move mode. Releasing the left mouse button switches the mode back to Selection.

Left-clicking a vertex (point) selects it; dragging the mouse while holding the left mouse button moves the vertex around. The line segments sharing this vertex are stretched at the same time.

In the **“Select Line \ Entity Move”** mode, left-clicking a line segment selects it; dragging the mouse while holding the left mouse button moves the selected line segment around. The line segments sharing vertices with the selected line are stretched at the same time.

In the **“Select Polyline \ Entity Move”** mode, left-clicking a polyline selects it; dragging the mouse while holding the left mouse button moves the polyline.

To move multiple entities, press and hold the **<Ctrl>** key first; then hold the left mouse button; drag the mouse.

Saving Changes and Restoring Original Values

Region Apply

The **"Region Apply"**... function in Custom Draw applies any changes you have made to the support region currently showing in the Custom Draw workspace. You can see the changes you make to the supports for a region back in the main 3D Lightyear software workspace at the end of a Custom Draw edit session. (If you reduce the Custom Draw window, allowing a portion of the main window to show, you can see the application of changes without leaving Custom Draw.)

You can also apply updates to the displayed region by pulling down the **"File"** menu and selecting **"Region Apply…"**, or by having the **"Auto Apply"** function enabled (checked) in that same menu. With **"Auto Apply"** *on*, any changes you make to the displayed region of supports are applied whenever a different region is loaded, or when you exit Custom Draw.

Region Reload

The **"Region Reload"**... function allows you to discard any modifications you make to the region currently showing in the workspace since you last used the **"Region Apply"** function.

Instead of clicking on the icon, you can also access the function by selecting **"Region Reload"** in the **"File"** menu.

NOTE!
The Region Reload function is a "one-in-one-out" facility. You can only restore the region currently showing in the workspace to the state it was in *after you last used the Region Apply function.*

Undo and Redo

The **"Undo"**... and the **"Redo"**... functions allow you to undo (or cancel) the last command, or last set of changes, or redo a canceled command, or the last set of canceled commands.

Techniques for Quicker Editing of Supports.

1. Switch from **“Draw Polyline Mode”** to **“Select Polyline Mode”** and vice versa by clicking the right mouse button.

2. Switch from **“Draw Line Mode”** to **“Select Line Mode”** and vice versa by clicking the right mouse button.

3. Switch from any selection or drawing mode to the zoom mode and vice versa by pressing the **“z”** key on the keyboard.

4. Delete the selected line or lines by pressing the **<Delete>** or **“x”** key on the keyboard.

Customizing the User Interface

The Main Toolbar and Drawing Toolbar are moveable and dockable. You can drag them to anywhere in the window or dock them along the application window frame. These two toolbars can also be toggled on or off through the pull down menus **View-Main Toolbar** and **View-Drawing Toolbar** respectively.

Why Translating Parts Makes Their Supports "Invalid" for Editing

Because the ODF file containing the information on the location of the supports does not monitor the orientation of those supports in the workspace. The positional data on the supports—which are actually a separate STL file—once created and stored in the ODF, remains static; it does not “update” if you translate your parts.

NOTE!
If you translate or rotate your parts —together with their supports—in the X or Y axes, you will be presented with the following “error” message:

Figure 115. The supports may become invalid (Warning Box)

NOTE!
If you attempt to edit the supports subsequently, 3D Lightyear software will load (and then SAVE) the *OLDER*, pre-translated support STL. This will effectively and irrevocably separate your part STL from its supports. You will have to delete the support STL and create new supports.

Importance of the "Minimum Support Angle" Setting

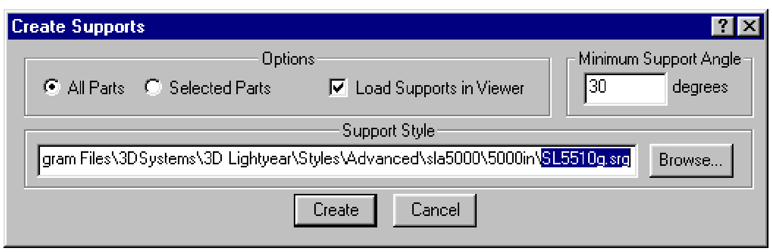


Figure 116. Create Supports Dialog with Minimum Support Angle

The value represents the largest angle (with respect to the Build Platform, considered 0°) of any down-facing and near-down-facing regions for which the program's Support Generator considers a supportable region. The range for this setting is 0 to 90°. (As stated earlier, whether the program actually creates supports for the regions depends on many other factors.)

NOTE!
Exercise caution in having 3D Lightyear software generate fewer or more supports than the default.

Too few supports, and your parts could "crash" during a build because of "sagging" or separating layers. Too many supports, and you may have more difficulty obtaining a serviceable surface finish during post-processing.

Increasing and/or decreasing 3D Lightyear software's quantity of supports generated for your parts is an acquired skill. Remember, both part geometry and properties of the resin being used in a build constitute variables in any hypothetical equation to determine the optimum setting for the "Minimum Support Angle". Thus, since these variables, in fact, can vary so much, most SLA system users find that only through experience building their particular type of parts can they gain a "sense" of what works best for them.

If you do decide to "experiment" due to some less-than-desirable characteristic in the parts you are building, making relatively small changes in the Minimum Support Angle setting is strongly advised.

The Regions List box

This List Box displays region number, type, and status of all the Support Regions available (for the part whose supports you have opened in the editor).

- *"Num"* is the Region number, assigned based on the physical size of the Region, arranged from largest to smallest.
- *"Type"* is 3D Lightyear software's description of the classification of the feature of your part for which the supports have been generated.
- *"CD-Status"* is the current status of the listed region relative to "Custom Draw". This is blank in its initial state, or show "edited" if you change or add supports using the Custom Draw facility.

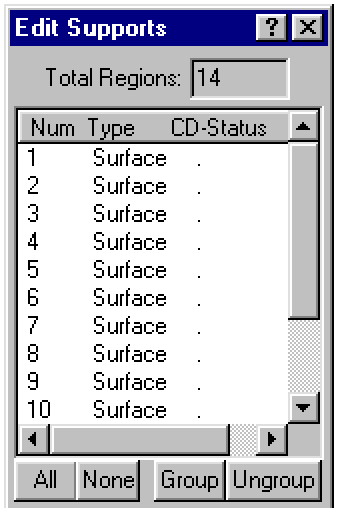


Figure 117. Regions List Box

When you click on a region in the list, the associated Supports change color in the Supports Editing workspace to signify that they too are selected.

Press and hold **<Shift>** or **<Ctrl>** key while clicking on Regions in the list to select more than one region at a time (for Grouping, and otherwise applying parameters changes to more than one Region simultaneously).

Clicking on one, or **<Shift>** or **<Ctrl>** clicking on more than one of the listed Regions, has the same effect as clicking on the Supports (or Regions) themselves in the Supports Editing workspace.

Using the Orienting Tools to Optimize Build Speed

The icons below represent the graphical tools for changing the way your parts are situated on the Build Platform. Each of these tools are fully described in the section ***"Using Other 3D Lightyear software Tools and Functions"***.

“Copy”..., “**Delete\Unload**”..., “**Translate**”..., “**Rotate**”...,

“**Scale**”..., “**Mirror**”..., “**inch to mm**”...,

“**mm to inch**”..., “**Make Downfacing**”...,

“Make Upfacing”...,

“Pick and Point [In Top, Bottom, Front, Back, Left, Right View]”....

NOTE!
You can also access each of the functions represented by these icons in 3D Lightyear software by pulling down the “Edit” menu and selecting the associated item.

To better understand the techniques involved in developing optimum parts orientation, a cursory examination of some of the tenets of the stereolithographic process with respect to the orientation phase of parts preparation is necessary. To wit:

AXIOM:
SLA system time costs money. The more parts you can build simultaneously in a job on your SLA system, the sooner you will begin to realize a return on your Rapid Production and/or Prototyping investment.

THEREFORE:
Usually, it is a good idea to use both the Auto-Place tool and the other, manual orientation tools available in 3D Lightyear software to fit as many parts as possible onto your Build Platform at one time.

AXIOM:
The amount of time it takes to build an object using stereolithography can vary depending upon the orientation of that object on the Build Platform. Remember, all the parts are ***sliced*** along their Z-axis by 3D Lightyear software as part of their conversion to build files. This slicing process essentially turns your three-dimensional objects into a series of vertically stacked layers. Depending upon the build and recoat style parameters chosen for a particular part or a region of that part, different laser manipulations and controls can take place, layer by layer, as your object is analyzed. Some “manipulations” take longer than others, and the application of certain styles can also have an effect on the amount of time it takes to finish a layer on the SLA system.

THEREFORE:
If you are not happy with the amount of time it takes to build your parts on your SLA system machine, experiment by changing the orientation of individual objects on the Build Platform, and with the orientation of objects relative to one another on the Build Platform.

AXIOM:
The process of building objects using stereolithography produces smooth up-facing surfaces. Side-wall, and “near-flat” (or almost-up-facing) surfaces are less smooth (relative to up-facing surfaces), and down-facing surfaces have the roughest surface finish (again, relative to up-facing surfaces).

THEREFORE:
Depending upon the downstream application in which you intend to employ your stereolithographic parts—design evaluation, testing, mold making—you should analyze the geometry of each object you intend to build in order to determine which of its surfaces you wish to reproduce in solid resin with the highest degree of smooth surface finish out of the vat. Orient the object(s) based on your analysis.

How Does Part Orientation in the Z Axis Affect a Build?

Orient the parts to minimize the overall height of the object. This reduces the number of layers to be built, thereby reducing the build time.

Build Time and Part Orientation in the X and Y Axes

Except for the very early SLA systems (i.e., the SLA 190), all SLA systems make use of a "sweeper" blade (either a regular "Doctor" blade, or the more advanced "Zephyr" blade) that helps even the distribution of liquid resin atop the layer last cured.

This sweep, when executed, must be slow and deliberate in order to preclude the generation of bubbles or other physical phenomena in the vat that could effect the surface quality of the finished parts. That is, we have to be careful with the sweep-phase of each layer's build, and it is this extra care that imbues the entire stereolithography process on the SLA system with a significant amount of additional, non-laser time on a layer-by-layer basis.

Auto-Place performs a basic optimization of your parts in an effort to minimize the amount of time that your SLA system spends sweeping the vat during the build. This is known as "SmartSweep".

What is "SmartSweep"?

SmartSweep is a feature used to reduce the build times by sweeping only over that portion of the vat where a part is being built instead of sweeping the full area of the vat.

NOTE!
By default, 3D Lightyear software's Auto-Place function orients each of the parts on the build platform relative to each other, relative to the build platform itself, and relative to all three axes.

If you do not wish to change the orientation of your parts relative to the Z axis with Auto-Place...

1. **Pull down the "Tools" menu in the main workspace.**
2. **Choose "Options". This will bring up the "Options" dialog (Figure 118).**

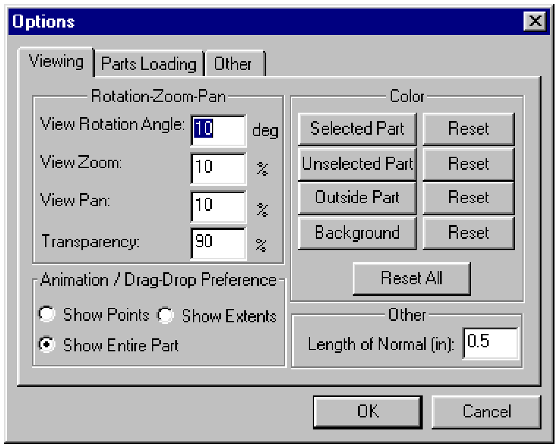


Figure 118. Options Dialog Box

3. Click on the sheet tab labeled "Other".

4. "Uncheck" the box for "Move parts in the Z direction during Auto-Place" (Figure 119).

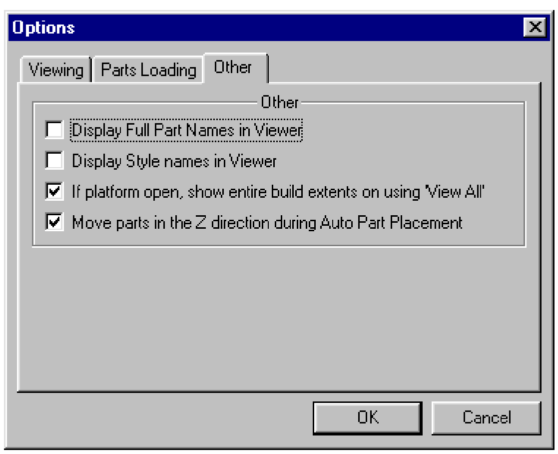


Figure 119. Options Dialog Box (Other tab)

Tools for Increasing Part Accuracy

Shrink Compensation

Shrink Compensation values are used to offset the shrinkage factors for the type of Resin you selected. All UV-photosensitive resins shrink when cured The values for the amount of shrink are determined by 3D Systems, and should work with any geometry. For maximum accuracy, build and measure CHRISTMAS-TREES using the AccuMax Data Analysis software.

Determining the Correct "Beam Width" Setting

Step 1 of the "New Machine Setup Wizard" dialog prompts you for values from your SLA system that 3D Lightyear software uses when determining how to slice your parts while creating build files.

Notice that the entry fields are for “***Beam Widths***”. 3D Lightyear software and 3D Systems’ *Buildstation Controller Software* both distinguish between *cured linewidth* and *laser beam width*.

Laser *beam* width is used to ***calculate*** the cured *line* width that 3D Lightyear software uses in determining how to slice your parts.

The values for these *beam* width fields are set to known defaults by 3D Lightyear software, based on the selection you make for Machine Type. If you know the actual beam width, enter it during the machine setup.

What are "Laser Beam Width" and "Line Width Compensation"?

Laser Beam Width, is the width of the laser beam at the surface of the resin. Line Width Compensation is the measurement of, and compensation for, the width of a cured line of resin, and is important for two reasons. The line width should also be known and compensated for, to further preserve the overall dimensional accuracy of a stereolithography part.

Border vectors delineate the perimeter of a layer. Line width of a border vector is yet another key factor in the dimensional accuracy of a stereolithography part. The line width of the border vector should be compensated for in the overall dimension of the part.

Figure 120 below illustrates the difference between compensating for, and not compensating for the width of the border vector in the overall dimensions of the part. Line width compensation is used to move the border vectors in the X/Y plane toward the solid volume of the part by a distance equal to one-half the width of a cured border vector. Without such an adjustment, exterior dimensions would be too large by one line width (half of one line width on each side of the part). Similarly, interior dimensions would be too small by one line width.

After the line width compensation is calculated, the hatch vectors are automatically adjusted and bound by the new offset border vectors.

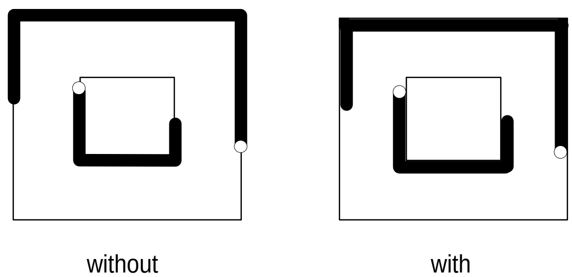


Figure 120. Line Width Compensation

High Resolution Spatial Tolerance Check Box

This version of 3D Lightyear software adds a new feature that helps maintain part accuracy in highly tessellated parts. You enable the feature by clicking the check box in the **"Modify Build Styles"** dialog next to the function **"High Resolution Spatial Tolerance"**. This feature should be used only when you notice "notching" in a surface (especially a curved surface) on a highly tessellated part where you expect the surface to be smooth.

Minimum Z Height

What is "Correct Minimum Z Height"?

The minimum allowable vertical distance between the surface of the SLA system Build Platform and the bottom-most layer of your parts is called the "Minimum Z Height". The ***correct*** distance to allow for the fabrication of anchoring supports between the Build Platform and the bottom of your parts is typically ***greater than*** this minimum.

The ***correct*** positioning of a part in the Z axis ***must*** take into account the discrete height above the Build Platform necessary for the SLA system to fabricate supports during a build job. These settings are listed in the following table. ***NOTE*** that this distance is different for different types of 3D Systems' stereolithography machines.

Table 2. Minimum Z Height

Type of SLA	Correct Minimum Z Height	Minimum Z Height
190, & all types of 250's,	7.62 mm (0.300 in)	6.35 mm (0.250 in)
350, 3500, 500, 5000, & 7000	10.16 mm (0.400 in)	7.62 mm (0.300 in)

Can I Go Higher?

Yes, but you probably do not really want to. Remember, the "taller" your part, the longer it takes to build.

3D Systems' Process Engineering has developed—and continues to provide constant refinements to—the Minimum Z Height values for each SLA system type and Resin. Over time, and after considerable experimentation, you may find it beneficial, under some circumstances, to increase the Minimum Z Height value in 3D Lightyear software for a build job. You may discover, for example, that the anchoring supports are easier to remove from the base of a part with a particular geometry built with a particular Resin.

Can I Go Lower?

Yes, and while this may save time and Resin (which is desirable), again, we recommend you exercise extreme caution. You may run into trouble with the "Safe Sweep Zone" and with getting removal tools "safely" between the bottom of your part and the surface of the physical Build Platform.

The Safe Sweep Zone

When a 3D Systems' Field Engineer installs and performs the initial calibration of your SLA system he/she makes a determination of the minimum distance required for the Recoating Blade to operate safely (this distance is often slightly different from SLA system to SLA system due to manufacturing tolerances). He/she programs a "Safe Sweep Zone" into the machine controls based on this measured distance.

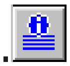
NOTE!
Setting the minimum Z height in 3D Lightyear software to a value less than the safe sweep zone setting on the SLA system for which you are preparing parts will cause a portion of the part(s) to start building in the Safe Sweep Zone. While building supports without sweeping is OK, building the part without sweeping will cause your build to crash.

Changing the Minimum Z Height Setting

1. **The Minimum Z Height can be changed by changing the "Min Support Height" value in the "New Platform Configuration dialog, which can be accessed by selecting "Load Empty Build Platform" from the "File" menu.**

Viewing and Getting Information on Layers of a Sliced Object

NOTE!
The Layer Properties display box is only available for parts in the workspace that are SLI, BFF, or V file objects.

1. Once you have "sliced" (prepared) your parts and loaded a BFF into the workspace, click the "Layer"...  **icon ...or select "Properties/Layer..." from the "View" pull-down menu. The "Layer Display" dialog appears as shown in Figure 121.**

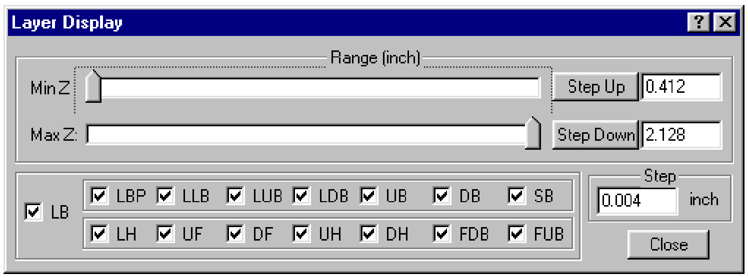


Figure 121. Layer Display Box

Note when this dialog active, only the region of the selected object that falls between the “Min Z” and “Max Z” parameters are visible. The different types of boundaries and vectors will be displayed for BFF, V, and SLI files.

BFF files show only border vectors (no hatch or fills), but upfacing, downfacing, layer, and layer prime borders are all different colors. The same is true for SLI files for SLA 350/3500, SLA 500/5000, and SLA 7000. The SLA 7000 also has different colors for large and small spot.

V files should show hatch and fill vectors as well as all the border types in different colors. The same is true for SLI files for SLA 190 and SLA 250. The unselected files will be displayed in a single color.

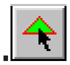
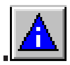
You can choose to see only certain types of boundaries by checking their names in the dialog. Only checked boundaries or layers will be visible.

There is no range set for the Min or Max edit field. The ranges of the edit fields and the sliders correspond to each other and are respectively equal to the Minimum and Maximum extent of all the parts open.

For further information on the individual vector classes and vector types, see the chapter, “Reference Topics”.

Viewing and Getting Information on Triangles in an STL File

You can display the properties of individual triangles in the tesselated part by:

1. Select one or more triangles using the "Select Triangles"...  **tool, then click the "Triangles Properties"...**  **icon to open the "Selected Triangle Properties" display box as shown in Figure 122.**

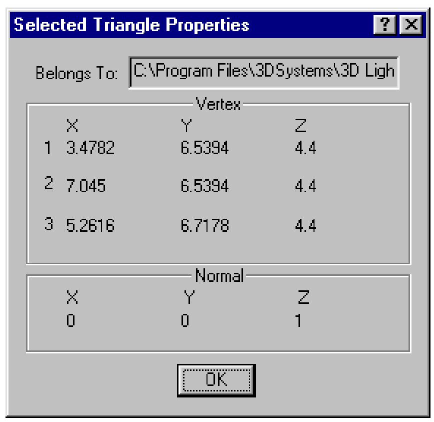


Figure 122. Selected Triangle Properties Display Box

NOTE that when this display is active, the coordinates of the selected triangles are also displayed. This is to make it easier to match the object to the information being displayed in the box when a series of triangles are selected. The extents information in the workspace disappears when you close the properties display box.

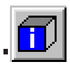
Click the... 

button to see the parameters for each of the selected triangles in the workspace.

Viewing and Getting Information on Part Properties

You can display the properties of parts in 3D Lightyear software.

To open the display box:

1. **With at least one part selected, click the “Part Properties”...**  **icon open the "Part Properties" display as shown in Figure 123.**

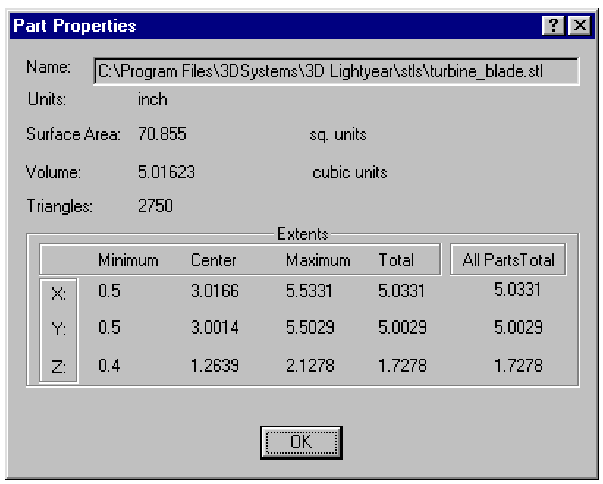


Figure 123. Part Properties Display Box

Note that when this display is active, the coordinates of the extents of all objects on the Build Platform are also displayed. This is to make it easier to match the object to the information being displayed in the box. The extents information in the workspace disappears as soon as you close the display box.

Cress the... 

button to see the parameters for each of the selected parts in your workspace.

Part Loading Options

The **"Options"** dialog (Part Loading tab selected) as shown in Figure 124, allows you to place the part(s) at a desired location during loading.

"Load as is": loads the part(s) at the location specified in the STL or SLC file.

"Load at preferred location": loads the part(s) at the X, Y, and Z coordinates specified in the edit fields. These values represent the location of the minimum extents of the part.

"Center of Platform": when **"Load at preferred location"** is active, and this box is checked, loads the part(s) at the center of the platform.

"Smart Z Placement": when the **"Load at preferred location"** is active, and this box is checked, loads the part(s) at a height of 0.300 inches for an SLA 190 and SLA 250, and 0.400 inches for all other SLA systems. These values represent the recommended minimum height for creating supports for that type of platform.

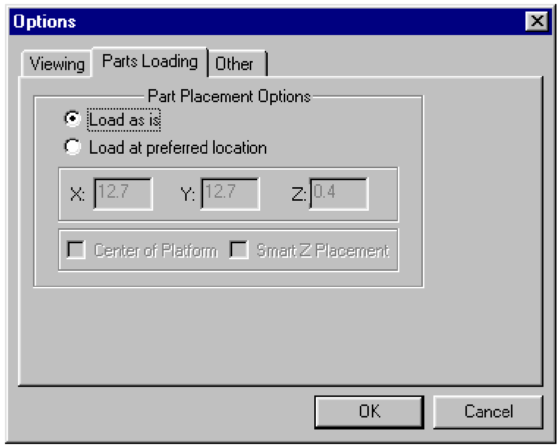


Figure 124. Options Dialog Box (Parts Loading Tab)

Using the Reference Plane

Selecting **“Reference Plane...”** from the **“Tools”** menu opens the **“Reference Plane Control”** dialog as shown in Figure 125. This dialog allows you to display a grid or solid plane on either the X, Y or Z-axis. When the dialog opens the cross section plane is automatically activated about the Z axis, as shown in Figure 126. You can also set the number of grids displayed in each axis.

The movement of the plane along the selected axis is governed by the extents of the part for that axis. The level of the plane within the extents is controlled by the “Level” slider. The “Level” slider will always set itself to the minimum value whenever an axis is chosen.

To raise or move the plane anywhere up to the maximum extent:

1. **Type an absolute amount in the number box and press <Enter>.**

   or

2. **Reposition the slider using the mouse.**

The slider bar works like a standard slider (or scaler). The numbers in the number box update accordingly as the slider is moved.

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Using Other 3D Lightyear Software Tools and Functions

Using the Trackball and Mouse to Change the Views in the Workspace

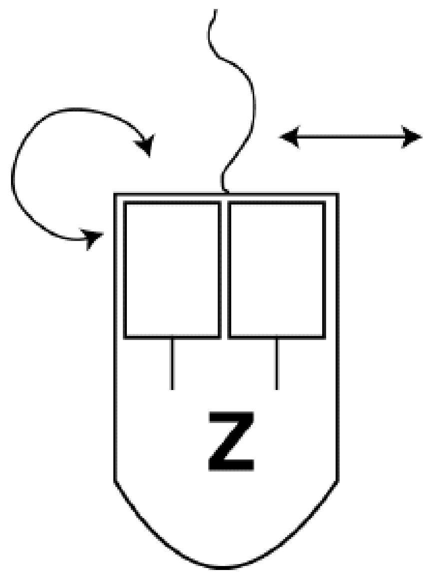


Figure 125. Trackball Cursor

This illustration represents the cursor icon used in the 3D Lightyear software workspace whenever you are in the program's **"Modify View"** mode. You use this mode to change your view of the workspace with simple clicks and drags of your mouse.

The "buttons" in the diagram correspond to the buttons on any, standard two-button mouse.

When in the **"Modify View"** mode, each mouse button has a specific function. "Chording", or clicking and holding both mouse buttons simultaneously also serves as a distinct tool.

You activate 3D Lightyear software's Modify View Mode by clicking the **"Modify View (Trackball)"**... icon on the **"Main Toolbar"**. Alternatively, pull down the "**View**" menu and choose "**Modify View**". The cursor in your workspace changes to the... icon as illustrated in Figure 127.

NOTE!
If your mouse is equipped with a scrolling wheel, (Microsoft Intellimouse) you can Zoom IN by rolling the wheel down (toward you), and Zoom OUT by rolling the wheel up (away from you).

Note too that the wheel effects zoom changes even when you are pressing the other mouse buttons to pan or spin the view. This means that, if you are dextrous enough, you can zoom-spin, zoom-pan, etc.

The "Print" Function

The **"Print"**... function allows you to obtain "hard copy" output of the workspace. By default, the facility uses the output device you have set up as your printer, either on your network or directly connected to your workspace.

Copy Selected Parts

The **"Copy Selected Part"**... function is used to copy the selected parts. You can select one or multiple parts. You specify the number of copies and their spacing using the dialog shown in Figure 126. Copies are offset from the previous part by the Offset distance values

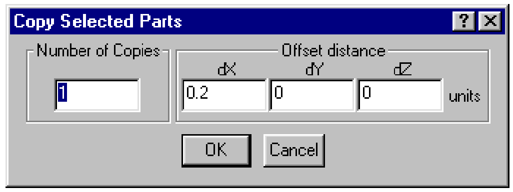


Figure 126. Copy Selected Parts Dialog

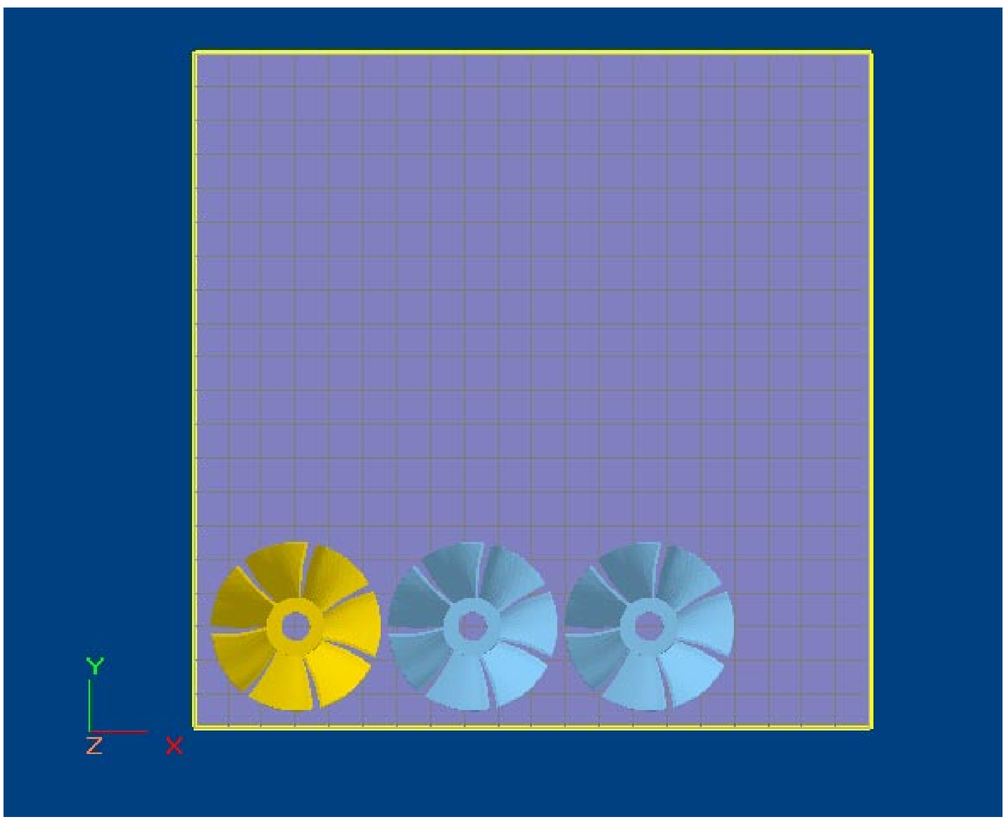
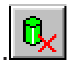


Figure 127. Original and two copies of the Turbine Blade

Delete Selected Parts

The **"Delete Selected Parts"**... function is used to delete the selected part or parts. A confirmation dialog, as shown in Figure 128, is displayed before the operation is actually performed.

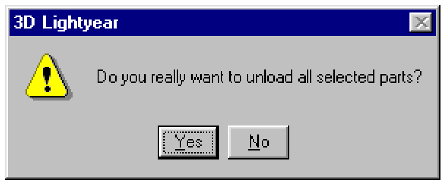
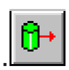


Figure 128. Confirmation/Unload Selected Parts?

You can also delete selected parts by pressing the **<Delete>** key on your keyboard. You can unload parts by selecting **"Unload Parts"** from the **"File"** menu.

Translate Selected Parts

The **"Translate Selected Parts"**... function is used to translate (move) the part or parts along one ore more of the axes. On selecting this option, the dialog shown in Figure 129, is displayed. The X, Y, and Z distances entered in the three edit fields specifies the relative or absolute locations, depending the option selected in the dialog. You can also use the dialog to translate the part to the origin.

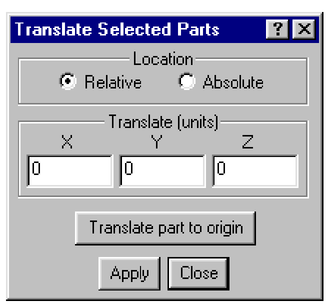
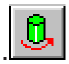


Figure 129. Translate Selected Parts Dialog

Rotate Selected Parts

The **"Rotate Selected Parts"**... function is used to rotate the selected part or parts about the X, Y, or Z axis. On selecting this option, the dialog shown in Figure 130, is displayed. The rotation angles can be entered in the X, Y, and Z edit fields. The center-of-rotation can be changed using the two options provided in the dialog. The part or parts can either be rotated about its own center of extents or about the location specified in the lower three edit fields. If non-zero values have been entered, then the order of rotation is, X axis, then Y axis, and then Z axis.

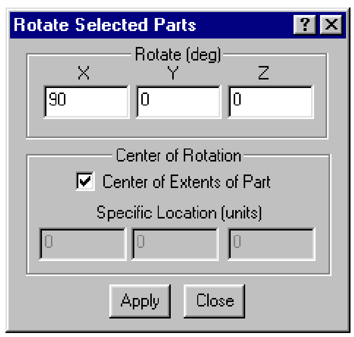
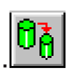


Figure 130. Rotate Selected Parts Dialog

Scale Selected Parts

The **"Scale Selected Parts"**... function is used to scale the selected part or parts in an X, Y, and/or Z direction. On selecting this option, the dialog shown in Figure 131, is displayed. The part can be scaled equally along the X, Y, and Z axes by checking the **"Same amount in all directions"** option. The scale percentage is entered in the field next to the option. If you uncheck this option, the part can be scaled by different amounts in the three directions. The scales are performed with respect to the minimum extents of each part.

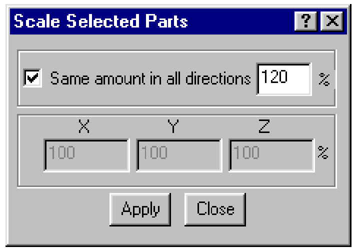
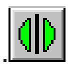


Figure 131. Scale Selected Parts Dialog

Mirror Selected Parts

The **"Mirror Selected Parts"**...  function is used to mirror the selected part or parts about the X-Y, X-Z, or Y-Z plane. On selecting this option, the dialog shown in Figure 132, is displayed. The distance between the mirrored part and the original part is specified in the single edit field in the dialog. The mirrored part is always placed on the more-positive side of the original part.

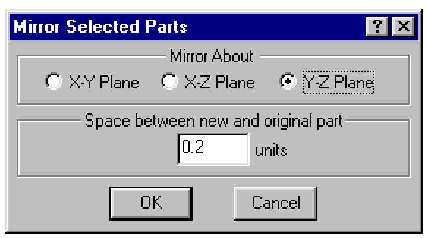


Figure 132. Mirror Selected Parts Dialog

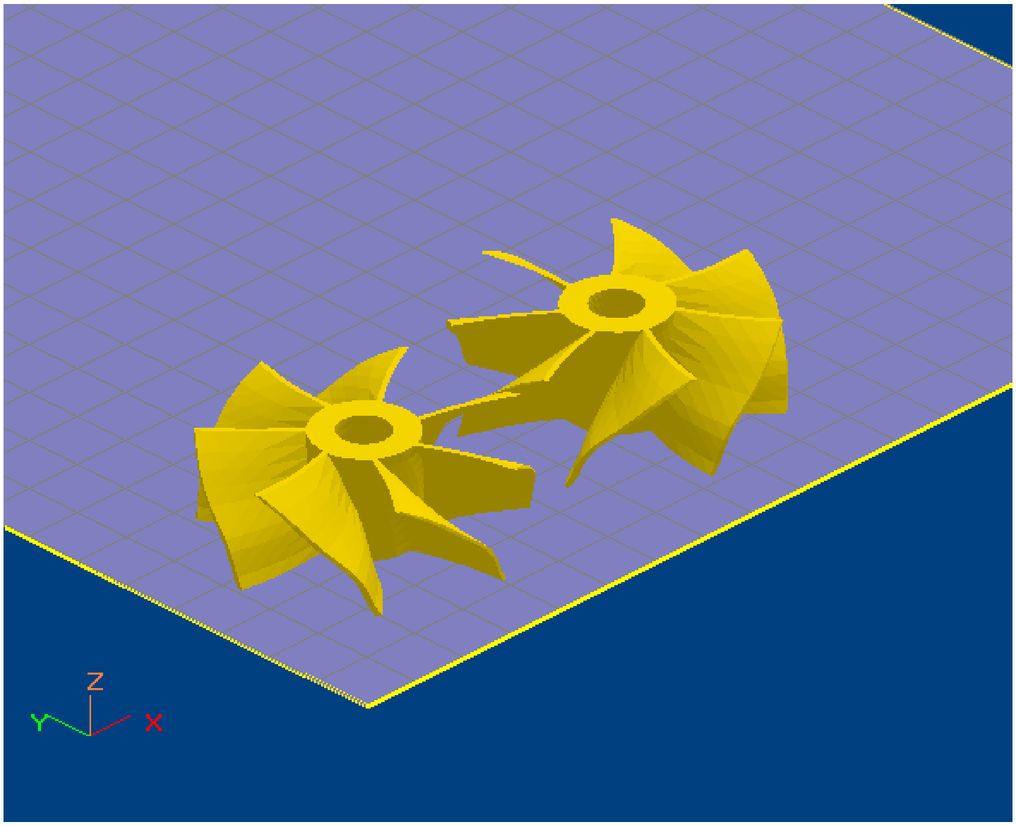
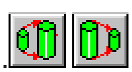


Figure 133. Mirrored Copy of Turbine Blade on Right

The "Change Units" Function

The “Change Units”... functions allow you change the units **“inch to mm”** and **“mm to inch”** on all the parts displayed in the viewer. The change must me made prior to creating supports.

The message asking if you wish to proceed, shown in Figure 134, appears after clicking either one of these icons.

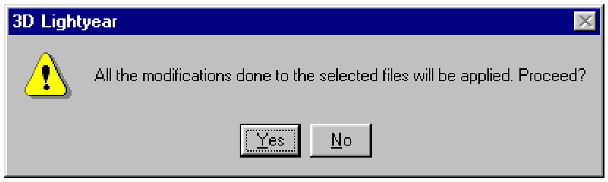
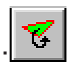
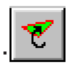
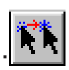


Figure 134. Proceed? Box

Make Downfacing or Upfacing Plane

The **"Make Downfacing"**...  and **"Make Upfacing"**...  functions, active when there is exactly one triangle selected per part, make the selected triangle either a downfacing or upfacing triangle; that is, it make the triangle parallel to the platform. The primary purpose of these functions is to ensure that selected surfaces are valid for the application of Vents and Drains in QuickCast build styles. These functions also work with multiple parts simultaneously as long as only a single triangle per part is selected.

Pick and Point

The **"Pick and Point"**...  function is used to place a part precisely at a desired location. This option can only be used in the **Top**, **Bottom, Front**, **Back**, **Left** and **Right** view. Switch to one of the views, select the part with a left mouse click, and then click on the spot where the part needs to be placed. The part automatically moves to the selected spot. Note that the point that was clicked to select the part, moves to the location indicated while placing the part.

Working with the View Parameters

3D Lightyear software allows great flexibility in the way you work with its tools and features. One of the first things you'll notice is how many ways you can “customize” the workspace display, with respect to both the manner in which objects are displayed, and your perspective on the workspace itself. Often, things such as changing the “virtual” lighting on a part, or enabling the display of the Triangle Normals can help you to isolate problems that could prevent the part preparation process (and subsequently your build) from completing successfully.

NOTE!
Some of the tools and menu selections listed/shown in the 3D Lightyear software window are enabled (available as valid selections) only when you have loaded parts on to the Build Platform.

Changing the Color of Your Workspace Display

You can change the color of the **Selected Part**, **Unselected Part**, **Outside part**, and **Background** using the “Options” as shown in Figure 135. Clicking one of the color buttons, brings up the **"Color"** dialog as shown in Figure 136.

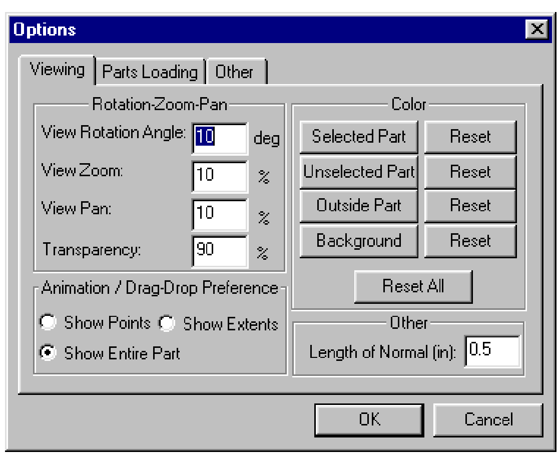


Figure 135. Options/Color Dialog

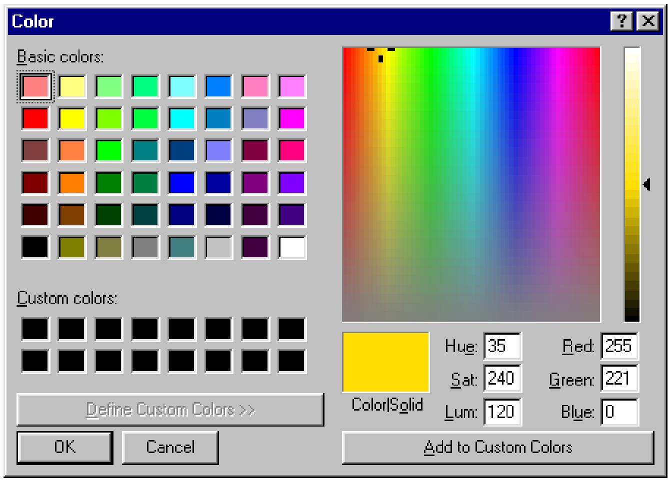


Figure 136. Color Dialog

Light Intensity and Position

The intensity and position of the lighting in the workspace is changed using the **"Light Properties"** dialog as shown in Figure 137. You access this dialog by selecting **"Light Instensity and Position..."** from the **"View"** pull-down menu. This option is used to specify the new light intensity and position of the light source in the view.

On selecting this option, the dialog shown in Figure 137, is displayed. The four sliders are used to modify the intensity (0 to 100% scale) and the absolute position of the light. The **"Reset"** button will set all four to their default values. Changes are reflected in the view area only after clicking the **"Apply"** button.

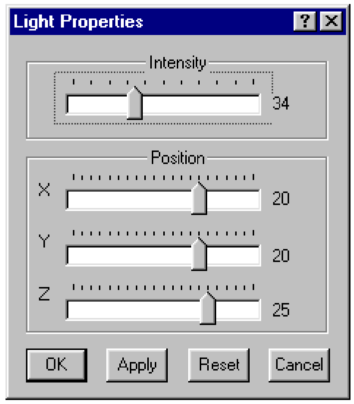


Figure 137. Light Properties Dialog

Setting Your View Preferences

To set your viewing preferences:

1. **Click on "View" from the main menu, to open the "View" Pull-down menu (Figure 138).**
2. **Select "Preferences" from the menu and click on the desired options in the pop-up menu to the right.**

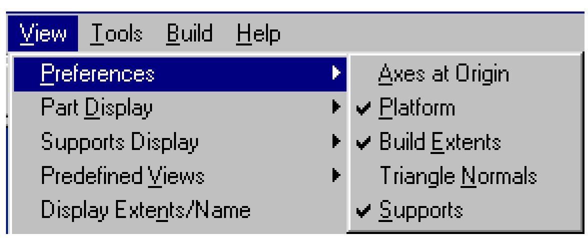


Figure 138. View Pull-down Menu (Preferences)

- **"Axes at Origin":** shows or hides an X, Y, and Z axes indicator at the Zero Point or "origin" of the Build Platform

  The checkmark next to this selection means that the axes indicator is ON. Many users find it useful to keep this feature turned on for a quick, visual reminder of "which way is up", when spinning and/or rotating the workspace display with the trackball view modifier tool.

- **"Platform":** shows or hides the physical representation of the SLA system Build Platform in your workspace.

  A checkmark next to this selection activates a colored square representing the Build Platform.

- **"Build Extents"**: shows or hides the display of the Build Extents in your workspace.

  A checkmark next to this selection means that you can see a faint "box" extending upward from the Build Platform. This "box" is a representation of the "buildable area" for the type of SLA system you have chosen with the New Machine Setup Wizard.

- **"Triangle Normals"**: shows or hides the display of the Triangle Normals in your workspace.

  Clicking here activates the display of small vectors extending outward from the center of each triangle that makes up the parts on the Build Platform.

  This setting is often used to help isolate problems with STL files. "inverted" triangles show up with opposing normals on adjacent facets.

- **"Supports":** shows or hides the supports for objects in your workspace.

  Clicking here activates 3D Lightyear software's display of any support structures you create for your parts.

Setting the Display Parameters for Parts

To set the display parameters for parts:

1. **From the "View" Pull-down menu, select "Part Display".**
2. **Click on the desired options in the pop-up menu to the right (Figure 139).**

NOTE!
The settings for displaying your parts in the workspace are mutually exclusive. You can only activate one of the settings at a time.

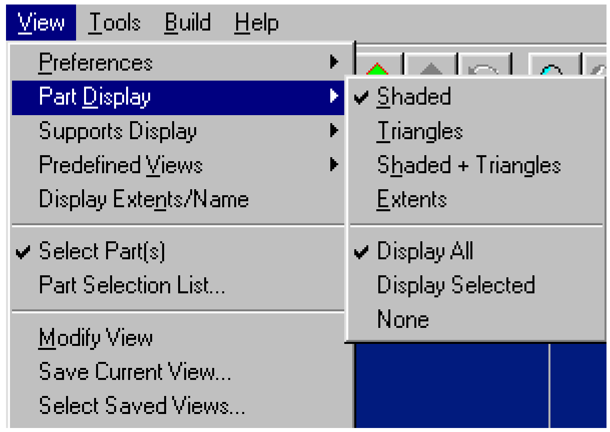


Figure 139. View Pull-down Menu (Part Display)

- **"Shaded":** displays your parts as shaded solids.

  Click here to make any part in the workspace appear as a solid, three-dimensional object. This is the part display that is most used and is useful for viewing part geometry and distinguishing between the interior and exterior surfaces of your parts.

- **"Triangles":** displays your parts as transparent triangles.

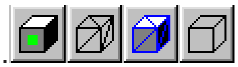
  Click here to make any part in the workspace appear as a transparent, three-dimensional object defined by the edges of the triangles that make up its facet edges.

- **"Shaded + Triangles":** displays your parts as shaded solids with the edges of their triangles highlighted.

  Click here to show parts in the workspace as solid, three-dimensional objects **that also show** the edges of the triangles used to define the facet edges. The additional definition of this setting is sometimes useful for viewing especially complex geometries whose internal and external surfaces might otherwise be hard to discern from one another.

- **"Extents":** displays the "Extents" of your parts.

Click here to configure 3D Lightyear software to display the extents of any parts loaded into the workspace. This setting is sometimes useful when trying to get a large number of objects to fit on a Build Platform without being placed one atop another.

Alternatively, you can click the **"Part Display"**...  icons. These perform the same functions as the first four selections in the previous pop-up menu. They are: **Shaded**, **Triangles**, **Shaded + Triangles**, and **Extents**.

- **"Display All":** displays all parts anywhere in your workspace.
- **"Display Selected":** displays only those parts that have been selected
- **"None":** disables the display of all part in the workspace.

This setting is sometimes useful for examining aspects of the support structures otherwise blocked from view by the part itself.

Alternatively, you can click the radio buttons on the **"Part Display Preferences"** dialog bar as shown in Figure 140. These buttons perform the same functions as the last three selections in the previous pull-down menu.

Figure 140. Part Display Preference dialog bar

Setting the Display Parameters for Supports

To set your display parameters for supports:

1. **From "View" Pull-down menu, select "Supports Display".**
2. **Click the desired option from the pop-up menu to the right as shown in Figure 141.**

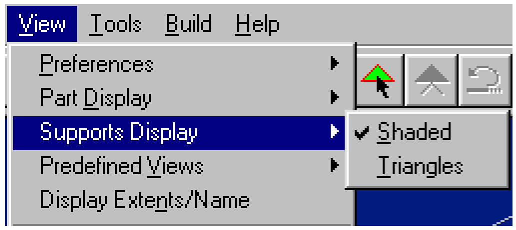
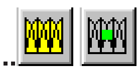


Figure 141. View Pull-down Menu (Supports Display)

- **"Shaded"**: displays support structures as shaded triangles.
- **"Triangles"**: displays support structures as transparent triangles.

Alternately, you can click on the **"Supports Display"...**  icons. These perform the same functions as the two selections in the previous pop-up menu. They are: **Shaded**, and **Triangles**.

HINT!

Turn the display of your parts OFF in your workspace to get a really good look at an object's support structures.

Keeping Track of the Axes Orientation

The lower left hand corner in the platform/part display area displays the X, Y, and Z axes indicator as shown in Figure 142. This indicator represents the orientation of the build platform in the X, Y, and Z axes.

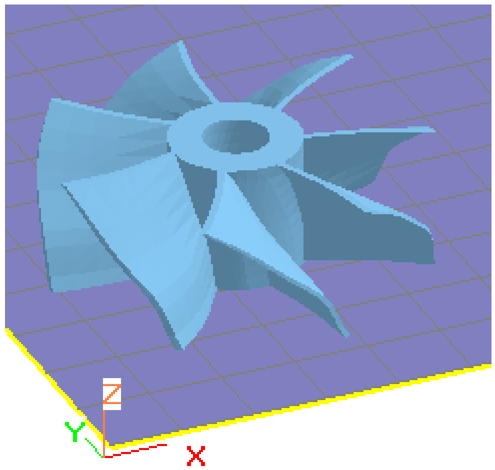


Figure 142. Platform Orientation Indicator

Saving Current View Settings

This option allows you to save a particular viewing angle or zoomed view of the platform and object. You can apply this setting to other projects by assigning a name to the saved view. Once you have a view that you wish to save:

1. **Select "Save Current View..." from the "View" menu.**

   The "Save View As" dialog opens as shown in Figure 143.

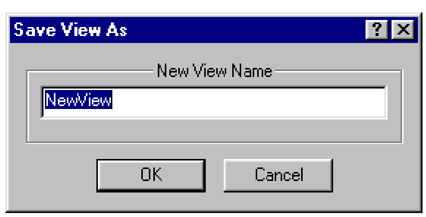


Figure 143. Save View As Dialog

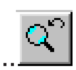
2. **Type the desired name for the new view.**
3. **Click the "OK" button to save.**
4. **The new view can be retrieved selecting "Select Saved Views..." from the "View" menu as shown in Figure 144.**

Figure 144. Select Saved Views

5. **Select the name of the new view from the pull-down menu.**
6. **Click the "Set View" button to set the view.**

   You can delete the new view at any time by highlighting it the window and clicking the "Delete View" button.

Zooming the View of Your Workspace In and Out

The **"Zoom"**... and **"Zoom Previous"**... tools, selectable by clicking the workspace icons, pulling down the "**View**" menu and choosing "**Zoom**" or "**Zoom Previous**", or with the "**z**" hot-key, control the relative closeness of the Build Platform and any objects placed on it.

To Zoom IN:

1. **Click the "Zoom"... tool, or pull down the "View" menu and choose "Zoom", or press "Z" on your keyboard.**

   Your cursor will change to a cross-hair .
2. **Position the cursor to the top and left of an area you want to zoom, then click and hold the left mouse button, and drag the mouse down and to the right. You see a box formed in the workspace defining the area that is to become your new workspace view.**

3. **When you release the mouse button, your workspace will "zoom in" until it consists exclusively of the area you defined in step 2.**

To zoom "out" to a previous view...

1. **Click the "Zoom Previous...**  **icon, or pull down the "View" menu and choose "Zoom Previous".**
2. **When you release your mouse button, the display of your workspace will "zoom out" to the view that was being used before you last "zoomed in".**
3. **Continue to "zoom out" until you have returned to the display you desire.**

Using Other Tools to Change the View of Your Workspace

The following tools, as shown in Figure 145, allow you to change the view of your workspace by specific increments. These tools allow you rotate the angle of the view up, down, left and right, as well as pan the view up, down, left or right by specific increments. You can also zoom in and out on the view by specific increments.

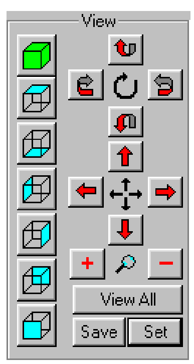


Figure 145. Other Tools to Change the View

The increments by which each of these tools work are user-configurable. To access the settings dialog, click the... Options... button to open the "Options" dialog as shown in Figures 146 and 147.

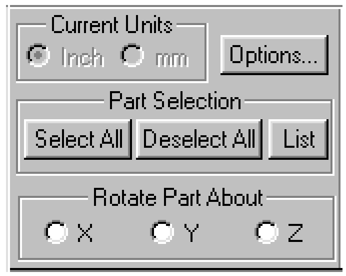


Figure 146. The Options Button is Here

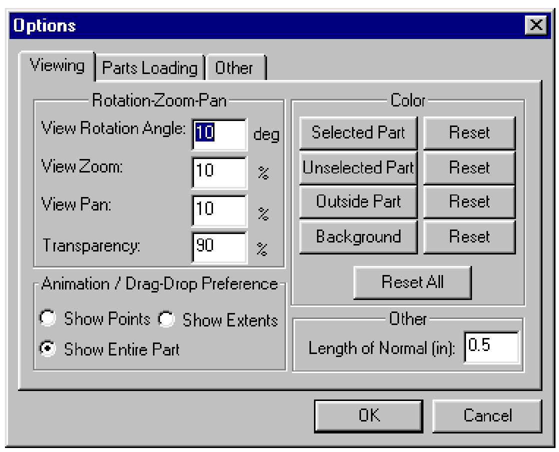


Figure 147. Options Dialog (Viewing Tab)

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Using QuickCast

What is QuickCast, and How Do I Use It?

A proprietary build style developed by 3D Systems, QuickCast produces quasi-hollow stereolithographic patterns.

The exterior surfaces of an SL pattern fabricated in the QuickCast build style are, as in the case of the other Build Styles, highly accurate, physical manifestations of your three-dimensional CAD designs. Unlike Tooling, EXACT, or FAST build styles, however, the interior of QuickCast patterns consists of a latticework of honeycomb structures. Together with the vents and drains added to the exterior surface of QuickCast patterns, this latticework allows liquid resin to be removed from the object without compromising its shape in any way. The resulting “nearly hollow” SL object can be used to create a “negative” mold in a separate downstream application.

By using stereolithographic QuickCast fabrication methods, you can produce accurate, complex masters for downstream molding operations in a fraction of the time needed to produce these items with traditional methods of machining or tooling.

QuickCast-Specific Parameters

When you select a part with a **QuickCast** build style assigned to it, you access the QuickCast-specific parameters from the **“QuickCast Parameters”** dialog. Opening this dialog is slightly different for Standard and Advanced users as follows:

1. **Click the “Modify Build Styles”... icon on the “Tools Toolbar” to open the “Modify Build Styles” dialog.**
2. **From the “Modify Build Styles” dialog, click the... [Edit] button to open the “Build Style Parameters” dialog.**
3. **From the “Build Style Parameters” dialog, click the... [QuickCast Parameters] button if you are an Advanced user, or the... [Hatch Parameters] button if you are a Standard user.**

Advanced users see the "QuickCast Parameters" dialog as shown in Figure 148, while Standard user see the dialog as shown in Figure 149.

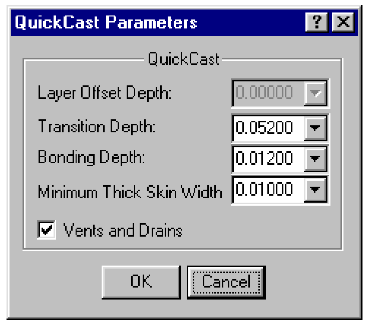


Figure 148. QuickCast Parameters Dialog, Advanced Users

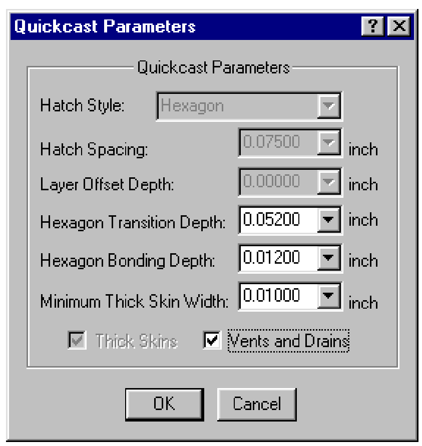


Figure 149. QuickCast Parameters Dialog, Standard Users

The QuickCast-specific parameters are listed below.

Layer Offset Depth: allows you to change the height to which the square column is built before it is shifted along the X and Y axis. The new position places the vertex of the subsequent column in the centroid of the previous column. The position will shift back again to the original position when the shifted column on the specified pattern reaches the specified height. Position shift occurs throughout pattern building from bottom to top.

Transition Depth: allows you to change the depth to which two parallel sides of the hexagon are built before transitioning to build the next two parallel sides in a different direction.

Bonding Depth: allows you to change the depth to which two sides of the hexagon continue to be built following the transition to the next two sides. This helps the vectors in the new direction adhere to the previous vectors.

Minimum Thick Skin Width: provides a method of eliminating unnecessary **Thick Skins**. Any feature that has a width less than the value shown, will not be given **Thick Skins**. Thick Skins are the result of filling up and downfacing regions for three layers.

Vents and Drains: when checked, adds vents and drains to the pattern. Vents and drains are used to remove trapped liquid resin from the completed pattern. Vents are created on upfacing surfaces, and drains are created on downfacing surfaces.

Hatch Style: displays the type of QuickCast style hatch.

Hatch Spacing: displays the QuickCast hatch spacing value. Hatch Spacing is the internal X and Y grid work vectors drawn by the laser beam within the border vectors.

What are "Vents and Drains", and How are they implemented in QuickCast?

The liquid resin trapped inside a cured SL pattern as a result of fabricating it with the QuickCast Build Style—the material that, due to the viscosity and surface tension forces present in SL resins, lingers in the honeycomb structures that form the interior of your pattern—must be drained from the interior of the pattern before it can be used in any downstream fabrication operation involving heat.

"Drains" are created and attached to down-facing surfaces near the bottom of a QuickCast pattern with the Vents and Drains tool in 3D Lightyear software. Drains allow liquid resin to exit the pattern due to gravity when the pattern is raised from the vat. The same drains also serve as resin exit ports when the pattern is then centrifuged during the requisite complete evacuation of liquid step, prior to its use in any mold-making operation.

"Vents" complement the creation and attachment of Drains, and are created on up-facing surfaces of the pattern near or on its top, to allow air to move in to the interior of the pattern to further facilitate proper resin drainage.

To add Vents and Drains to your patterns:

1. **Click the "Part Selection"... tool to pick the object on your Build Platform to which you will be adding Vents and Drains.**

NOTE!
You may find it easier to create the Vents and Drains for the pattern BEFORE generating Supports. The process of adding Vents and Drains involves the selection of specific facets (triangles) on up and down-facing surfaces. If Supports are present, it is sometimes difficult to view and select the optimum location for Drains in particular.

2. **(Optional) Click on either the "Display Parts as Transparent Triangles"... icon or the "Display Parts as Shaded Triangles"... icon to make it easier to locate and select the facets to which you will be affixing Vents and Drains.**

3. **Click the "Add Vents and Drains"... icon on the "Tools Toolbar",**

   OR...

   Pull down the "Tools" menu and choose "QuickCast", then "Vents and Drains".

   The dialog as shown in Figure 150 opens:

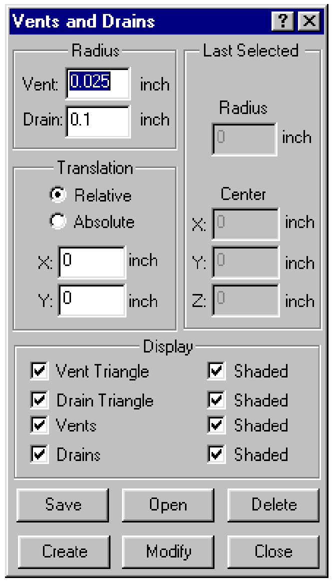


Figure 150. Vents and Drains Dialog

Assuming the display options are selected accordingly, (Figure 151), the display of the selected pattern in your workspace also changes to highlight the triangles of its surface that are candidates for Vents and Drains.

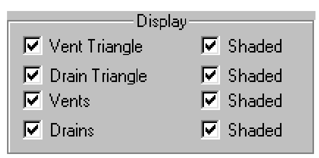


Figure 151. Vents and Drains Check Boxes

IMPORTANT!
Only those triangles that are highlighted after activating the "Add Vents and Drains" tool can be used as the basis for Vents and Drains.

4. **Click the "Select Triangles"... icon.**
5. **Click on a number of triangles (the number of which is size and geometry dependent) on the top-most surfaces of the object.**

   As you select them, the Vent triangles change color.

NOTE!
Hold down the <Ctrl> key on your workstation keyboard and click on a selected triangle to de-select it.

6. **Click on a number of triangles (the number of which is size and geometry dependent) on the bottom-most surfaces of the pattern.**

   As you select them, the Drain triangles change color.

NOTE!
Use a combination of the Zoom and appropriate Change View tools to get a better look at the candidate triangles on the bottom of your pattern. Also, use the "Make Downfacing" and "Make Upfacing" triangle tool to orient specific triangle as valid vent/drain surfaces.

7. **Click the...** Create **button.**

   The display of your pattern in the workspace shows the addition of the Vents and Drains as contrasting colored spots on each of the triangles you selected in Steps 4 and 5.

8. **Click the...** Save **button to create a file called "[filename].V_D" in the same directory on your workstation where the STL file originated. ("[filename]" is the name of the STL file to which you are currently attaching Vents and Drains). This file consists of the Vent and Drain parameters on the QuickCast STL, and can be re-called to the workspace later on for modification purposes, if necessary.**

At this point you have created the default Vents and Drains for your pattern.

9. **Click the... Close button to return to the main program workspace.**

   Repeat the procedure for each QuickCast pattern on your Build Platform, as appropriate.

NOTE!
Do not use the "Automatic Part Placement" feature after creating vents and drains.

Modifying the Default Vents and Drains

As with many of the parameters for preparatory tools in 3D Lightyear software, you can either modify the settings for ***creating*** Vents and Drains on a QuickCast pattern, or you can edit the settings of Vents and Drains ***that have already been created***. We suggest editing the parameters first in the case of QuickCast.

Here's how:

1. **Use the "Part Selection"... tool to pick the object on your Build Platform to which you will be adding Vents and Drains.**
2. **(Optional) Click on either the "Display Patterns as Transparent Triangles"... or the "Display Patterns as Shaded Triangles"... to make it easier to locate and select the facets to which you will be affixing Vents and Drains.**
3. **Click the "Add Vents and Drains"... icon on the "Tools Toolbar",**

   OR...

   Pull down the "Tools" menu and choose "QuickCast", then "Vents and Drains".

The dialog shown in Figure 152, opens:

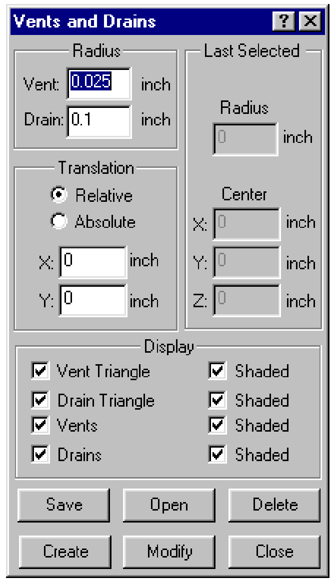


Figure 152. Vents and Drains Dialog

Assuming the display options are selected accordingly, (Figure 153) the display of the selected pattern in your workspace also changes to highlight the facets (triangles) of its surface that are candidates for Vents and Drains.

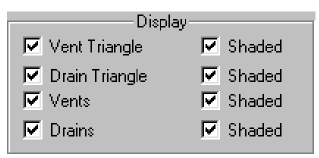
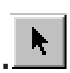


Figure 153. Vents and Drains Check Boxes

4. Use the "Part Selection"...  **tool to select the Vent or Drain to be modified.**

5. **The defaults for the size of the Vents and Drains that 3D Lightyear software will create is Build Style-dependent. The values shown in the respective radii fields as shown in Figure 154, represent the size specifications that our Process Engineers have determined to be optimum for these features in the majority of cases.**

   Enter new values, if desired to change the respective radii.

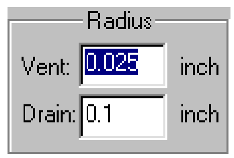


Figure 154. QuickCast Radius Dialog

NOTE!

Any changes entered here only take effect when the... Modify button is pressed, and the "Modify" button is only available when prospective triangles are selected.

6. **Click the... Save button to create a file called "[filename].V_D" in the same directory on your workstation where the STL file originated. ("[filename]" is the name of the STL file to which you are currently attaching Vents and Drains). This file consists of the Vent and Drain parameters (including the number created, their size(s), and their respective location(s)) for the QuickCast STL.**

NOTE!
You can "re-call" this "[filename].V_D" file later on, if desired, by clicking the... Open button in this dialog when you have this same pattern selected. This is particularly useful when making changes to any aspect of Vents and Drains for your pattern if, after 3D Lightyear software preparation is complete, you find that modifications are necessary.

How the QuickCast Pattern is Used in a Foundry

Once you have successfully fabricated your QuickCast pattern on your SLA system, it is typically sent to a casting facility to serve as a master pattern.

Presuming a foundry has been matched to your needs, these are the steps your facility will most likely be performing to ensure the production of superior cast patterns from QuickCast masters:

1. **The QuickCast pattern is examined for any apparent holes in surfaces.**
2. **Any holes found are filled with wax or some similar material.**
3. **Any sharp edges are removed from the pattern or mode.**
4. **The pattern is tested for leaks. There are many techniques for this, but typically a negative pressure is set to the interior of the QuickCast pattern via a temporarily opened vent or drain.**

CAUTION!
Normal compressed air contains moisture and should NOT be used to test for leaks unless it has been processed to remove the moisture.

NEVER immerse a QuickCast pattern in water or other liquid. Most fluids will destroy the pattern if allowed to penetrate the interior.

5. **Gating locations are wiped with RG-IPA and Venting holes below the gate attachment points are cut.**
6. **Wax gating material is attached using special adhesive foundry wax.**
7. **The prepared QuickCast pattern is then submerged or otherwise subjected to the investment, often dipping the pattern in some type of refactory slurry.**

   Typically, between 7 and 10 coats of slurry are used for small patterns. More dips (up to 16) can be required for some geometries.
8. **Depending upon the slurry material used, each coat is usually allowed approximately 24 hours to dry.**
9. **The wax gating applied in Step 6 is then removed, using either an autoclave or a carefully controlled flash-fire furnace.**
10. **The QuickCast pattern, now completely encased in hard-ened mold material is eliminated from the process by flash-fire with high oxygen concentration.**
11. **The mold is then typically cooled and residual ash is re-moved.**
12. **The metal material is then poured into the mold (possibly requiring re-heating, depending upon the cast material).**
13. **The shell is then removed and any remaining gates are cut off.**

Other QuickCast Considerations

The Importance of Surface Finish

Patterns reproduce all of their imperfections in the metal casting. You should provide a high degree of surface finishing to your pattern. Most foundries can provide you with a benchmark wax pattern sample for comparison.

The Significance of Holes

NOTE!
All holes in the QuickCast pattern *must* be filled with wax or otherwise sealed prior to initiation of the investment casting process.

This can be done by you or by the foundry. In either case, the pattern must be air-tight to prevent the face coat material from penetrating into the pattern.

The two types of holes you are likely to find are the intentional ones such as the vents and drains, and unintentional pinholes resulting from layer separation, bubbles in the resin, or as a result of the Supports removal process.

Before shipping your patterns to the casting facility, either mark all holes with a permanent marker, or fill them with an epoxy/acrylate resin cured with an EFOS UV light pen or in a PCA.

Testing for Surface Leaks

Some holes in the surface of patterns can be hard to locate. Even very small holes can cause the casting process to fail at various points, and so you should take whatever means at your disposal to guarantee that your QuickCast patterns are leak-free.

One method of detecting surface holes is to use a “leak-down tester”, an apparatus commonly available at automotive patterns stores. Basically, the system consists of a hand-held vacuum pump that indicates pressure changes over time.

NOTE!
Some SL resins are more brittle than others. Exercise caution in removing the air from your patterns that doing so does not cause any collapse.

Reference Topics

Block Mnemonics and Vectors

The abbreviations used to represent the vectors that are derived during the execution of 3D Lightyear software's "Prepare" function are called ***"Block Mnemonics"***.

Figure 155 shows a typical Layer Display dialog listing all the block mnemonics used in 3D Lightyear software.

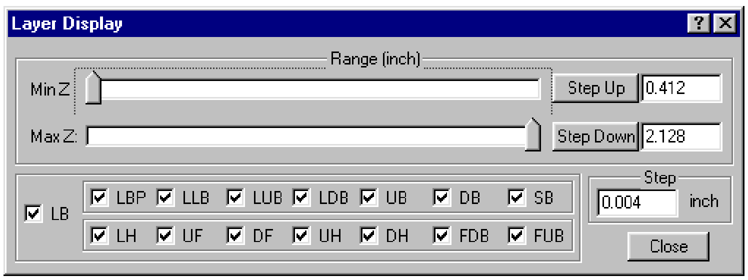


Figure 155. Layer Display Dialog

The Block Mnemonics for any slice layer in your part represent the vector types, including those for supports, borders, hatches, and fills, that the SLA system's laser scans on the vat of liquid resin. With the exception of Large Layer Borders (LLBs) and Layer Border Primes (LBP), the mnemonics for a layer consist of the combination of the vector class and the direction (up- or down-facing) of the normal of the triangle's normal whose vector is being drawn.

The lines traced by the SLA system's laser on the surface of the liquid resin are called ***"vectors"***. In 3D Lightyear software, the characteristics of every layer in the "sliced" (Prepared) version of your parts are described by vectors.

When it "slices" (Prepares) objects on the Build Platform, 3D Lightyear software performs a detailed analysis of part geometry, using the parameters set in the relevant Build Style files. Based on this analysis, the vectors needed to fabricate every layer of the "sliced" (Prepared) part on the SLA system are derived and saved as part of the build file.

In Stereolithography, the magnitude of a vector is considered to be the size and strength (milliwatt output) of the laser beam as it is drawing (controlled by the machine's interpretation of the build file). Vector direction is considered to be determined by the geometry of the part in the region and area of the layer that is being fabricated.

3D Lightyear software uses three classes of vectors to define layers in a sliced object. They are:

- Border
- Hatch
- Fill

Each of these vector classes are further defined (and assigned to aspects of a layer) according to the relationship of the layer being drawn to the other layers in the prepared object. That is, based on how the layer is used in the fabrication of a particular cross-section of the object being built, it may have any combination of:

Layer Border	**LB**
Layer Border Prime	**LBP**
Large Layer Border	**LLB**
Large Up-facing Border	**LUB**
Large Down-facing Border	**LDB**
Up-facing Border	**UB**
Down-facing Border	**DB**
Support Border	**SB**
Up-facing Fill	**UF**
Down-facing Fill	**DF**
Flat Down-facing Border	**FDB**
Flat Up-facing Border	**FUB**
Layer Hatch	**LH**

Up-facing Hatch	**UH**
Down-facing Hatch	**DH**

These vector classifications are called the "Block Mnemonics*" of a layer.*

NOTE!
BFFs used by the SLA 350/3500-, 500-, 5000-, and 7000 systems contain MACHINE-TYPE-SPECIFIC parameters including, but not limited to, the block mnemonics, for fabricating parts.

As such, BFFs are inherently machine-type-specific. BFFs created for an SLA 3500 CANNOT BE BUILT on an SLA 7000; they can ONLY be built on an SLA 3500. Files created for an SLA 7000 CANNOT BE BUILT on an SLA 500, and so on.

Vector or ".v" Files

Vector files, as their name implies, consist of the mathematical representations of all the vectors used to make up the layers in a "sliced" (Prepared) part.

Vector files are used by 3D Systems' older generation of SLA systems, the SLA 250 and SLA 190 machines. When you prepare STL and/or SLC files for building on an SLA system from either of these models, 3D Lightyear software creates a:

- V = Vector file
- R = Region file
- L = Layer file

and a

- PRM = Parameters file

…as opposed to a BFF. ***All*** of these files are required by the version of Buildstation software running on SLA 190 and 250 to execute a successful build.

Layer Hatches

“Hatch Vectors”, or ***Layer Hatches***, are the vectors that form an internal grid structure created to solidify the internal areas of the part.

The spacing between hatches are user defined.

Fills

Vectors that are “drawn” by the laser in your SLA system so closely spaced that they form a skin are called ***“fills”*** or ***“skin fills”***.

Skin fill vectors define horizontal (top and bottom) surfaces. They are a series of closely spaced parallel vectors that form a skin when drawn by the laser beam. Skin fill vectors function to smooth out flat surfaces and to provide a solid foundation on initial downfacing areas. Skins also are use to trap resin inside the part when building in the QuickCast build style.

Anatomy of an STL File

“STL” is an abbreviation for the term *“**ST**ereo**L**ithographic”*. An STL file is one that has been formatted according to the public domain “open standard” developed by 3D Systems for use with its SLA system stereolithography machines and solid object printers, the ThermoJet™ and Actua™.

Most third-party developers of software applications creating, editing, and rendering three-dimensional objects on PCs and workstations offer STL as an output file format option.

STL Format

The STL file itself is defined as a triangular-faceted representation of a three-dimensional surface geometry. In converting or saving your CAD, CAM, CAE, etc. files as STLs, their surfaces are said to be “tessellated”, or broken down logically into a series of unique (within the object), irregular triangles. Each triangular facet can then be described in the data of the STL file by a series of ASCII or binary numerical values representing the three coordinate points in XYZ space that correspond to the triangle vertices (corners).

Normals

A vector located at the planar center of a facet (triangle), and pointing "outward", away from the object's interior solid mass or the solid mass of the feature of the object is called a "Normal". (See Figure 156.)

Normals are used in Stereolithography, and in particular, in the analysis of the surface of an object that takes place during the Verify process in 3D Lightyear software, to identify and distinguish between its "interior" and its "exterior" [surfaces].

If in an STL file, adjacent triangle normals point in opposing directions, there exists a likelihood that one or more triangles are "inverted"; a "violation" of the "rules" of a valid STL file.

Occasionally, the geometry of your parts may cause problems for the software routine that converts it from its "native" format to STL. These problems occur when the data that represents the tessellated surface of the object being converted fails to conform to the "rules" for formatting an STL correctly.

The basic "rules" are:

- All exterior surfaces must be devoid of "gaps"
- All Triangles must conform to the "Right-handed" specification
- All Triangles must be oriented one to another in a Vertex-to-Vertex fashion

The Gap-less Exterior Rule

A valid, "slice-able" STL should have no gaps anywhere on its exterior surface. Occasionally, in converting its proprietary format to STL, CAD and other solid- and surface-rendering applications "make mistakes" with objects of particularly complex exterior geometry, resulting in "gaps" (classified in the 3D Lightyear software software's Verify tool as "wide" or "narrow").

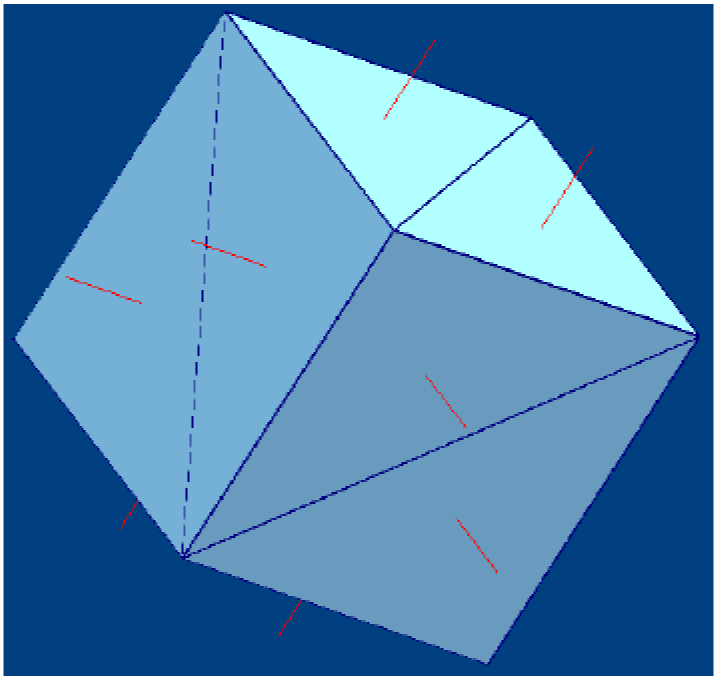


Figure 156. Normals

The Right-Hand Rule

In addition to comprising the surface of a tessellated object, the facets—or specifically, the *orientation* of the facets, one to another—determine what volume of CAD space constitutes the interior and which the exterior of that object. This orientation is specified in two ways which, in order to constitute a *valid* STL file, **MUST** be redundant. First, the direction of the "normal" of each facet (triangle) that makes up the object must point "out", away from its relative interior. Second, the vertices that make up each triangle must be considered in **counterclockwise** fashion when viewing the object from its exterior. (These specifications together are often referred to as "The Right-hand Rule".) The Right-hand Rule is illustrated by in Figure 157.

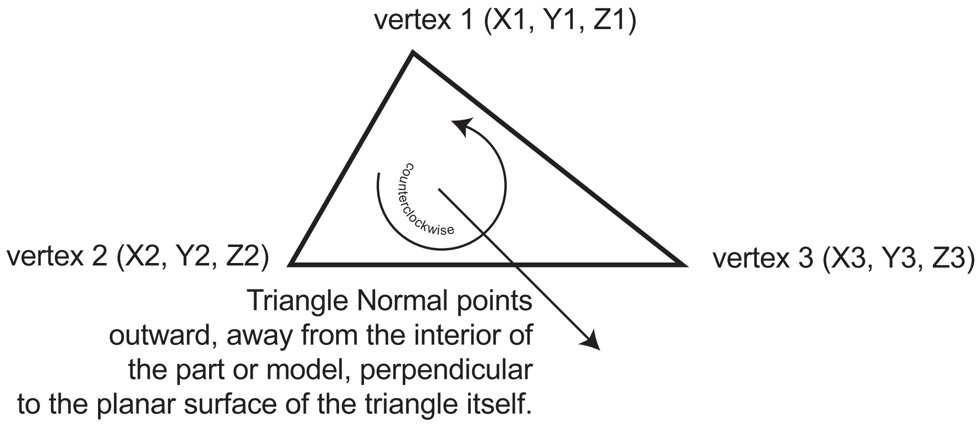
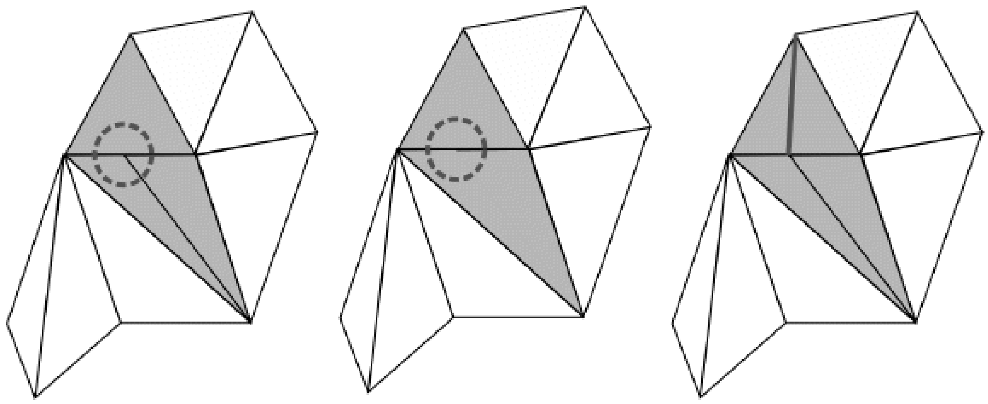


Figure 157. Example of the Right-Hand Rule

The orientation of an object's facets (triangles) in a valid STL file is determined by the direction of the triangle Normal. The standard format for an STL lists the coordinates of the vertices (in three-dimensional CAD space) of each triangle IN ORDER in a counterclockwise fashion around the Normal.

The Vertex-to-Vertex Rule

In addition to the Right-hand Rule, each triangle represented in an STL file must share two of its vertices with each of its adjacent neighbor triangles. That is, the vertex of any triangle may not butt the side of any other triangle. The Vertex-to-Vertex Rule is illustrated in Figure 158.



Circled area shows "violation" of Vertex-to-Vertex Rule.

Anomaly can be corrected by deleting a line (which may effect geometry) or adding a line (preferred).

Figure 158. Example of the Vertex-to-Vertex Rule

The Positive Octant Rule

The object represented by the STL data does not have to be located in the positive octant of three-dimensional space to perform verification. Before generating supports or slicing any STLs, however, all parts must be oriented so that all vertex coordinates are non-negative and non-zero.

NOTE!
The STL file does not contain any scale information; the coordinates used to represent the triangles in the object are represented in arbitrary units.

How Verify Fixes Problem STL Files

When initiated, the verification algorithm first makes a copy of the file or files you designate (you are prompted, after starting Verify, to perform the process on either selected STL files or on all of the STL files in your workspace). It then performs an "analysis" of the integrity of the copy (or copies). Whenever it detects an "anomaly", it attempts to effect rudimentary "repairs", writing a log to the Information Dialog at the bottom of your workspace.

If, for example, you notice missing triangles in a surface of your part as it is displayed in the 3D Lightyear software workspace, it could be due to a "flipped" facet (incorrect normal), or a gap of one or more triangles. Errors such as these can result from imperfections in the conversion routines used by third-party solid- and surface-rendering applications to save their proprietary formatted files as STL files—particularly when the part being converted has a highly complex geometry or a high number of small, proximate surfaces.

Left uncorrected, these types of errors can prevent your parts from being Prepared (sliced) properly by 3D Lightyear software and ultimately cause your SLA system build job to fail.

"Anomalies" that are typically detected and for which 3D Lightyear software executes repairs include:

- **Degenerate-sided Triangles**
  What they are: Triangular facets in the tessellated solid (your part) whose three defining axes ALL lie in the horizontal plane of the intended build. The "sides" of degenerated triangles would create, in effect, "extra" borders in a given layer. These are usually the result of your design application's attempt to tessellate a particularly complex geometry.

  What Verify does: Removes the offending triangles, melding the area with the next larger geometry of the layer itself, as defined by the borders formed by the non-degenerate triangles at that level in the intended build.

- **Narrow Gaps, Wide Gaps**
  What they are: A "violation" of the "Gap-less Exterior Rule", these are empty spaces between defined triangular facets in the tessellated solid (your part). These too, are usually the result of your design application's attempt to tessellate a particularly complex geometry.

  What Verify does: Fills the empty space(s) with as many additional triangles as necessary, interpolating the orientation and block mnemonic of adjacent, "legal" triangles to determine the most likely orientation and class (near-flat incline, large-flat, etc.)

- **Inverted Triangles (Incorrect Normals)**
  What they are: A “violation” of the “Right-Hand Rule” for the formation of valid STL files. These are triangular facets in the tessellated solid (your part) whose respective surfaces, when compared to the majority of adjacent triangles’ surfaces, appear to be oriented “outside IN”. That is, when examining the continuity of a region’s exterior surface, these triangles (based on the respective directions of their Normals) appear to be oriented such that their exterior surfaces are facing inward.

  What Verify does: Attempts to orient all triangles with their normals pointing outward, relative to the filled, interior of the part being verified.

- **Unmatched Triangle Sides**
  What they are: A violation of the “Vertex-to-Vertex Rule” for the formation of valid STL files. These are triangles whose vertices touch the sides of adjacent triangles.

  What Verify does: Attempts to remove one of the sides, or add a side (dividing a large area into two) of an adjacent triangle, creating a vertex to “match up” with the offending vertex.

Problem STLs - What if Verify is Unable to Repair Them?

Often, problems with STL files can be rectified by re-orienting them in the original design or rendering application (CAD), and re-saving as an STL.

If you still have trouble Verifying your STL file or files, again return to the originating application and examine the surfaces of the object to make sure that there are no topological errors in your design (e.g., make sure that exterior surfaces are contiguous throughout, and do not conflict with interior surfaces).

Some applications have built-in facilities for checking the orientation and continuity of triangles in the tessellated form of the object. These facilities are usually equipped with editing tools to correct problems.

3D Lightyear Software Files

Files that Can Be Opened and Viewed with 3D Lightyear Software

3D Lightyear software can open:

- Platform Files…**[filename].pla**
- STL Files…**[filename].stl**
- SLI Files (or "Slice Files")…**[filename].sli**
- SLC Files…**[filename].slc**
- Vector Files (or ".v Files)…**[filename].v**
- BFF Files (or "Build Files")…**[filename].bff**

Files that Are Created by 3D Lightyear Software

The result of the processing 3D Lightyear software conducts on your three-dimensional image files depends upon the type of SLA system upon which you are going to "build" your parts. For "older generation" machines, the SLA 190 and SLA 250, a suite of files is generated. For the SLA 350/3500, SLA 500, SLA 5000, and flagship SLA 7000, a single BFF file is generated.

In addition to these files, which are "ported" to your SLA system Buildstation, several ***ancillary*** files are generated and saved in various locations on your workstation hard disk. These include:

[filename].vmf

This is an ASCII text file containing all the messages returned by your 3D Lightyear software during the verification of your STL. Its contents can be viewed with any text editor such as Windows' Wordpad or Notepad.

[filename].odf

This is a binary file containing the data on the "regions" of your part. It comprises an algorithmic description of the Block Mnemonics, of all the facets (triangles) in the STL for which you have generated supports. The supports that are generated are associated with these "regions".

[filename].crg

This is the parameter file created for each STL, SLC, and support STL upon which the Prepare (slice) process is performed.

[filename].ctl

This is the compressed version of an STL file used by most of the file processing tools in 3D Lightyear software. It is created whenever you "load" an STL into your workspace. Its format is proprietary.

[filename]_s.stl

This is an STL file created by 3D Lightyear software's support generator.

[filename]_v.[suffix]

This is the STL file created by 3D Lightyear software as a product of its Verification process. Typically, once Verify is complete, the original STL is replaced by this file in your workspace (assuming you have selected the default option to do so). Here, "[suffix]" stands for the types of files that may be verified or generated as a result of verification; "stl", "odf", "_s", and "crg".

NOTE!
You should always use the "_v" version of your STLs when generating supports and Preparing (slicing). If you use the default settings for Verify STLs in 3D Lightyear software, the "_v" files will automatically be loaded into your workspace and used as appropriate.

[filename].smp

This is a simple bitmap file created by and for 3D Lightyear software's previewing of STL files in the Explorer-like dialog for loading objects into your workspace.

In the list above, "[filename]" stands for the name of your STL file. 3D Lightyear software automatically "reads" the name of the file for which it creates the ancillary files listed.

More About the "Platform File"

The Platform File is 3D Lightyear software's data mechanism for managing its work session information. Any time parts are loaded in a workspace that also has a machine definition (platform) loaded, all the elements needed to create and save a Platform File to your PC's hard disk are present.

The settings contained in the Platform File comprise more than the Build Platform. In fact, they govern the manner in which 3D Lightyear software treats all objects loaded into the workspace, as well as determining the range of customization available to you for things such as Build Extents, Resin Type, Z compensation, etc.

If saved to disk at the end of your work session, the Platform File enables you re-call to the workspace the entire Build Platform, the parts that were loaded on it when it was saved, their orientations, any customization, Styles, etc.

By naming and saving your Platform Files in such a way that they can be readily accessed for repeat BFF generation, you can save yourself a great deal of time not having to recreate all the settings. You can also use Platform Files as BFF creation "templates" or "boilerplate"; they can serve as the basis for alternate iterations of frequently devised build jobs

How can I tell if I have a Platform File open?

The 3D Lightyear software Status Bar (Figure 159) is the principle indicator of the existence of an active Platform File. It gives a "real-time" readout of the state of the primary Platform File components.

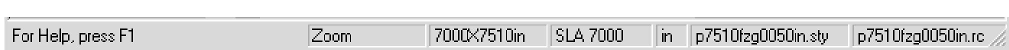


Figure 159. Status Bar

If your workspace display is not showing the Status Bar:

1. **Pull down the "View" *menu.***
2. **Click on the "Status Bar" selection (make sure that it is "check marked").**

A Platform File, distinguishable in Windows' Explorer by its ".pla" filename suffix, contains:

- The parts that are present anywhere in your workspace
- Supports and SRG files for any parts, including any modifications you may have made to either when the Platform File was saved
- Part Build and Recoating, and Support Build and Recoating Style Files, including any modifications you made to any of those files when the Platform File was saved
- All the settings for the SLA system Machine Type and any modifications

IMPORTANT!
A Platform file consists of every physical aspect of your workspace at the time you create it *INCLUDING ALL RELEVANT OPERATING system PATHS*.

Typically, one of the last tasks you perform as part of a work session in 3D Lightyear software will be to save your work. This usually involves creating or otherwise saving the Build Platform, in the form of a Platform File, on your workstation hard disk.

Whenever you create a Platform file (3D Lightyear software adds a "**.pla**" suffix to the name you designate), ***everything*** about the Build Platform that is showing in the workspace is saved as part of that file. All parts (STLs, SLCs, etc., any and all Build Styles, parameters effecting the SLA system used to fabricate objects, colors—everything.

Furthermore—and here's a key point—all of the information that 3D Lightyear software would need to **retrieve** the entire Build Platform later on is also stored as part of the **.pla** file. If you move any of the files—**.sty** files, **.srg** files, **.stl** files, etc.—that comprise the **.pla** file at any time after having initially saved it, trying to open that Platform file again will cause a program error. This also applies if you change any of the file names.

Keyboard “Shortcut Mnemonics”

Sometimes referred to as “keyboard shortcuts”, mnemonics substitute specific sequences of PC keyboard keystrokes for clicks of your mouse in executing commands and functions in 3D Lightyear software.

Most of the pull-down menus in 3D Lightyear software are equipped with mnemonic keyboard shortcuts. Typically, they consist of the first letter of the command itself. When combined with the Windows’ facility for activating pull-down menus, **<Alt> + <Pull-down mnemonic>**, you will find it possible to save significant time tracking your mouse across larger the larger displays common on CAD workstations.

For example, you can execute the **“Open”** function in 3D Lightyear software by clicking on the pull-down **“File”** menu and selecting **“Open”** from the list of items there. Alternatively, using mnemonics, you can execute the key-stroke combination:

<Alt> + “f” to pull down the **“File”** menu, then simply **<o>** to bring up the **“Open”** dialog.

Most mnemonics are easily identified in the 3D Lightyear software interface. Any underlined letter on any menu or in any dialog is a viable mnemonic.

Other shortcuts that do not reside on any menus enable you to quickly switch from tool to tool when orienting your parts or the workspace.

They are:

“a” Selects all the parts showing in the program workspace.

“d” De-selects any parts that are showing in the workspace as selected.

“i” Activates the Information dialog along the bottom of the workspace. Press <i> again to turn the dialog off.

“s” Toggles between the program tools for Selecting Parts and using the Trackball to change the view of the current Build Platform in the workspace.

“v” Restores the view so that all the parts anywhere in the workspace are shown.

“z” Activates the Zoom tool

"Restricted Areas" of the Build Platform

Each model family of 3D Systems SLA system has a different sized physical platen and vat. The dimensions, arranged from smallest to largest are as follows:

- SLA system 190 or 250 – 254 x 254 x 254 mm (10 x 10 x 10 inches)
- SLA system 350/3500 – 350 x 350 x 400 mm (13.8 x 13.8 x 15.7 inches)
- SLA system 500, 5000 – 500 x 500 x 583 mm (20 x 20 x 23 inches)
- SLA system 7000 – 500 x 500 x 600 mm (20 x 20 x 24 inches)

NOTE!
If you orient parts so that they abut the (imaginary) walls of the Build Envelope, the supports (and/or braces) generated by 3D Lightyear software are *VERY* likely to hang off the edge of the physical Build Platform platen. *You will not be able to prepare the build with any STL file in negative space or outside the build envelope.*

Whenever you attempt to translate or otherwise orient a part or its supports outside the build envelope, it turns red (when not selected) in your workspace.

It is possible, depending upon the geometry of a particular part, to effect an orientation with object areas abutting the edges of the build envelope. Some self-supporting aspects of certain geometries, for example, will not necessarily cause 3D Lightyear software to generate supports, and even if they are generated, these supports can subsequently be "edited out".

NOTE!
If you attempt to build an object on your SLA system such that some portion of its supports or braces or the object itself overhang the known edge of the Build Platform, there is a high likelihood that small bits of cured resin will detach from the build-in-progress and drift into vat. The ultimate result can be spurious corruption of object surface finish, decreased vat life, and crashed builds.

Glossary

BFF…Often used interchangeably with the term “build file”, “BFF” is an acronym that stands for the phrase “Build File Format”. The BFF is a proprietary file format developed by 3D Systems that serves as the data input to an SLA system’s machine control software. It comprises all of the information an SLA system needs to fabricate a three-dimensional solid out of liquid resin using stereolithography.

Based on the SLA system’s interpretation of the information in the BFF, your designs**—**processed by 3D Lightyear software**—**are reproduced as three-dimensional, solid plastic objects using stereolithography.

Build Extents (or Build Envelope)... The total cubic area that can be used by an SLA system for building parts is called the Build Envelope or the machine Build Extents. Figure 161 shows an example of the Build Extents (envelope) of an SLA 250 system.

CAD, CAM, CAE…These terms are most often used to designate software applications that create solid-models that are, in turn, saved as STL files, the three-dimensional objects that can be “built” using stereolithography. Most of these applications provide facilities for converting their own, proprietary file formats to 3D Systems’ open-standard format, STL**—**the primary file format accommodated by 3D Lightyear software as input.

For those applications that do not output STL files, a host of third-party conversion utilities are available.

Laser...Light Amplified by the Stimulated Emission of Radiation.

Origin...This is the term used in 3D Lightyear software to refer to the zero point of all the axes of the Build Platform. The origin in your 3D Lightyear software workspace corresponds to the near, left-hand corner of the physical build chamber on your SLA system (as you stand looking into the chamber from the front of the machine).

Part Extents...The extents of a part refer to the minimum cubic area into which the object can fit. (See Figure 160.) Part extents are always determined with respect to the orientation of the axes of the Build Platform. This means that if you change the orientation of your part, its build extents might change.

SLA system...The term “SLA system” (or “SLA machine”, as it is often called) is an abbreviation for “***S***tereo***L***ithography ***A***pparatus”. An SLA system is any one of 3D Systems’ line of laser-equipped, stereolithographic solid object fabrication machines.

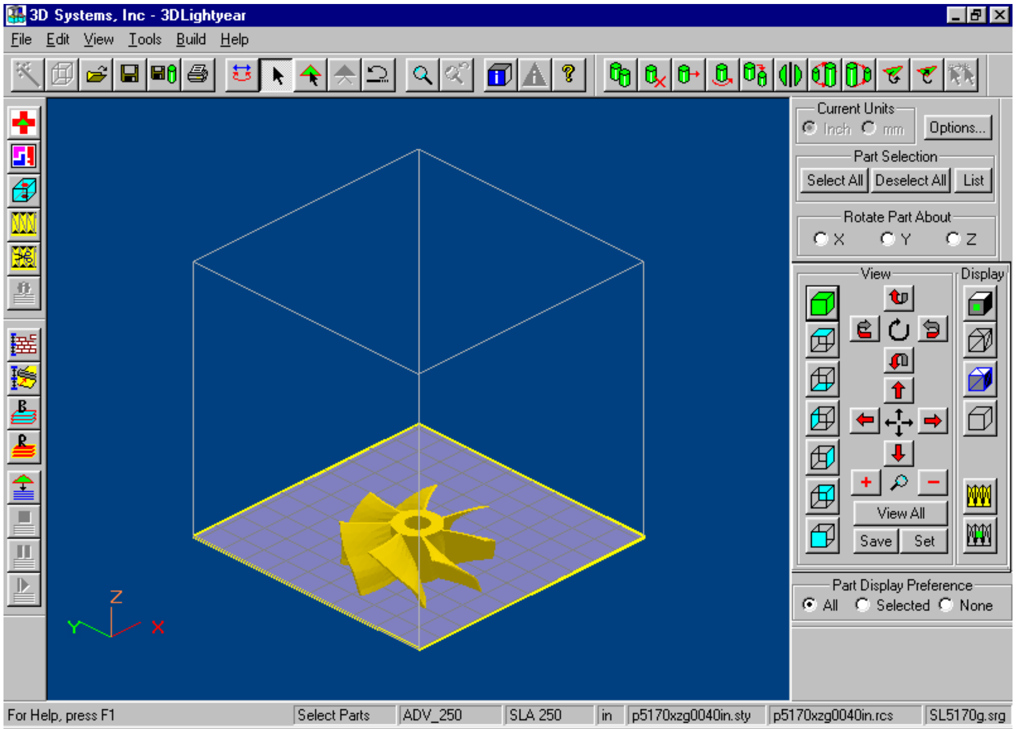


Figure 160. Workspace Displaying Build Extents

SLC File...SLC is an abbreviation for "***Sl***iced ***C***ontour" file. This is a 3D Lightyear software-compatible format generally available as an output option from applications in the medical field. The applications and equipment used to create CAT scans, MRIs, etc. often include facilities for producing SLC files.

NOTE!
SLC files can only be accommodated by 3D Lightyear software if they already have supports.

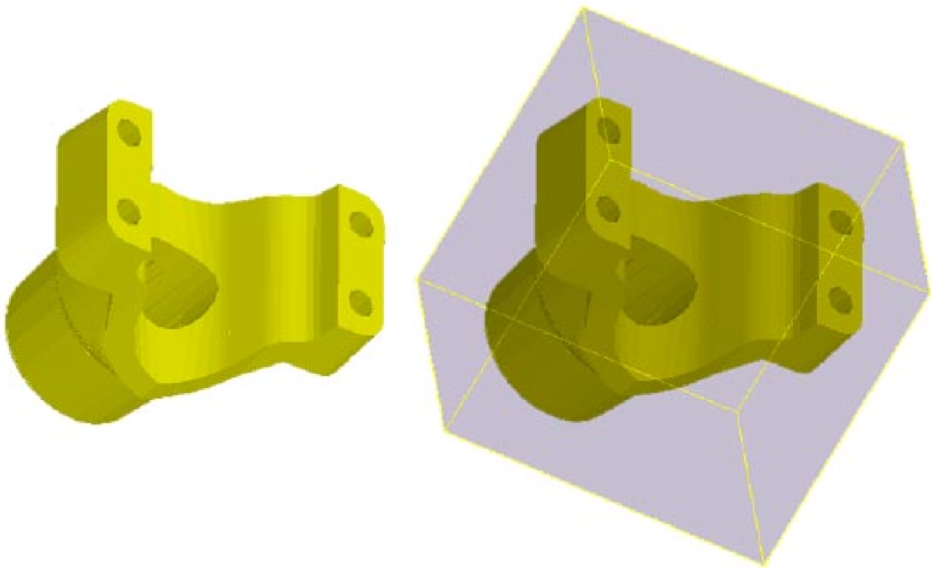


Figure 161. Showing a Parts Extents

SLI File... An "SLI" file, often called a "Slice file", is a product of 3D Lightyear software's processing of an STL object on the Build Platform. One of the principle functions of 3D Lightyear software's **"Prepare"** operation is to create a series of stacked, cross-sectional layers of the STL files representing your parts—"slicing" them in their tesselated form along the Z axis of the Build Platform (***after*** all support, style, and other building parameters have been set).

Each cross sectional layer in the SLI file has a different coordinate location in the Z axis. Each range of layers may also have a unique thickness, dictated by the parameters of the Build Style associated with its vertical positioning (a dictation that is part and parcel of 3D Lightyear software's application of Style Files).

Build Style Tables

The following tables list the build styles provided with the 3D Lightyear software at the time of this printing. It does not include those styles available on the distribution CD ROM as “Recommended Baseline” styles.

NOTE!
The information in the following tables are “dynamic”.

3D Systems and its development partners are constantly working to design and produce new and improved SLA system resins, Build Styles and techniques. This results in frequent updates to Resin availability and parameters, Build Styles and parameters, and totally new and improved hardware.

Table 3. SLA system 190 Build Styles

Type of SLA	Recoating System	Type of Resin	Build Style	Layer Thickness (mm/in)
SLA 190	N/A	5170	QuickCast - Box	.1500/.0060
SLA 190	N/A	5170	FAST	.2000/.0080
SLA 190	N/A	5170	EXACT	.1500/.0060

Table 4. SLA system 250 Build Styles

Type of SLA	Recoating System	Type of Resin	Build Style	Layer Thickness (mm/in)
SLA 250	Regular	5149	FAST - General	.1250/.0050
SLA 250	Regular	5149	FAST - General	.2500/.0100
SLA 250	Regular	5170	QuickCast - Box	.1500/.0060
SLA 250	Regular	5170	EXACT - General	.1500/.0060
SLA 250	Regular	5220	QuickCast - Hex	.1500/.0060
SLA 250	Regular	5220	EXACT - General	.1500/.0060
SLA 250	Regular	5220	EXACT - Inclined	.1500/.0060
SLA 250	Zephyr	5170	QuickCast - Box	.1000/.0040
SLA 250	Zephyr	5170	QuickCast - Box	.1500/.0060
SLA 250	Zephyr	5170	FAST - General	.0625/.0025
SLA 250	Zephyr	5170	QuickCast - Hex	.1500/.0060
SLA 250	Zephyr	5170	EXACT - General	.1000/.0040
SLA 250	Zephyr	5170	EXACT - General	.1500/.0060
SLA 250	Zephyr	5210	FAST - General	.1000/.0040
SLA 250	Zephyr	5210	FAST - Gemeral	.1500/.0060
SLA 250	Zephyr	5210	EXACT - General	.1000/.0040
SLA 250	Zephyr	5220	FAST - General	.1500/.0060
SLA 250	Zephyr	5220	FAST - Inclined	.1500/.0060
SLA 250	Zephyr	5220	QuickCast - Hex	.1000/.0040
SLA 250	Zephyr	5220	EXACT - General	.1000/.0040
SLA 250	Zephyr	5220	EXACT - Inclined	.1000/.0040

Table 5. SLA system 350/3500 Build Styles.

Type of SLA	Recoating System	Type of Resin	Build Style	Layer Thickness (mm/in)
SLA 350(0)	Zephyr	5190	QuickCast - Box	.1000/.0040
SLA 350(0)	Zephyr	5190	FAST - General	.1250/.0050
SLA 350(0)	Zephyr	5190	Tooling - General	.0500/.0020
SLA 350(0)	Zephyr	5190	EXACT - General	.1000/.0040
SLA 350(0)	Zephyr	5510	FAST - General	.1000/.0040
SLA 350(0)	Zephyr	5510	FAST - General	.1250/.0050
SLA 350(0)	Zephyr	5510	QuickCast - Hex	.1000/.0040
SLA 350(0)	Zephyr	5510	Tooling - General	.0500/.0020
SLA 350(0)	Zephyr	5510	EXACT - General	.1000/.0040
SLA 350(0)	Zephyr	5510	EXACT - General	.1500/.0060
SLA 350(0)	Zephyr	5520	FAST - General	.1250/.0050
SLA 350(0)	Zephyr	5520	EXACT - General	.1000/.0040
SLA 350(0)	Zephyr	5530	Tooling - General	.0500/.0020
SLA 350(0)	Zephyr	5530	EXACT - General	.1000/.0040

Table 6. SLA system 500 Build Styles.

Type of SLA	Recoating System	Type of Resin	Build Style	Layer Thickness (mm/in)
SLA 500	Regular	5154	FAST - General	.1250/.0050
SLA 500	Regular	5154	FAST - General	.2500/.0100
SLA 500	Regular	5180	QuickCast - Box	.1500/.0060
SLA 500	Regular	5180	EXACT - General	.1500/.0060
SLA 500	Regular	5410	QuickCast - Box	.1500/.0060
SLA 500	Regular	5410	QuickCast - Hex	.1500/.0060
SLA 500	Regular	5180	EXACT - General	.1500/.0060
SLA 500	Zephyr	5180	QuickCast - Box	.1000/.0040
SLA 500	Zephyr	5180	QuickCast - Box	.1500/.0060
SLA 500	Zephyr	5180	QuickCast - Hex	.1500/.0060
SLA 500	Zephyr	5180	EXACT - General	.1000/.0040
SLA 500	Zephyr	5180	EXACT - General	.1500/.0060
SLA 500	Zephyr	5410	QuickCast - Box	.1500/.0060
SLA 500	Zephyr	5410	QuickCast - Hex	.1500/.0060
SLA 500	Zephyr	5410	EXACT - General	.1500/.0060

Table 7. SLA system 5000 Build Styles.

Type of SLA	Recoating System	Type of Resin	Build Style	Layer Thickness (mm/in)
SLA 5000	Zephyr	5195	FAST - General	.1250/.0050
SLA 5000	Zephyr	5195	QuickCast - Hex	.1000/.0040
SLA 5000	Zephyr	5195	Tooling - General	.0500/.0020
SLA 5000	Zephyr	5195	EXACT - General	.1000/.0040
SLA 5000	Zephyr	5195	EXACT - General	.1500/.0060
SLA 5000	Zephyr	5510	FAST - General	.1250/.0050
SLA 5000	Zephyr	5510	FAST - Inclined	.1250/.0050
SLA 5000	Zephyr	5510	QuickCast - Hex	.1000/.0040
SLA 5000	Zephyr	5510	Tooling - General	.0500/.0020
SLA 5000	Zephyr	5510	EXACT - General	.1000/.0040
SLA 5000	Zephyr	5510	EXACT - Inclined	.1000/.0040
SLA 5000	Zephyr	5520	FAST - General	.1250/.0050
SLA 5000	Zephyr	5520	EXACT - General	.1000/.0040
SLA 5000	Zephyr	5520	EXACT - Inclined	.1000/.0040
SLA 5000	Zephyr	5530	Tooling - General	.0500/.0020
SLA 5000	Zephyr	5530	EXACT - General	.1000/.0040

Table 8. SLA system 7000 Build Styles.

Type of SLA	Recoating System	Type of Resin	Build Style	Layer Thickness (mm/in)
SLA 7000	Zephyr	7510	FAST - General	.1250/.0050
SLA 7000	Zephyr	7510	FAST - Inclined	.1250/.0050
SLA 7000	Zephyr	7510	QuickCast - Hex	.1000/.0040
SLA 7000	Zephyr	7510	Tooling - General	.0250/.0010
SLA 7000	Zephyr	7510	Tooling - Inclined	.0250/.0010
SLA 7000	Zephyr	7510	EXACT - General	.0750/.0030
SLA 7000	Zephyr	7510	EXACT - Inclined	.0750/.0030

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