

3D Builder

Converts Your Photos to 3D Models

Version 3.0

3D Construction Company

122 Creative Station
Elizabethton, Tennessee USA 37643-5358
1-423-543-8917
Fax 1-423-543-4011
Email: threedc@usit.net

3D Builder Reference Note

3D BUILDER REFERENCE NOTE

Copyright 1995, 1996, 1997, 1998 3D Construction Company
All rights reserved

SOFTWARE LICENSE AGREEMENT

3D Construction Company grants you a non-transferable, non-exclusive license to use only this copy of the **3D BUILDER** program and its accompanying materials according to the following terms:

LICENSE

- a) You may use the program on only one computer at a time.
 - b) You may make one copy of the program only for backup purposes, provided that you reproduce all proprietary notices on the copy.
 - c) You may transfer the program onto your hard disk only for use as described above providing that you can prove ownership of the original disks.
 - d) You may physically transfer the program from one computer to another provided that the program is used on one computer at a time.
 - e) You may NOT use the program in a network unless you pay for a separate license for each terminal or workstation from which the program will be accessed.
 - f) You may NOT reverse engineer, decompile, disassemble, modify, translate, or create derivative works based on, or copy the program or accompanying materials(except for the backup copy listed above).
 - g) You may NOT transfer, rent or grant any rights to the program in any form or accompanying materials to any person or company without the prior written consent of 3D Construction Company.
 - h) You may NOT remove any of the proprietary notices, or labels, or marks on the program or accompanying materials.
- This license is not a SALE. Title and copyrights to the program, all or any accompanying materials, and any copy made by you remain the property of 3D Construction Company.

TERMINATION

Any unauthorized copying of the **3D BUILDER** program (alone or merged with any other software) or any of the accompanying materials, or failure to comply with the above restrictions will result in the automatic termination of this license and will make available to 3D Construction Company other legal recourse and action.

WARRANTY AND DISCLAIMER

"As Is". The **3D BUILDER** program and all accompanying materials are provided to you "as is" without warranty of any kind, either express or implied, including, but not limited to, the implied warranties or merchantability and fitness for a particular purpose.

3D Construction Company does not warrant that the functions and/or performance of this program will meet your requirements or that the operation will be uninterrupted or error free. The risk as to the use, performance, and/or quality of the program and any/all accompanying materials is entirely with you. Should the program prove defective, you, and not 3D Construction Company assume the entire cost of any/all necessary repairs. 3D Construction Company does warrant the media on which **3D BUILDER** is furnished to be defect free in workmanship and materials under normal use for a period of 30 days from the date of delivery to you as evidenced by a copy of your receipt. The duration of any implied warranties is limited to the period stated above. 3D Construction Company's entire liability will be the replacement of the media.

The images presented here are for instructional purposes only and may not look exactly like the ones on your machine.

LIMITATION OF LIABILITY

4 **3D Builder Reference Note**

Under no circumstances will 3D Construction Company be liable for any damages, including loss of data, lost profits, cost of cover or other special, consequential or indirect damages arising from the use of **3D BUILDER** or any or all of its accompanying materials. You acknowledge that the license fee reflects this allocation of risk.

If you have any questions, please call or fax

3D Construction Company, 122 Creative Station, Elizabethton, Tennessee USA 37643-5358, 1-423-543-8917, FAX 1-423-543-4011 or you may write to us at the above address.

FAX or MAIL in your registration card today. Return of the registration card is required for all product updates and all notices of new versions

All trade names referenced are the registered trademark of their respective owners. **3D BUILDER** is a registered trademark of 3D Construction Company, Elizabethton, Tennessee USA.

Document #L798

TABLE OF CONTENTS

Table of Contents

TABLE OF CONTENTS	5
INTRODUCTION	15
System Requirements	16
About This Manual	16
Conventions Used In This Manual	16
Installation Procedures	17
What You Will Need	17
3D Builder Installation	17
License Authorization Instructions	18
Key Points	19
Make A Back Up	19
Updates and Registration	20
Getting Help	20
Using the Commands on the Help Menu	20
NEW FEATURES	21
QUICK GUIDE	25
TO 3D BUILDER	25
Even If You Don't Read Anything Else, Read This Section."	25
Choosing Images	25
Add The Images To The Project	25
Enter Camera Information If Known	26
Use Tools To Locate Reference Targets, And Coordinate Axes, If Any	27
Tie Reference Points Together In Multiple Images	29
Group Images Taken From Same Camera Station	29
Initial Calculations Of Camera Stations	30
Use Tools To Create Objects	32
Calculate Object 3D Geometry	32
Export the Model To A Rendering Package	32
Measurements And Natural Cues	33

6 3D Builder Table of Contents

Known Camera Height And Two Coordinate Axis Pairs	33
Two Pairs Of Coordinate Axes	34
One Known Point And Two Known Lengths	35
Three Known Points	35
Known Lengths Between Three Points	36
LICENSE AUTHORIZATION	37
License Instructions	37
Key Points	38
STARTING A PROJECT	41
The 3D Builder Environment	42
Begin a New Project	43
The Image Window	43
The Project Window	44
The 3D Preview Window	45
Navigating Between Opened Windows	46
Setting the Display of the ToolBar	46
Setting The Display Of The Status Bar	47
Keyboard Accelerators	47
Saving A Project	47
Exiting 3D Builder	48
Camera Lens Data File	48
Material Data File	48
MENUS	51
File Menu Commands	51
File/ New Project (CTRL +N)	51
File/ Open Project (CTRL + O)	52
File/ Close Project	52
File/ Save Project (CRTL +S)	53
File/ Save Project As (....)	53
File/ Add image to Project (INS)	53
File/ Calculate 3D (F3)	54
File/ Export...	55
Perspective Correction for Texture Maps	57
File Export.../ Camera Viewpoints tab	58
File/ Exit	59
Camera Lens Data File	59
Material Data File	60
Edit Menu commands	60

Editing an Individual Item	60
Edit/ Delete (DEL)	61
Edit/ Properties...	61
Edit/ Material Properties...	61
Edit/ Object Properties...	62
Edit/ Select	63
Edit/ Select All	63
Draw Menu Commands	63
Draw/ Point (P)	64
Draw/ Line (L)	65
Draw / Line: Polyline Tool for Multiple Line	67
Draw / Line: Point on a Curve or Circle	67
Draw /Free-form curve (B)	68
Draw /Circle/Arc (C)	68
Draw/ Polygon (F)	68
Draw /Extrusion (E)	70
Draw/ Merge (M)	70
Semi-Automatic Point Matching	71
Draw/ Pick Color	71
Draw/ Texture Map	73
Make Menu Commands	74
Make/ Make Colinear	75
Make/ Make CoPlanar	76
Make/ Make Equal Length	77
Make/ Make Parallel	78
Make menu/ Make Perpendicular	78
Make/ Make Behind (Behind/In Front Of Command)	78
View Menu Commands	79
View/ Tool Bar	80
View/ Status Bar	81
View/ As Input (I)	81
View/ As Calculated (U)	81
View/ Select Image (F2)	82
View/“Next” Image (>)	82
View/“Prior” Image (<)	82
View/ The Pan Tool (N)	82
View/ Zoom (Z)	82
View/ Zoom In (+)	82
View/ Zoom Out (-)	83
Placing Points Outside an Image	83
View/All (A)	83
View/ Properties... (D)	83
Camera Target Point	87

8 3D Builder Table of Contents

View/ Filter...	89
View/ Background Color	91
View /Solid	91
View/ Wireframe	91
Insert Menu Commands	92
Insert/ Insert Photo... (Ins)	92
Insert/ Insert Object...	93
Insert/ Insert Grid...	94
Insert/ Insert Material...	95
Insert Material Message Box	96
Insert/ Insert Station...	97
Introduction to the Camera lens Wizard	99
Insert/ Insert Camera Lens...	99
Editing A Camera Lens:	107
Digital Camera Information Sheet	109
Tools Menu Commands	110
Tools/Verify Points...	110
Action: Verify, fine tune point locations in images	111
Action: Verify occurrences of the same point in pairs of images	112
Tools/ Settings...	113
Tools/Settings/Line Weight...	115
Tools/Settings/Defaults...	115
License	115
Calibrate Camera Lens	117
Window Commands	118
Window/ New Window	118
Window/ Cascade	118
Window/ Tile	119
Window/ Arrange Icons	119
Window/ Split	119
Window/ Project	119
Window/ 3D Preview Window (F4):	121
Window/ Recent Files	122
Help Menu	122
Help/ Index	122
Help menu/Tutorials	122
Help menu/Show Tips for...	123
Help/ About 3D Builder	123

TOOLBAR	125
Docking Toolbar:	125
Toolbar/ Selector Tool	125

Toolbar/ Point Tool	126
To Edit A Point	128
Toolbar/ Merge Point Tool	130
Semi-Automatic Point Matching	131
Toolbar/ Line Tool	131
To Edit A Line	132
Toolbar/ Polygon Tool	133
Toolbar/ Pan Tool (N)	133
Toolbar/ Zoom (Z)	134
Toolbar/ Zoom In Tool (+)	134
Toolbar/ Zoom Out Tool (-)	134
Toolbar/ Insert Photo (Add image to the Project)Tool	134
Toolbar/ New Window Tool	135
Toolbar/ Select Image List Tool (F2)	135
Toolbar/ Save Tool	136
Toolbar/ Calculate Tool (F3)	136
Toolbar/ Help Tool	137
New Independent mini-toolbars	137
Display mini-toolbar:	137
Circles mini-toolbar:	138
Curves mini-toolbar:	138
Extrusion mini-toolbar:	138
Changes in the line mini-toolbars:	139
Flip Line/Curve Sense Tool:	139
Object and Material Assignment from the Toolbar	139

WORKING WITH PHOTOGRAPHS**141**

Getting Images Onto Your Hard Drive	141
Importing File Formats	141
Adding Photos to a Project by “Inserting” them in a Project	141
Add Images All At Once To Your Project.	142
File Menu/ Add image to Project	142
Add New Window And More Photos	142
Manipulate The Image On The Main Screen	143
The Pan Tool	143
View/ Zoom	143
The Zoom In Tool	143
The Zoom Out Tool	143
Enlarge an area of the image in the Splitter thumbnail	144
Properties	144
Resize the Image Window using the Maximize/Minimize Boxes	144
Close The Image	145

10 3D Builder Table of Contents

Working With Multiple Images	145
How many images at a time?	145
Cascade	145
Tile	145
Take one or more images down to an Icon	146
Close One Photo	146
Resize one image	146
Image Select Viewing Window Tool	146
Project Tree	147
Delete a Photo from a Project	147
Saving A Project And Re-opening It Next Time	148
Summary	148
EXPORTING YOUR	149
3D BUILDER PROJECT	149
Introduction	149
Export File Formats	149
Beginning The Export Process	149
Problem Reporter	151
Texture Exporting	151
COLORS, MATERIALS, TEXTURE MAPS	153
Overview	153
JPEG Texture Maps	153
Functions	154
Touching Up Textures	155
Reviewing the Touch-Up Texture Map	157
Exporting Textures	158
Perspective Correction for Texture Maps	158
CONSTRAINTS	161
Introduction	161
Functions	161
Make CoPlanar	161
Make Equal Length	162
Make Parallel	162
Make CoLinear	162
Make menu/Perpendicular	163
Constraint Project Tree	163

CIRCLES AND ARCS	164
Introduction	164
Draw Menu/ Circle Tool	164
“Just-In-Time” On-Screen Helps for the Circle Tool	165
How the Circle Tool Works	166
Editing a Circle or Circular Arc	169
Exporting a Circle or Circular Arc	169
Texturing a Circle or Circular Arc	169
Useful Notes on the Circle Tool	169
FREE-FORM CURVES	170
Bezier Spline Curves	170
Introduction	170
Draw Menu/ Curve Tool	170
“Just-In-Time” On-Screen Helps for the Curve Tool	171
How the Curve Tool Works	172
Editing a Curve	174
Texturing a Curve	174
Useful Notes on The Curve Tool	174
EXTRUSIONS	175
Draw Menu/Extrusion Tool	175
“Just-In-Time” On-Screen Helps for the Extrusion Tool	175
How the Extrusion Tool Works	176
Editing the Results of an Extrusion	178
Viewing the Results of an Extrusion	178
Useful Notes on the Extrusion Tool	178
PHOTO TIPS FOR IMPROVED ACCURACY	180
Take Good Pictures...Build Great Models!	180
Plan Ahead	180
Equipment Needs	181
Location Is Important	181
Several Pictures From Widely Spaced Angles	181
Overlapping Coverage Of An Object	181
Photographing A Small Object	182
Different Camera Heights	183
One Photo	183
Mixed Lenses	183
Problems:	184
Obstructions In The Way	184

12 3D Builder Table of Contents

Lighting Changes	184
Set-Up Takes Time	185
If This Is A Critical Project	185
Know Your Camera	185
Basics Count	185
Targets Improve Accuracy	185
Measurements Help	186
Cropping of the Photos	186
After The Shoot	186
Summary	186
ACCURACY	189
Introduction	189
Sources of Error	190
Other Accuracy Features in 3D Builder	191
How to Improve Accuracy	191
How to Determine Accuracy	191
CAMERA LENS CALIBRATION	193
Preparation	194
Using the Calibration Wizard	195
WHAT DO I DO IF?	197
Unknown focal length of the camera	197
Unknown camera type	198
Camera not on 3D Builder “camera list”	199
No measurements known	200
No reference marks visible in the photo	200
Pictures taken by someone else and “Handed to You”	201
No natural right angles and parallel lines in the photos	201
Need to know the location of a point or “point location”	202
Need to know the length of a line	203
Point location is unseen/blocked by something	203
Suggestions for complex, organic objects or objects with unusual shapes...	204
Model due YESTERDAY! Need model ASAP	204
Have Pictures, but no negatives	204
Have pictures AND negatives, BUT need to model ASAP	204
I am Having Trouble with Texture Maps in Wavefront and/or Inventor files: Go to Tools/Settings/Defaults...	204
How Do I Delete a Photo from a Project ?	205
I Keep Getting An Error Message when I Calculate...What Am I doing Wrong?	205

3D Builder Table of Contents	13
I Get A Message after Calculating: Lens Focal Length Conflicts with Actual...	206
Other Error Messages Upon Calculating...	206
The Password For the License that I Typed In Does Not Work...	206
Other Problems not Listed Here	206
CUSTOMER SERVICE PLAN	207
Registration:	207
Customer Service:	207
Call Our Technical Support For Specific Questions About Using The Software.	207
Customer Service And Technical Support	208
APPENDIX A	209
CALCULATE 3D MESSAGES	209
Need At Least One Known Point	209
Need Three Known Points Or Two Pairs Of Axes.	210
X Axis Line Direction Conflict	213
Y Axis Line Direction Conflict	213
Z Axis Line Direction Conflict	213
X Axes Do Not Intersect	214
Y Axes Do Not Intersect	214
Z Axes Do Not Intersect	214
Known Points Are Colinear	215
Points Not Located Because They Are Visible In This Image Only	216
Points Not Located Because The Other Image(s) That They Are Visible In Have Not Been Calculated Successfully	217
Lens Focal Length Calculated From Axes Conflicts With Actual	218
Need To Specify Camera Lens Focal Length	219
Axis Coordinate System Is Not Right handed	220
APPENDIX B	221
FIELD NOTES FORMS	221
APPENDIX C KEYBOARD ACCELERATORS	2-223
Under File Menu:	2-223
Under Edit Menu	2-223
Under Draw Menu	2-223
Under View Menu	2-223

14 3D Builder Table of Contents

Under View Menu	2-223
Under Insert Menu	2-223
Under Window Menu	2-223
Help Menu	2-223

APPENDIX D 225

FUNDAMENTAL 3D CONCEPTS 225

Coordinate Systems	225
2-D Space	226
3-D Space	227
Points	228
Lines	228
Faces	228
Axes Planes	229
3-D Modeling	229

APPENDIX E 231

TECHNICAL SUPPORT FORM 231

APPENDIX F 233

LIST OF FIGURES 233

INDEX 237

Introduction

Chapter

1

3D Builder for Windows is a productivity tool designed to help you convert photos into 3D models. As a desktop photogrammetry system, **3D Builder** provides the first constraint-based modeling software package to work directly from your photographs. **3D Builder** gives you accurate “X”, “Y”, and “Z” locations for “as built”, as well as giving you both the camera locations and orientations. **3D Builder** works seamlessly with the major rendering tools, such as 3D Studio, as well as CAD packages such as AutoCAD. **3D Builder** uses a standard Windows user interface making it easy to learn. Our new CAD-style tools for creating circles, Bezier spline curves and extrusions saves considerable time in the modeling process.

3D Builder does not require any special cameras or any special experience to transform your photos of real world data into detailed 3D models. **3D Builder** offers a cost effective solution for custom modeling needs, especially when compared to other 3D modeling techniques. Using a powerful, comprehensive math solver, **3D Builder** is able to combine information from a large number of photos of simple or complicated objects, extract information, and merge it all together into a single 3D model ready to export to the target rendering program.

This program can save you both hours of frustration and money. **3D Builder** simplifies the complex mathematical work and frees you to concentrate on the creations possible with today’s rendering, animation, CAD or Internet packages. **3D Builder** takes the mystery and the drudgery out of building dimensionally accurate 3D models.

If you are familiar with other programs for Microsoft Windows, you should have no trouble using **3D Builder**. You will find the user interface comfortable and easy to use. This manual describes **3D Builder’s** features and gives procedures for using them.

All brands and products listed are the property of their respective owners.

System Requirements

The following minimum requirements are needed to run **3D Builder** successfully:

- A PC with a 386 or higher processor
- At least 16 megabytes of RAM and 16 megabytes of available hard disk space
- Windows 95 or 98, WindowsNT 3.51, 4.0, or later.
- 256 color (or higher) capable video board



Note: You can work with images that are in 16, 8, or black and white **if** you convert the image in a Paint program, saving it as 256 colors first.

About This Manual

This manual contains information about how to use **3D Builder** to convert photos into 3D models. It assumes that you are familiar with how to navigate in a Windows environment. This manual also assumes a basic knowledge of photography and/or video techniques.

Conventions Used In This Manual

To help you find information, this manual adheres to the following conventions:

- Indicates a note of importance. Read carefully.



Note: **3D Builder** gives you a lot of flexibility. You may start with any image you choose, in any order that you choose.

-
- Indicates that this feature or function can only be used with the **3D Builder PRO** version. It cannot be used with **3D Builder POWERLITE** ve



-
- Indicates a command button that you can select from the toolbar.



- Indicates the name of a menu command, such as **Edit**.
- Indicates the name of an object, such as a dialog box or a menu, “Point Tool Dialog Box”.

-
- The plus sign (+) indicates that you should press and hold down the first key while pressing the second key. Then release both keys at the same time. For example, “Alt + C” indicates that you should press down “Alt” and hold it while you press “C”. Then release both keys.

Installation Procedures

This section explains how to install **3D Builder** on your computer’s hard disk. During installation you will be given an opportunity to select either a full Install or a Custom Install. A “Full Install” installs all necessary files, plus the Tutorials. A “Custom Install” allows you to install only the desired components of **3D Builder**.

What You Will Need

To install **3D Builder** you will need:

Either the **3D Builder** program disks or the **3D Builder CD**.

At least 16 mg of available space on your hard drive.

3D Builder Installation

To install **3D Builder**, you must be running Microsoft Windows 95, 98 or WindowsNT. **3D Builder** requires at least 16 megabytes of hard disk space.

CD Installation Instructions:

1. Insert the CD in your CD drive. From the program manager or the File Manager, type: **e:setup**, where “e” is the drive letter of your CD drive from which you will be installing. Then press “Enter” or “OK”. After a pause, you will see the **3D Builder** setup window. Follow the instructions given on the various message boxes which will appear on your screen.
2. Enter a directory for installing **3D Builder** in the entry field provided. The default directory and drive for installing **3D Builder** is **C:\Program Files\3DCo\3DBuilder**.
3. Follow the instructions given on the various message boxes will appear on your screen.

18 3D Builder Introduction

It is recommended that you read the “Read Me” file for any last minute instructions that may have been added after this manual was printed.

A message box will appear when **3D Builder** has been successfully installed.
To run the **3D Builder** program, double click on the **3D Builder** icon.

Floppy Disk Installation Instructions:

1. Insert Disk 1 in any 3.5” disk drive. From the Program Manager or the File Manager, type **A:setup** where “**A**” is the drive letter of the 3.5” drive from which you will be installing. Then press “Enter” or “OK”. After a pause, you will see the **3D Builder** setup window. Follow the instructions given on the various message boxes which will appear on your screen.
2. Enter a directory for installing **3D Builder** in the entry field provided. The default directory and drive for installing **3D Builder** is **C:\Program Files\3DCo\3DBuilder**.
3. Follow the instructions given on the various message boxes which will appear on your screen.



IMPORTANT: Make sure that you choose correctly when asked what system: Win 95 98 or NT.

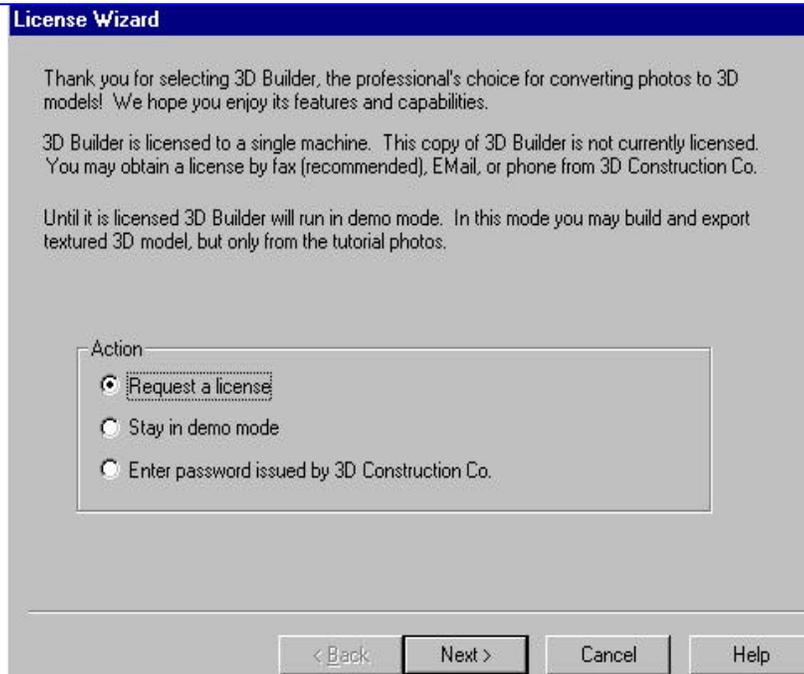
It is recommended that you read the “Read Me” file for any last minute instructions that may have been added after this manual was printed.

A message box will appear when **3D Builder** has been successfully installed.
To run the **3D Builder** program, double click on the **3D Builder** icon.

License Authorization Instructions

3D Builder for Windows is licensed to an individual machine. After installing the program you will need to license it by faxing or Emailing (preferred) information to 3D Construction Company. If **3D Builder** has not been licensed it will display the License Wizard when it starts up (see below). The License Wizard will guide you through a series of questions and will prepare a form to be faxed or Emailed (preferred). 3D Construction Company will then send you an authorization code which unlocks the program.

Note: On some machines (or where a printer is not available, this information is available in a file called “XNETINST.TMP” in your 3D Builder directory.



Key Points

- **3D Builder** is licensed to an individual machine and to a specific location on a machine.
- **3D Builder** automatically defaults to running in a demo mode. Using the demo mode, you can run the tutorials and learn about **3D Builder's** program tools and features, but you are limited to working with the supplied tutorial image files.
- **3D Builder** can be turned on for a free 30 day trial period or it can be turned on for full unrestricted use.
- To activate the program for either a 30 day trial evaluation or for full unrestricted use, refer to the chapter on "License Authorization" later on in this manual.

Make A Back Up

It is a good idea to make a working back up copy of the **3D Builder** master disks. Store the originals in a safe place. If anything happens to the working copies, the originals will be intact.

20 3D Builder Introduction

Updates and Registration

Please take a moment to fill out the registration card and mail or fax it back to 3D Construction Company with the address of where you want information sent. This is the best way for us to tell you about bug fixes, upgrades and new features.

Only registered owners can receive upgrades and technical support.

Getting Help

On-Line Help is provided on most topics in **3D Builder**. Use on-line help when you want immediate information about any of the features of **3D Builder**.

The help system includes an extensive topics index, a glossary, and special features. Many of the new tools feature “Just-In-Time-On-Line Helps” which give you information about using the tools. Also, the tutorials are on-line and give additional help information. Context sensitive helps are available by moving your mouse over the desired object or menu item.

Using the Commands on the Help Menu

You can get help by selecting the “**Help**” button on the toolbar or pressing “**F1**” to access the “on-line help”.

New Features

Chapter 2

3D Builder has added the following features to help you convert photos into 3D models.

Changes and New Features from Release 2.0

- **Circles and Arcs:** **3D Builder Pro** features new tools for circles and arcs. Located under the “Draw” menu, each menu item is activated by clicking on it. The circle tool also has an icon for easy access from the toolbar.
- **Free-form Curves:** **3D Builder Pro** features new tools for free-form (Bezier spline) curves. The “curve” tool is used to create any type of curve. You can create an “Open Curve” or a “Closed Curve”.
- **Extrusions:** **3D Builder** features new tools for creating extrusions from lines and faces you have previously created. The “extrusion” tool is used to extrude any type of object. Located under the “Draw” menu, each menu item is activated by clicking on it. The extrusion tool also has an icon for easy access from the toolbar.
- **Camera Wizard:** **3D Builder** now features an easy to use Camera Wizard for entering data about camera and lenses. The Camera Wizard will guide you through a series of questions to help you determine the camera information. This is especially helpful if you are using a digital camera, since many manufacturers do not provide the “true” focal length of the lens.
- **Camera Calibration Wizard:** **3D Builder** now features a simplified camera calibration wizard. The wizard will guide you through a series of questions to help you calibrate the camera and lens combination that you are using.

- Added a new toolbar icon for displaying the “Project Window”.
- Added power-user new shortcut keys, such as “F3” for “Calc3D” and “F4” to display the 3D Preview window. We have provided a bookmarker with the “Power Shortcut keys” printed on it for your convenience. The power shortcut keys are also listed in the Appendix of this “User’s manual”.
- Added sub-pixel precision for locating points.
- Added VRML 2.0 export file format.
- Added a "Camera Viewpoints" tab to the export dialog. Allows check marks to be placed on photos which are to have their camera position and orientation exported (Inventor and VRML only). These standard views make it easier to navigate with VRML browsers.
- Added menu commands under Help/Tutorial to launch a web browser for tutorials 1, 2, 3, 4 and 5. The **3D Builder** tutorials are now available in an "on-line" form. The online tutorials can be viewed from your Internet browser. From your Internet browser, choose tutor1.htm, tutor2.htm, tutor3.htm, tutor4.htm or tutor5.htm. These files can be found in **C:\Program Files\3DCo\3Dbuilder\tutorial\tutor1** or **tutor2** or **tutor3** or **tutor4** or **tutor5**. Selecting one of these .htm files will run the online version of the **3D Builder** tutorials. If you resize your Internet browser and the **3D Builder** screen, you can see both at the same time. This will allow you to "do" a tutorial while you read about it.
- Non-textured materials created during a project may now be saved to the master “material.dat” file when the project is saved. A pop-up window will ask if this should be done.
- Expanded the “Tools/Verify Points” wizard by adding an option for verifying point-point matchings between images. If this option is selected the wizard will cycle through pairs of what should be the same point in different images. This tool is intended as an aid when a project will not calculate correctly and it is suspected that one or more points may have been incorrectly merged between images.
- Added JPEG Texture Maps. **3D Builder** now saves texture maps as both **.BMP** and **.JPG** files. The **.BMP** file is required for the **3D Builder** “3D Preview” window, accessed via the “Window/3D Preview” menu, and may be exported to 3D Studio and other modeling programs. The **.JPG** file is used for VRML and Inventor exports. The **.JPG** file is much smaller which is better for the Internet.

- **Tools/Settings: 3D Builder** has added an option under the “Colors” tab for setting “line” and “curve” weights. You may now choose either a “single” or “double” weight for the display of the line. This was done to improve the visibility of the lines in curves.

- **Digital Camera Information:** Because of the widespread growth of digital cameras, **3D Builder** has added a lot of information concerning various types of digital cameras. The “camera lens combo box” now displays all available camera types with known camera magnification and other parameters.

Note: There is now a new entry for “Generic digital camera”. If you know the camera lens that took the image, be sure to specify the camera lens in addition to the type of camera. If you do not know the camera lens that took the picture, at least specify the type of camera.

- **Make Perpendicular constraints: 3D Builder Pro** has added a new command for indicating that two or three lines are perpendicular to each other.

- **New Screen Layout:** The layout is now optimized for 800 by 600 (or larger) SVGA screens. The **3D Builder** program still runs on 640 by 480 VGA screens, but you will need to rearrange the toolbars to fit the screen. Each toolbar is independent and can be docked in several areas on the screen.

- **“Drag and Drop” to New Locations: 3D Builder** has added a new “**dragging**” action for moving a point to a new location. Click once on a point with the “arrow” tool to select the point, then mouse down and drag the point to the desired new location.

- **New Independent mini-toolbars: 3D Builder** has added several new “**mini-toolbars**” making it easier for you to use tools in your 3D modeling. These new mini-toolbars are described here:

Display mini-toolbar:

3D Builder has added a new, independent, mini-toolbar to control what you see on the image. You may now turn off the visible display of lines, points and faces from the toolbar. This mini-toolbar is independent from the main toolbar and may be docked anywhere on your screen.

Circle, Curve, and Extrusion mini-toolbars:

3D Builder has added new, independent, mini-toolbars to the new circle/arc tool, curve tool and extrusion tool. These mini-toolbars are independent from the main toolbar and may be docked anywhere on your screen.

- **Line Flip Tool: 3D Builder** has added a “Line Flip” tool to the “Line” and “Select” toolbars. You can now change the direction of a line by using the “Line flip” tool, thus eliminating the need to double click on the line to bring up the “Line Properties” box. Now the direction of the line can be changed directly from the toolbar with a single click. This is done *after* selecting the line.

- **Zoom Feature to the 3D Preview Window:** You can now zoom in and out while previewing your 3D model created by **3D Builder**. This is very helpful for checking the accuracy of the 3D model. It is also useful when making a presentation to a client or customer. While running the 3D Preview window, clicking on the “+” key will magnify the image in the 3D preview window. Clicking on the “-”key will shrink the image in the 3D Preview window.

- **Polyline Tool:** Additional points on the curve (or circle) may be added by using the new “Polyline Tool”. The “Polyline Tool” adds a special kind of point when you create a line or a polygon that ends or begins on a curve (or a circle). To access the “Polyline” tool, select the “Line” tool. The “Line” tool mini-toolbar buttons appear on your screen. If you have already created a curve and you draw (or create) a polygon or a line, then a special kind of point is created. This special point is “tied” or connected to the curve (or circle). This special point is displayed as a “circle” point rather than as the other types of points which are displayed as a “square”. If you edit the curve, then the polyline point will also be moved.

QUICK GUIDE

TO 3D BUILDER

Even If You Don't Read Anything Else, Read This Section."

The goal of using **3D Builder** is to export a 3D model. By using photos, **3D Builder** allows you to take advantage of the rich pool of colors, textures and measurement information within the photos. Other methods of building 3D models of real world existing objects take a lot of time, require a lot of measurements, and can be quite frustrating. **3D Builder** helps you synthesize all of the information and does all the calculations needed to produce a 3D model.

Choosing Images

Take pictures of an object that you need to model. For suggestions for taking better photos, please refer to the chapter entitled "Photo Tips for Improved Accuracy" near the end of this user's guide. Have the pictures scanned from a 35mm camera, use a digital camera, video camera or use Photo CD. **3D Builder** recommends starting with a photo taken of the object from a reasonable distance and from an angle.

3D Builder also recommends starting with a photo in which any reference targets or "natural" X, Y, Z cues are visibly showing.

Add The Images To The Project

Create a **3D BUILDER** project and add the image files to it. Load the images by selecting "**File/ Add image to the Project**" or select "Photo" under the "**Insert/Photo**" menu or by clicking once on the "**Insert Photo**" toolbar button. The first image added is displayed in an image window. This image window displays both a thumbnail and a portion of the full image. The additional images are added to your project, but are not displayed on your screen. To display additional images, use the "**Window/New**



Insert
Photo

Window” command after the images have been added to the project with the **“Insert Photo”** command.

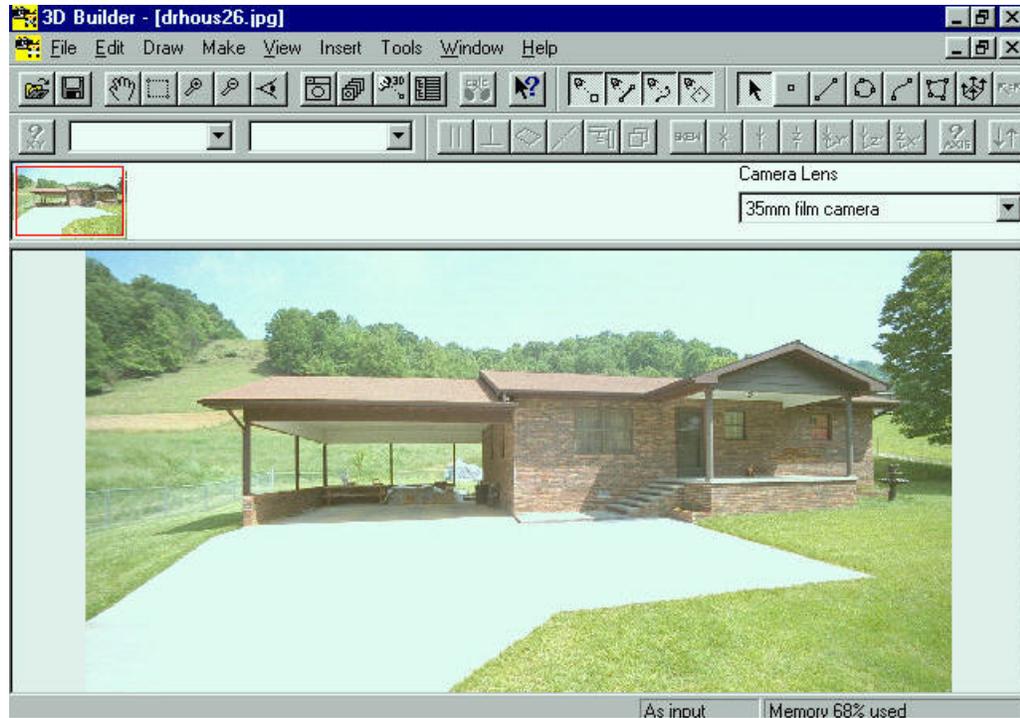


Figure 1 An image displayed in the main work area



Note: **3D Builder** gives you a lot of flexibility. You may start with any image you choose, in any order that you choose.

Enter Camera Information If Known

If you know the camera used to take the photos, then select it from the drop down list in the upper right corner of the image window. If the camera does **not** appear in the list, use the **“Insert/Camera Lens”** menu to define the camera and lens. A “Camera Wizard” will guide you through a series of questions to help you with the camera and lens information. Camera lens usage and other information about the image may be accessed from the **“Image Properties”** pop-up window. Single click with the right mouse button in an open area of the image, then select **“Properties”** from the pop-up menu. Select **“Camera Lens”** tab page. Or double click with the right mouse button in an open area of the image.

Use Tools To Locate Reference Targets, And Coordinate Axes, If Any



Point
Tool

Look for any reference targets or “natural” X, Y, or Z cues in the photo.

Place points on any reference targets by using the “Point Tool”. Place lines on any “natural” X, Y, or Z cues in the photos. Add additional points on obvious places in the photo, such as corners or key features.



Line Tool

Construction Hint Lines

For each image you **must** provide **two** pairs of coordinate axis lines, or at least coordinate axis **hint** lines (ie, 2 “X” lines and 2 “Y” lines, or 2 “X” lines and 2 “Z” lines, etc.).

3D Builder uses these to get a rough location and orientation of the camera.

If you are using an object like a building that already has several natural cues, it will be easy.

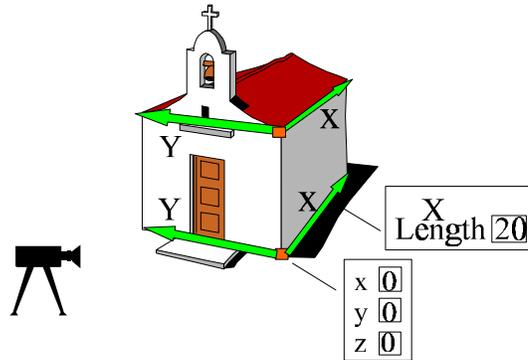


Figure 2 You need to identify 2 pairs of coordinate axis lines in your photo

Otherwise, use whatever you have available, such as using trees as rough estimates for verticals. If all else fails, just “eyeball it” and try to imagine where the “X”, “Y”, or “Z” axis lines would appear. **This is a must.**



Figure 3 Using construction lines for "Z" and "X" coordinate axes lines

3D Builder deals predominantly with points. You will need to locate points to build your model. Many objects, such as buildings have natural features so that points are readily visible in the images without any special markings before taking photographs. Other objects, such as curved smooth surfaces, lack natural features. You will need to prepare these before the photo shoot by putting some form of marking on them.

If you are trying to build an accurate model, then you should carefully place a small number of reference targets in the scene, and carefully measure the distance between these reference points. You will input these measured distances into the program by constructing lines between the points and setting the measured lengths of the lines.

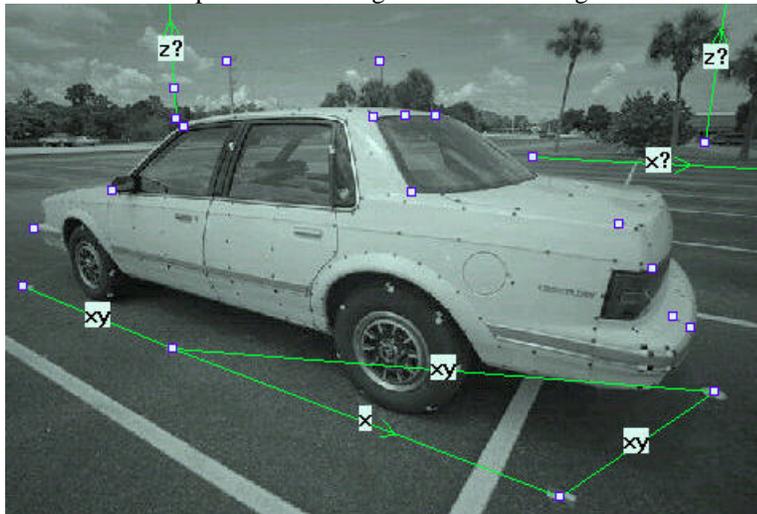


Figure 4 Construction "Hint" lines using measured reference targets



Note: There is always one point that is known, the 0,0,0 point. You may choose **any point** and declare it to be 0,0,0. **3D Builder** recommends, however, that this 0,0,0 point be in a visible “key feature” place, (such as a bottom corner of a building) and that the 0,0,0 point be visible in 2 images.

Tie Reference Points Together In Multiple Images



Merge Tool

Identify which reference points in each picture correspond to points in other pictures, using the “Merge Tool”, which may be accessed via the “Merge Tool icon” on the Toolbar or via the “**Draw/Merge**” command.



Note: You may need to use the “**View/Pan**” tool on the toolbar to place images in a favorable position to be able to see key reference points in both images. **Tool Icon Pan Tool**

Group Images Taken From Same Camera Station

If more than one picture was taken from the same camera location, you need to tell **3D Builder**. Use the “**View**” menu, select the “**Properties**” command or click with the right mouse button in an empty portion of your screen. Select “**Properties**” from the pop-up menu. The “**Image Properties**” window will appear.

Select the “**Station Location**” tab and change the station number to be the same as the station number from which the other image(s) were taken.

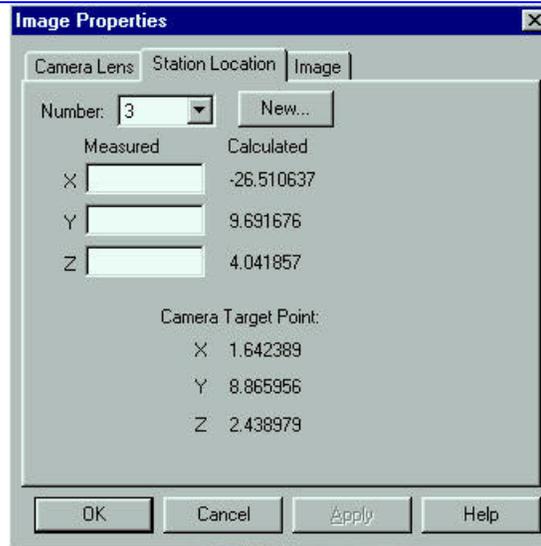


Figure 5 "Camera Station" dialog box, from the "Station" tab page, "Image Properties"

Initial Calculations Of Camera Stations



Calc 3D tool

Choose the "File/Calculate 3D" menu or click once on the "Calc" button on the toolbar. Or click on the "F3" key on the keyboard. This action begins the **3D Builder** calculation process. A "Calculate Dialog Box" appears on the main window and a progress reporter indicates the percentage of progress. When finished, **3D Builder** gives you the number of points and cameras calculated as well as any points or cameras that were unreachable. **3D Builder** also gives you suggestions as to how to improve the accuracy of any points or cameras unreachable. For further details on these accuracy suggestions, please refer to **Chapter 12** and **Appendix A** near the end of this user's guide.

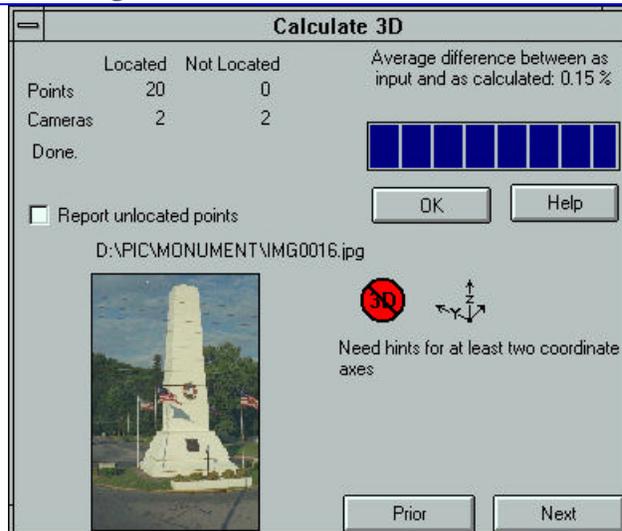
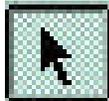


Figure 6 "Calculate 3D" dialog box, showing error messages



Select Tool

Note: You may edit any point or line at any time by choosing the "Select" tool from the toolbar menu and double clicking on the point or on the line. Or right mouse button click to select the point and/or line. The "Point" Properties tabbed page appears and the point may be edited directly from there. If a line has been selected, the "Line" Dialog Box appears and the line may be edited directly from there.

Also **note:** **3D Builder** puts the calculated view directly on the photo, so you can check the accuracy. Select "As Calculated" under the "View" menu to see the **3D Builder** calculated model. Select "As Input" under the "View" menu to see the project as you placed it.

Remember to return to the "As Inputed" view before doing any additional work on the project, including any editing work to improve accuracy.

Use Tools To Create Objects

Using the **3D Builder** tools, locate points, lines, circles, curves, extrusions, and/or faces of interest in the object just as you did for the reference targets or axes coordinates above.



Merge
Tool

Tie object points together in multiple images. Identify which points in each picture correspond to points in other pictures, using the “**Merge Tool**”, which may be accessed via the “Merge Tool” on the Toolbar or via the “**Draw/Merge**” command menu”.

Repeat the merging process for all points common to both images.



NOTE: 3D Builder gives you the flexibility to choose points in either image, in any order. As long as you “merge” the same point in both images, **3D Builder** will do the rest. Merging points will be easier if you use the **View Filter Tool** to turn off the display of points that have already been merged. Select the “View Filter” option by clicking on the “View Filter” tool icon (an eye shape) or click on the “**View**” menu and select “Filter”.

Calculate Object 3D Geometry



Calc 3D
tool

As above for the initial calculations of the reference targets, have **3D Builder** calculate the 3D geometry by clicking on the “**Calc**” button on the Toolbar or by using the shortcut key “**F3**”. The Calculate process may also be accessed via clicking on the “**File/Calculate 3D**” menu command.

Export the Model To A Rendering Package



Save Tool

To export your project files to a rendering package, choose “**File/Export**” menu command. This action brings up the “**Export Options**” window. Select the name and file format in which you would like the project exported. Click once on the “OK” button to accept the data as entered. If you want the textures of the model to be exported, remember to export them as well as the model. Your 3D model is now ready to be imported into your rendering package. Open your rendering package and use the “Import” method your rendering package recommends to bring up the **3D Builder** project.



Note: 3D Builder recommends you save your active data often. Choose “Save” under the “**File**” menu. This action saves all active data in your project to your hard disk.

Measurements And Natural Cues

3D Builder needs to determine where the cameras were that took your pictures and how they were oriented. You can help this by recording some information as the pictures are taken. The more information the better, but **3D Builder** can still produce a quality 3D model with only a small amount of data. For further information and a sample of the **3D Builder** “Field Notes Forms”, please refer to **Appendix B**.

There are six kinds of data that **3D Builder** can use:

- Measured “X”, “Y” and/or “Z” coordinates of target points in the scene.
- Measured distances between target points, not necessarily along coordinate axes.
- Measured “X”, “Y” and/or “Z” coordinates of the camera stations. Camera height (“Z”) is often easy to measure.
- Coordinate axis direction lines.
- Camera format.
- Camera lens focal length.

Mixing many possible combinations of the above items is possible and will still produce a successful 3D model. The following are a few of the most often used combinations of data:

Known Camera Height And Two Coordinate Axis Pairs

If natural x, y, and/or z coordinate axes are available in the scene, then the only measurement needed is the camera height. You will also need to arbitrarily choose one point in the scene as the 0,0,0 origin, although **3D Builder** will do this for you in a number of cases.

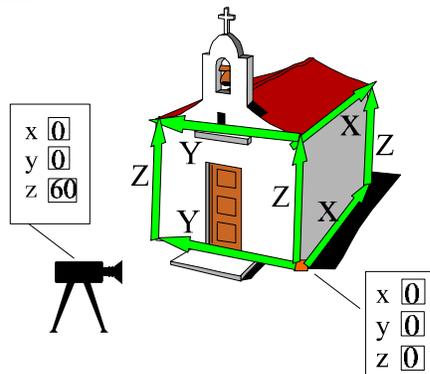


Figure 7 Known Camera Height

Two Pairs Of Coordinate Axes

In order to locate and orient the camera, **3D Builder** needs either three known widely spaced non-colinear points, or two widely spaced known points and some lines along the world x, y, and/or z axes. If natural cues are available, the latter case is the easiest to use. One point can always arbitrarily be chosen as the origin. If scale is not important, then an axial line from the origin point can arbitrarily be assigned a length. This is the “no measurements at all” case when using **3D Builder**.

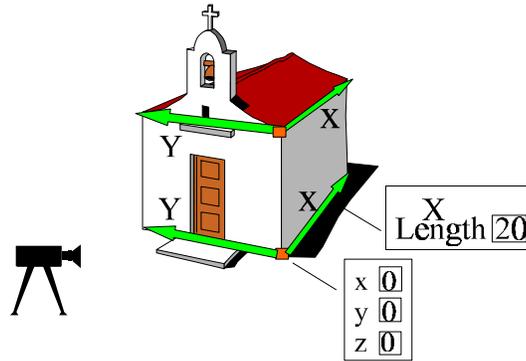


Figure 8 Two Pairs of Coordinate Axes

One Known Point And Two Known Lengths

Instead of typing in “x”, “y” and/or “z” coordinates for three measured coordinates, you may use one known point and set the length of two axial lines connected to it:

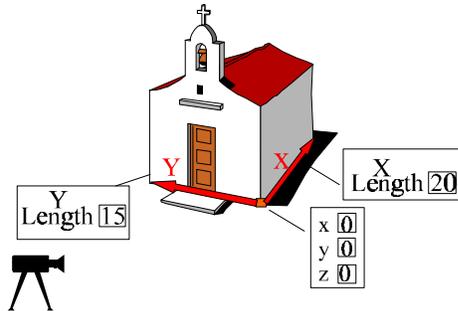


Figure 9 One Known Point, Two Known Lengths

Three Known Points

You can always just type in three known points, of course:

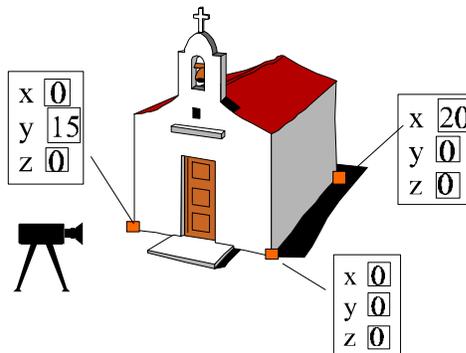


Figure 10 Three Known Points

Known Lengths Between Three Points

Another way of getting three known points is to have measured distances between three points. Again, you would arbitrarily pick one point as 0,0,0. Also arbitrarily assign one of the lines to a coordinate axis and put the other lines in that plane ("XY", "YZ", "ZX").

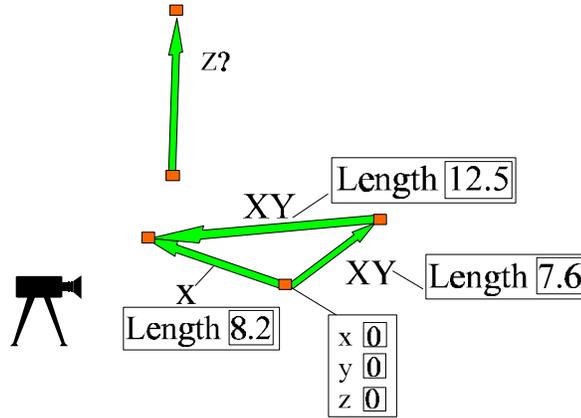


Figure 11 Known Lengths

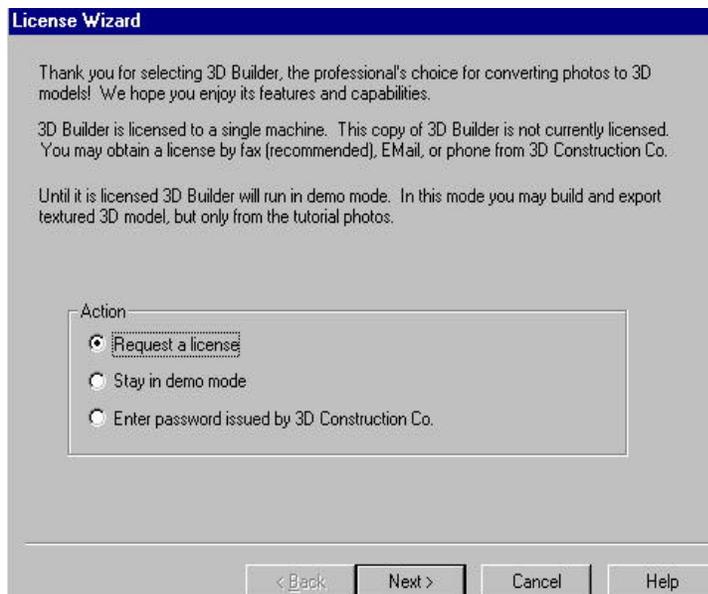
3D Builder offers a lot of flexibility. You are not limited to a certain method, nor are you required to “go” in a certain order. You may find that certain combinations seem more natural for you.

LICENSE AUTHORIZATION

This chapter includes basic information about the **3D Builder** license authorization procedures. It will provide an overview of the **3D Builder** license wizards.

License Instructions

3D Builder for Windows is licensed to an individual machine. After installing the program you will need to license it by faxing or Emailing (preferred) information to 3D Construction Company. If **3D Builder** has not been licensed it will display the License Wizard when it starts up (see below). The License Wizard will guide you through a series of questions and will prepare a form to be faxed or Emailed (preferred). 3D Construction Company will then send you a password which unlocks the program.



Key Points

- **3D Builder** is licensed to an individual machine and to a specific location on a machine.
- **3D Builder** automatically defaults to running in a demo mode. Using the demo mode, you can run the tutorials and learn about **3D Builder's** program tools and features, but you are limited to working with the supplied tutorial image files.
- **3D Builder** can be turned on for a free 30 day trial period or it can be turned on for full unrestricted time use. Select the type of license for the product you purchased. If you have already paid for the product, you have purchased an unrestricted time period license. Once you select the "unrestricted" mode, there is no refund of purchase price.

License Wizard

Please select the type of license you are requesting.

Type

Pro

Power Lite

Time Period: Unrestricted

30 Day Trial

Unrestricted

If you have installed 3D Builder from floppy disks or from an Internet download the serial number should appear below. If you are installing from a CD then enter the serial number found on the sticker on the CD cover or on the 3D Builder box.

Serial Number:

< Back Next > Cancel Help

Figure 12 License Wizard showing Time Periods

- To activate the program for either a 30 day trial evaluation or for full unrestricted use:
 1. Run the License wizard (under **Tools/License menu**). The License Wizard will lead you through a series of short questions.

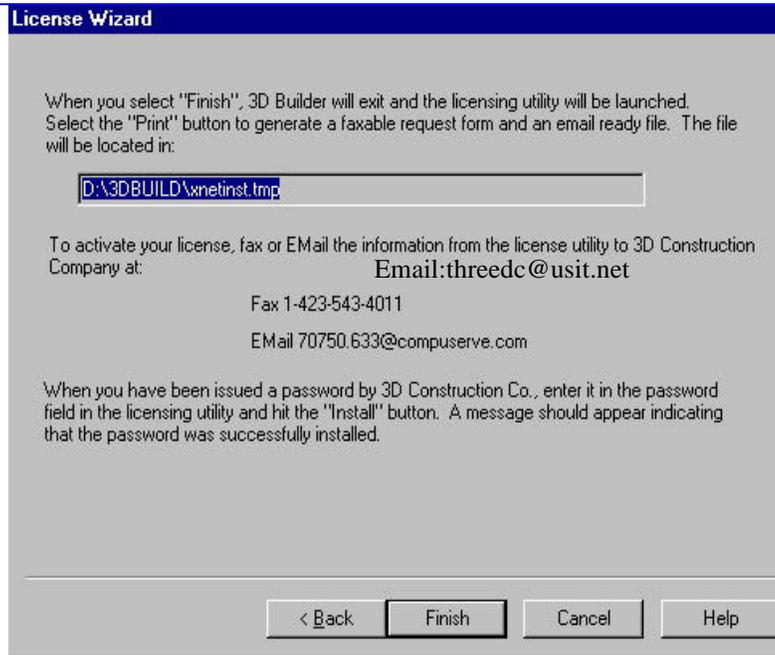


Figure 13 License Wizard Screen showing the "finish" button.

When you click on the "Finish" button, a new window appears which will assign you a **"Machine ID number"**. This number will be requested for the license authorization form.

2. Fax or Email (preferred) 3D Construction Company the information form provided by the License Wizard to receive your authorization code.

Admin Dir: C:\tmp

Enter Password:

Machine Id: ba5a8136 Id Type: DiskId (1)

Developer Id: 3d

License Server: lm2.visi.net
Email: threedc@usit.net

Print Cancel Install

3D Construction Company
Fax: 1-423-543-4011
Email: 70750.633@compuserve.com

To: 3D Construction Co. Fax: 1-423-543-4011
3D Builder License Request 12/13/96 2:48:22 PM

From:

Phone: Fax:
EMail:

Product: 3D Builder Version 2.0 (build 282)
Serial Number: 87BE-0DF7-2E2B-AD36
Platform: Windows 95 Version 4.0

Figure 14 License Wizard Screen showing the "MachineID" location.

3. Enter the authorization code you receive in the License Wizard . This action will activate the program.
4. Click on the "Install" button. A message will pop up indicating that the licensing system was successful. A second message box will appear, asking you if you want to "Install another password? Yes No". Click on "No."
5. Start **3D Builder** program by double clicking on the **3D Builder** icon.

- If you choose the 30 day trial option, you have 30 days of free evaluation of **3D Builder**. If you decide you do not want the product, return the product to us. Call for an RMA number. We will be disappointed, but we will credit the invoice or return your money. Please note that we cannot refund the shipping costs and we cannot take a **3D Builder** return after it has been authorized for *unrestricted* use. We encourage people to begin with the 30 day free trial evaluation mode.

Thank you for purchasing **3D Builder**. We look on your purchase as an opportunity to be of meaningful assistance to your company, and as past experience has shown, we take this opportunity seriously. We look forward to hearing from you.

STARTING A PROJECT

This chapter includes basic information about the **3D Builder** environment. It will provide an overview of the **3D Builder** windows and it discusses how to:

- The **3D Builder** Environment
- Use the Image Window
- Use the Project Window
- Use the 3D Preview Window
- Navigate between windows
- Set the display of the toolbar and status bar
- Keyboard Accelerators
- Save the contents of windows
- Close windows
- Exit **3D Builder**

The 3D Builder Environment

When you first open **3D Builder** the main menu bar, the tool bar, the status bar, and one empty image window appear.

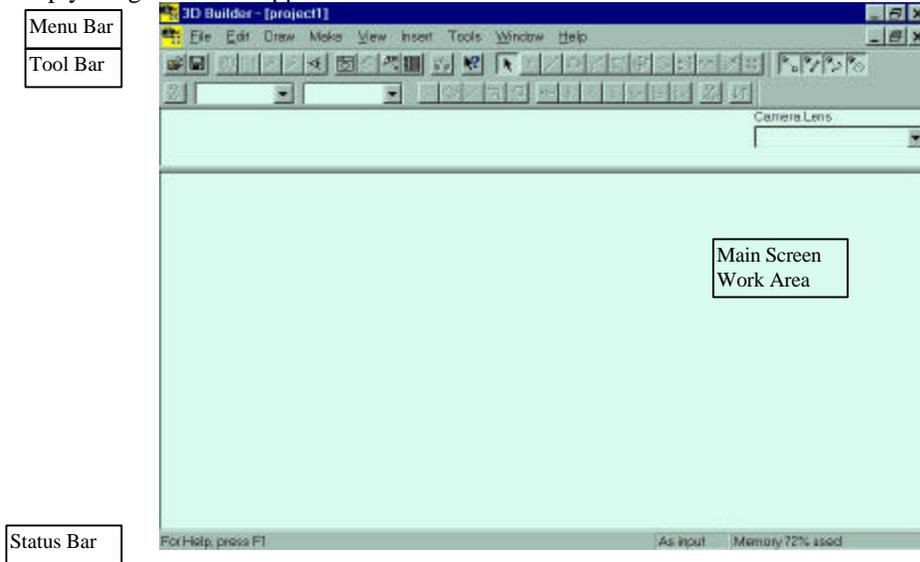


Figure 15 3D BUILDER Opening Screen

From the main menu bar, you can choose commands that will allow you to manage projects, create geometry, and work with **3D Builder**. Commands for creating geometry are described in the chapters on “Menus and Constraints”.

The buttons in the tool bar represent the frequently used menu commands. You can use the tool bar as a shortcut for choosing commands from the menus. When you pass the cursor over the tool buttons, a short tool tip appears and the corresponding command is displayed in the status bar.

The main screen work area is blank when you first open the program. It is the space where photo images are displayed and where you will create your model. The work area can display any number of photo image windows. If you are using the **3D Builder Pro** program, the maximum number of image windows that can be open at the same time is determined by how much memory your machine has. **3D Builder PowerLite** is limited to six images.



Begin a New Project

To begin a new project, select “**New Project**” from the “**File**” menu. Next, you will be asked the “Type of Project” you wish to begin. The default is the “Normal Project”.



Figure 16 "New Project" Window

Next, you will need to select the images for your project. Click on “**Add Images to Project**” from the “**File**” menu. This will access a file requestor box from which you can select your images, drives, directories, etc. To view each additional image selected (after the first image), you will need to create a “**New Window**” for the image. This is done by selecting “**New Window**” from the “**Window**” menu.

The Image Window

The images in a project first appear in the main window in an “**Image**” window. This gives a thumbnail image of the entire photo, and a close-up view of a section of the image. The size of the thumbnail can be adjusted by placing the mouse cursor over the “splitter bar”. Click once with the left mouse button, and drag the window to the desired height. Click-drag-release with the left mouse button in the thumbnail to define the portion of the image to be displayed in the main close-up view. All geometry creation is done in the main close-up view.

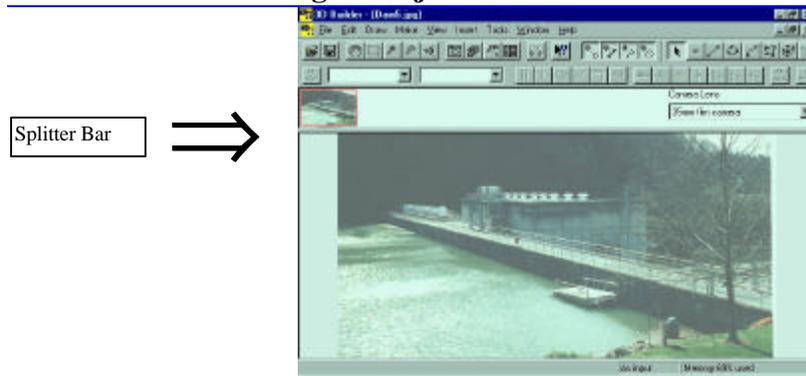


Figure 17 Splitter Bar in Image Window

The Project Window



Project Window

The Project Window gives an overview of all the things in your project. The window is brought up with the **“Window/Project”** menu command or by clicking on the “Project Window” toolbar icon button. You can have only one project window open at a time. The main topic headings are: camera lenses, materials, objects, camera stations, texture maps, constraints, stations, and photos that are in the project. Clicking on the “+” button to the left of the topic will expand the list to show the individual items. Double clicking on an item will bring up its property window, from which the item may be edited. Single clicking on an item selects it. Object and constraint items will be highlighted in any open image windows when they are selected in the project window. **You may delete items selected in the project window with the “Delete” key on the keyboard.**

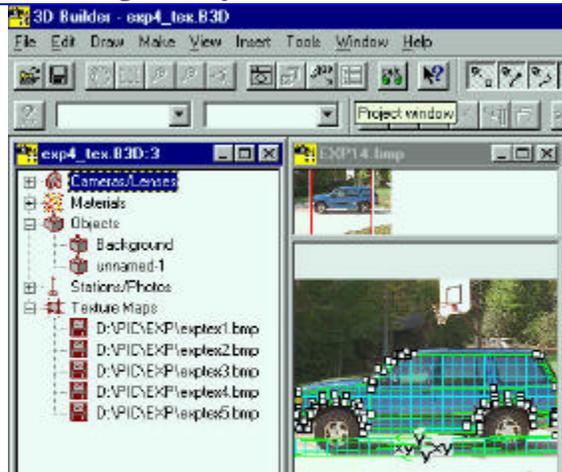
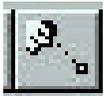


Figure 18 Project Tree, accessed by selecting "Window" menu, then choosing "Project"

The 3D Preview Window



3D Preview Tool

Once the 3D model has been calculated (under the **"File/Calculated 3D Preview"** menu command, it can be viewed through the "3D Preview Window". Click on the **"Window"** menu and select "3D Preview" to bring up the 3D Preview Window. Or click on the **"3D Preview"** tool icon on the toolbar. Or click on the shortcut key, **"F4"** from your keyboard. This can be rotated and viewed from any angle. The 3D Previewing window can be resized. The smaller the window, the faster the rotation. You can zoom in on the 3D model by clicking on the **"+"** key or zoom out by clicking on the **"_"**. The 3D model can be viewed in either a wireframe mode and/ or a rendered, shaded mode. Choose the viewing mode by clicking on the **"View/Solid"** or **"View/Wireframe"** menu items. The background color of the 3D Preview window can also be adjusted for optimum viewing. Choose the background color by clicking on the **"View/Background Color"** menu.

Note: Be sure to check either solid or wireframe or both in order to view the model. Also, if wireframe is checked, the wireframe image will be in white. Be sure your background color is **not white** or you will **not** see the wireframe image.

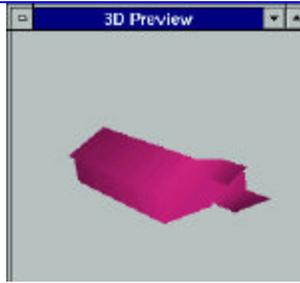


Figure 19 3D Preview Window

Navigating Between Opened Windows

The names of all open windows appear at the bottom of the “**Windows**” menu in the main menu bar. To make a window active, select any open **3D Builder** window by clicking in it. Selecting a window brings it to the top of the window stack and makes it active.



Figure 20 Activate an Image Window by the "Window" menu, select the desired image by clicking on it.

Setting the Display of the ToolBar

The toolbar shows icons on frequently used **3D Builder** actions. To set a visible display of the toolbar, select “**Toolbar**” under the “**View**” menu. A “check mark” will appear to the left of the word “**Toolbar**”. To remove the tool bar from visible view, select “**Toolbar**” under the “**View**” menu. The check mark is removed. The toolbar is no longer visible near the top of the main project window.

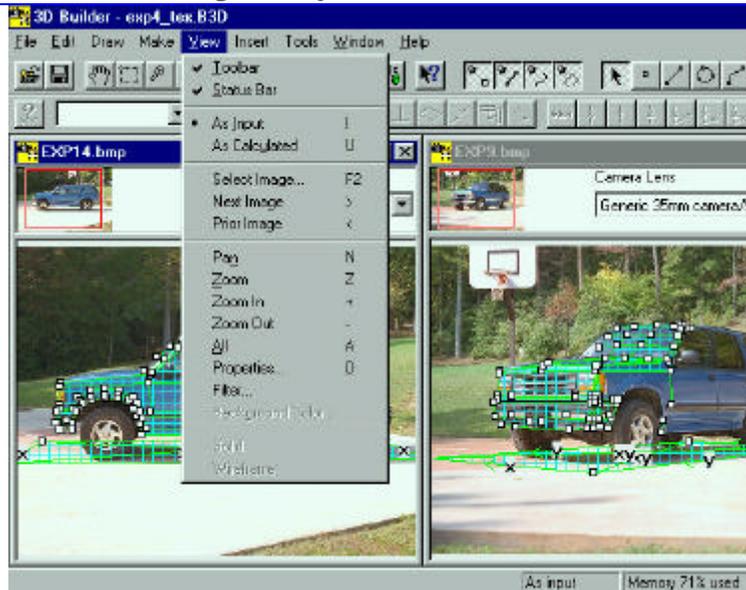


Figure 21 Visible Toolbar & Status Bar

Setting The Display Of The Status Bar

The status bar displays information about the selected item. To set a visible display of the status bar, select “**Status Bar**” under the “**View**” menu. A check mark will appear to the left of the word “**Status Bar**”. To remove the status bar from visible view, select “**Status Bar**” under the “**View**” menu. The check mark is removed. The Status Bar is no longer visible at the bottom of your main program window.

Keyboard Accelerators

Several keyboard accelerator or “shortcut” keys are available for the power user. Using these keys minimizes the time needed for mode switching. The keyboard accelerator keys are listed in the drop down menu boxes to the right of the menu item. Please refer to the *Appendix C* section for a complete list of keyboard accelerators.

Saving A Project



Save Tool

To save a project in **3D Builder**, select “**Save**” under the “**File**” menu. This action saves the project to your hard disk. To save the contents under a specific name or directory, select “**Save As**” under the “**File**” menu. This action brings up the “Save As Dialog

Box” and you may choose the file name and directory in which the contents of the active window are to be saved.

Exiting 3D Builder

To leave the **3D Builder** program, select “Exit” under the “File” menu. If the file contains any unsaved information, **3D Builder** displays a confirmation message asking you if you want to save changes.



Figure 22 Confirmation Message Box

Camera Lens Data File

The “Camera lens data” is stored in a separate file called “lens.dat”. If you have added, modified or deleted camera lenses during the session, you will also be prompted to write these changes out to the camera lens data file. **3D Builder** now prompts before saving new/modified camera lenses to the master lens.dat file. Similarly, if lenses are deleted from a project, **3D Builder** will prompt asking if they should be deleted from the master lens.dat file. This dialog box will also appear if a project was opened which contained camera lenses that were not in the master lens.dat file.

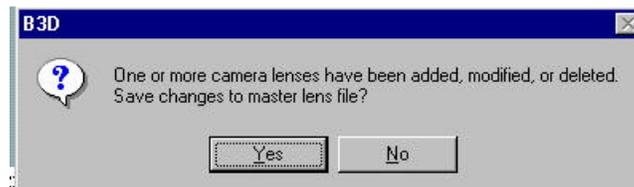


Figure 23 Message Confirmation Box for "lens.dat" file.

Material Data File

A similar message box appears if a new material has been added to the project.

include the word “project”. Thus, “**File menu/ New**” now reads “**New project**”. The word “Project” was added for clarity.

File/ Open Project (CTRL + O)

The “**Open Project**” command opens the file requester box for you to access a previously saved project file. You may choose directories, drives, networks, and file names. **3D Builder** has changed the title on the “**Open**” menu. These items now include the word “**Project**”. Thus, “**File menu/Open**” now read “**Open project**”. The word “Project” was added for clarity.

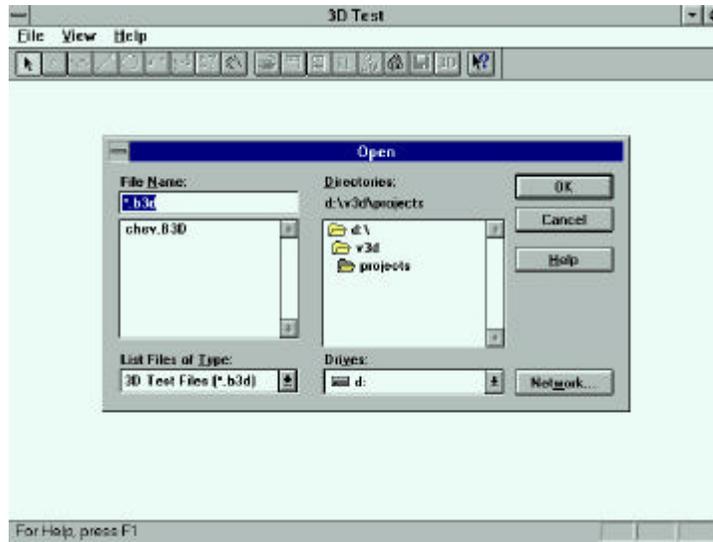


Figure 25 File Open Project Requester Box

File/ Close Project

The “**Close Project**” command closes the active project. If the project contains unsaved information, **3D Builder** will display a confirmation message box. When the confirmation message box appears, choose:

- “Yes” to save changes
- “No” to discard the changes
- “Cancel” disregards the “Close Project” command.

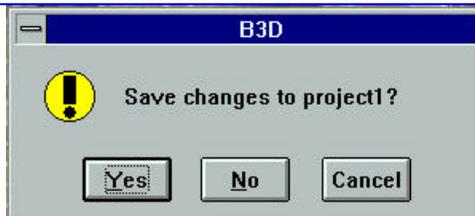


Figure 26 Close Project Command Dialog Box

File/ Save Project (CTRL +S)



The “**Save**” command saves the active project, using the current name. **3D Builder** has changed the title on the “**save**” menu. These items now include the word “**project**”. Thus, “**File menu/Save**” now reads “**Save project**”. The word “**Project**” was added for clarity.

File/ Save Project As (....)

The “**Save Project As**” command saves the active project using a new name. To “**Save Project As**” a file, Open the “**File**” menu and choose “**Save Project As**” to display the file requester box. Select a drive, and then select a directory. Next, choose a file type, then enter the name of the file. Click “**OK**” to save the file.

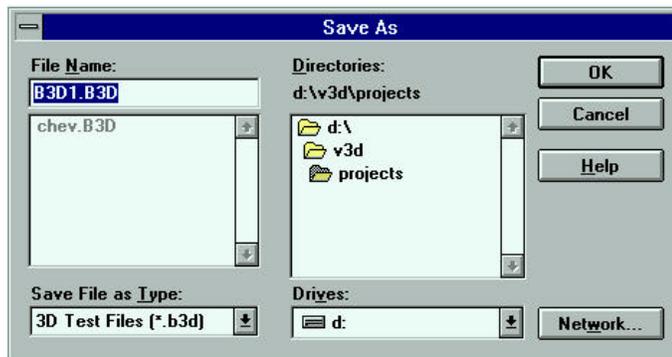


Figure 27 "Save Project As" File Requester Box

File/ Add image to Project (INS)



3D Builder has added a file menu item for adding an image to the project. You may also add an image to the project via the “**Insert menu/insert image**”. The keyboard shortcut for this command is the “**Insert**” key on the keyboard.

File/ Calculate 3D (F3)



The “**Calculate**” commands takes the points, lines, curves, circles, extrusions, and faces that you have located and the various hints that you have supplied and calculates the position of the cameras, camera information, and the 3D model for the objects. **3D Builder** does the complicated math for you and figures the “x”, “y”, and “z” coordinates.

3D Builder gives you a one “beep” signal when the initial estimate of the 3D model has finished. At this time, clicking on “Stop” will show you a 3D model. **3D Builder** gives a second “beep” signal when **3D Builder** has completely finished calculating the 3D model. Greater accuracy is achieved by waiting until the second beep signal.

A progress reporter box shows you what is happening as **3D Builder** converts your photos to 3D models. The dialog box will show the number of points calculated and the number of points unreachable. The dialog box will also show the number of cameras positions calculated and the number of cameras unreachable. Once the camera positions have been located and a 3D model has been calculated, **3D Builder** reverses the calculations and projects the model back onto each of the image planes. After the “Calculate 3D” dialog box has been closed, you may view these results by selecting the “**View**” menu, “As Calculated” option or by hitting the “U” key on the keyboard. Be sure to return to “Input” mode to continue working. If faces have been set, you can view them in the “**3D Preview**” window, accessed via the “**Window**” menu.

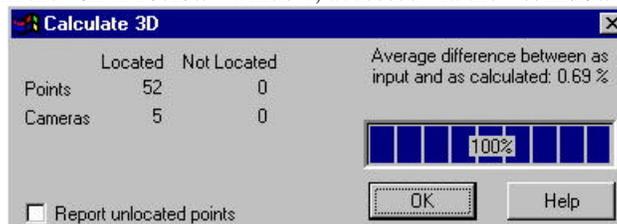


Figure 28 “Calculate 3D” Dialog Box

The average difference between the location of the calculated points on the image and the location of the points that you placed on the image is displayed as a %.

If problems are found during the calculations, the dialog box will expand. It will drop down to show a picture of the image (s) where there is a problem and a brief description of the problem.

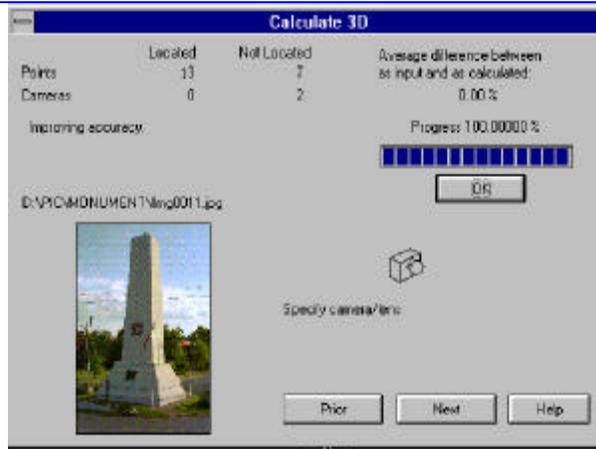


Figure 29 "Calculate 3D" Dialog Box expanded to show problem image

See "Appendix A" for a description of various types of problems and how to fix them. The most common problem is that one or more points were not located because they were visible in only one image and /or have no other hints available. This problem may be suppressed by leaving the "Report unlocated points" check box blank. If you put a check in this box and one or more points have not been located, the dialog box will expand down and will indicate which images contain the points that were not located.

File/ Export...

The "Export..." command allows you to export the files to a rendering, animation, Internet, CAD package. You will need to do a "Calculate 3D" before selecting the "Export..." command.

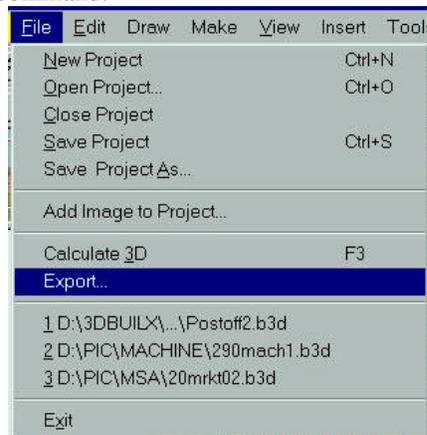


Figure 30 Export Menu Commands

Clicking on the “Export” command under the “File” menu opens up the “Export Options” window allowing you to choose the export format, file name, and which objects to export.

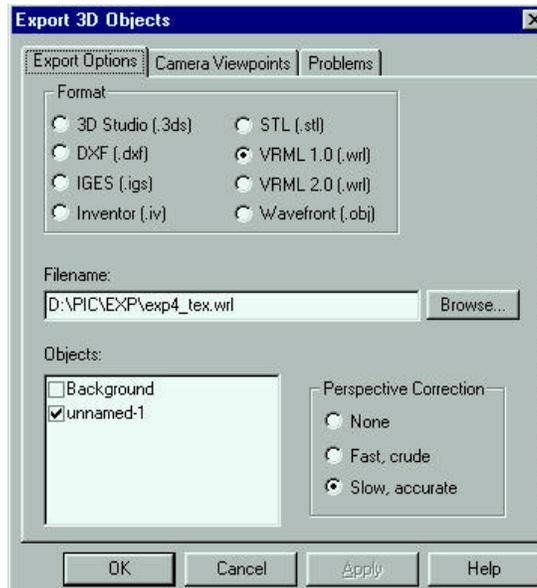


Figure 31 Export Options Dialog Box

In the Section labeled format, choose the type of file format to be exported. Simply click on the radio box to the left of the desired format. **3D Builder** can export files using the following formats:

1. DXF (used by many CAD systems)(**Both Pro and PowerLite**)
 2. 3D Studio (3D Builder PRO Only)
 3. IGES (used by many mechanical CAD systems) (3D Builder Pro Only)
 4. Inventor (3D Builder Pro Only)
 5. VRML 1(used directly on the Internet) (**Both Pro and PowerLite**)
 6. VRML 2 (used directly on the Internet) (**Both Pro and PowerLite**)
 7. Wavefront. (3D Builder Pro Only)
 8. .STL (used by many rapid prototyping machines) (3D Builder Pro Only)
- Under “File name”, type in the file name, directory and drive or click on the button labeled “Browse”. This action will open up a standard Windows browser to select drive, directory and file name.

- Under “Objects”, choose the objects you would like to have exported. Make sure that at least one object is checked. The default object is “unnamed-1”.

If there are any problems associated with exporting the desired file format, these will be reported to you on the “Problems” tab section of the Export File Tab Page.

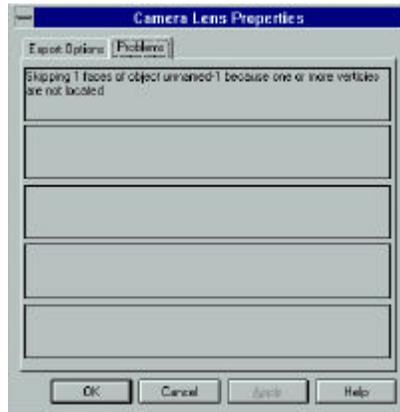


Figure 32 Export Problems Reporter



Perspective Correction for Texture Maps

By default, **3D Builder** applies perspective correction to the 3D Preview window and to all exported 3D models. This improves the visual quality of the 3D models but does increase their size. You may choose a lower quality perspective correction or you may turn off perspective correction altogether. The option is selected from the “Options” tab in the “Export” window, which is activated from the “**File/Export**” menu. The options are:

- no correction
- fast, but crude correction
- slow, but accurate perspective correction (Pro version only)

If you want to change the perspective correction for the 3D Preview window but do not need to do an export, use the “**File/Export**” menu command, set the option, then select “Cancel” from the Export window—the perspective correction option will be remembered even though Cancel has been selected.



Figure 33 File export "Options" for perspective correction.

Texture maps are also exported with the files and these are automatically corrected for perspective distortions. Automatic Correction for perspective is available in **3D Builder Pro** only.

3D Studio, Inventor, VRML, and Wavefront export files will include references to texture maps if the objects are textures. That is the export files will have the texture file name embedded in the file in one or more places, and perspective corrected texture coordinates will be contained in the file. You will need to copy the texture map images that you have previously created with the "Draw" texture map command, copy them to whatever directory is required by whatever rendering tool package (3D Studio, VRML browser, etc.)

File Export.../ Camera Viewpoints tab

A second tab has been added to the "**File/Export**" options tab page. The "Camera Viewpoints" tab gives you the option of exporting camera viewpoints into such rendering packages as Inventor Studio. The camera viewpoints exports are available for Inventor and VRML file exports.

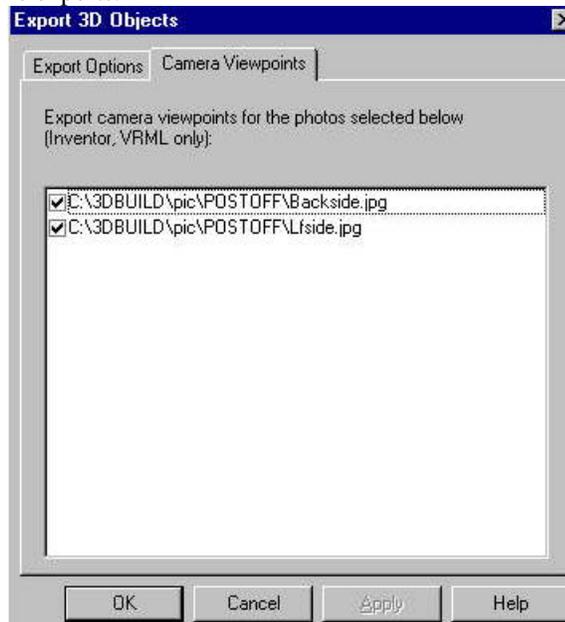
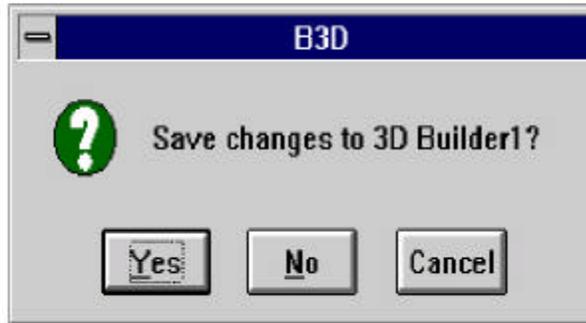


Figure 34 Export Camera Viewpoints Options Box.

File/ Exit

The “Exit” command closes **3D Builder**. If the file contains unsaved changes, **3D Builder** display a confirmation message asking you if you want to save changes.

- Yes saves changes before closing **3D Builder**.
- No discards changes and closes **3D Builder**.
- Cancel discards the “Exit” command.

*Figure 35 Exit Command Confirmation Requester Box*

Camera Lens Data File

3D Builder now prompts before saving new/modified camera lenses to the master lens.dat file. Similarly, if lenses are deleted from a project, **3D Builder** will prompt asking if they should be deleted from the master lens.dat file. This dialog box will also appear if a project was opened which contained camera lenses that were not in the master lens.dat file.

*Figure 36 Message Confirmation Box for "lens.dat" file.*

Material Data File

A similar message box appears if you have added a new material to the project.

Edit Menu commands

The commands in the **Edit** menu let you perform editing operations on any selected item, such as points, lines, and faces. Other **Edit** menu commands let you perform editing operations on materials, properties, and objects.

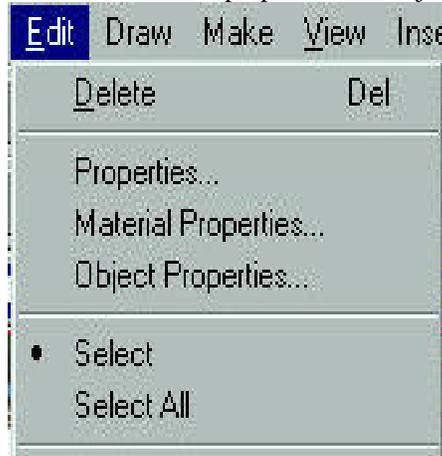


Figure 37 Edit Menu Commands

Editing an Individual Item

Before you can edit, the item must be selected. Clicking once on the individual item will highlight the points, circle, curve, lines and/or faces. Double clicking on the individual item will bring up a dialog box which tells you about the individual item to be edited.



Project
Window

You may also edit from the “Project Window”, accessed by the “**Window**” menu, selecting “Project” or by clicking on the “Project Window” toolbar icon button. This will open the project tree. Clicking once on the individual item will expand the tree branch. Select the desired item. This will highlight the individual item. Double clicking on the item in the project tree will bring up a dialog box which tells you about it.

Edit/ Delete (DEL)

The “Delete” command removes the currently highlighted items from the project. The keyboard shortcut for this command is the “Delete” key on the keyboard.

Edit/ Properties...

The “Properties” command allow you to edit the properties of a selected item. If you have a single item selected, you may use the **Edit** menu command “Properties” to bring up the “Properties” window for that point, curve, circle, extrusion, line, and/or face.

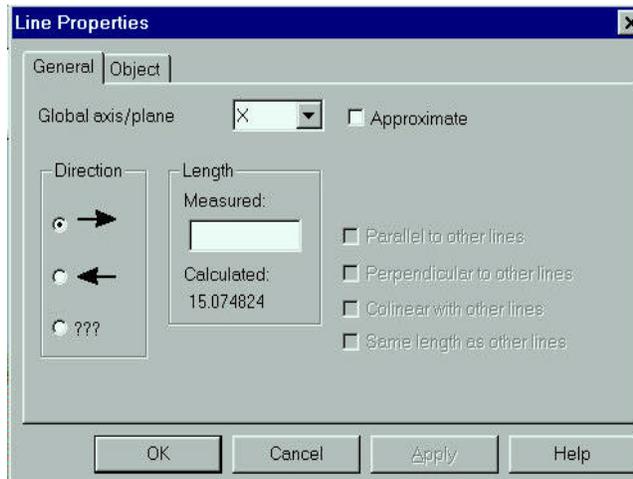


Figure 38 Edit menu "Properties" command, shown editing a selected "X" line

Edit/ Material Properties...



Project
Window

The “Material Properties” command allow you to edit the properties of a selected face material. This action will bring up the “Properties” window for the material type associated with the selected face. You can also access the “Materials” window by selecting the face, “right-mouse clicking” in an area of the face, then selecting “Materials”.

You can also edit a “material” from the “Project” tree accessed from the “Window” menu by selecting “Project”, then clicking on the “+” sign by “Materials” to expand the “Materials” tree branch. Double click on the desired item to edit it.

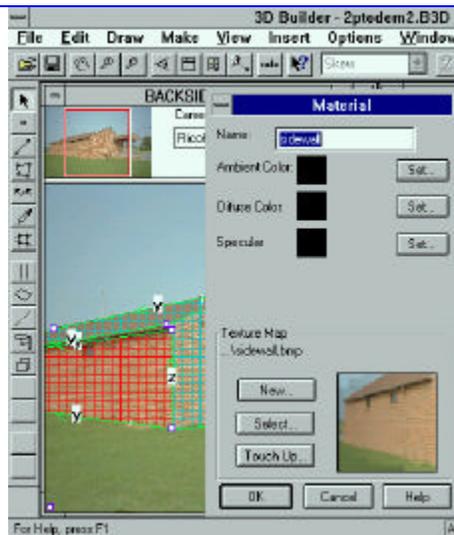


Figure 39 Edit "Material Properties" dialog box, showing selected face materials being edited

Edit/ Object Properties...

The "Object Properties" command allow you to edit the properties of a selected object. This action will bring up the "Properties" window for the selected object. You can also access the "Object Materials" window by selecting the object, "right-mouse click" in an area of the object , then selecting "Object Materials...". You can also edit a "object" from the "Project" tree accessed from the **Window** menu by selecting "Project", then clicking on the "+" sign by "Objects" to expand the "Objects" tree branch. Double click on the desired item to edit it.



Figure 40 Edit "Object Properties" shown here editing selected object

Edit/ Select



The “**Select**” command is the default cursor. Use the select command to locate and select anything. If you have a picture where you have more than one line to select, you may *multiple select* by holding down the “**shift key**” and selecting the lines. Go to the individual “Axis Plane” toolbar icon buttons at the top right of the main **3D Builder** window and select the correct axis. All selected lines will now change to the selected axis. You can also multi-select points, lines, or faces, or a combination.

Edit/ Select All

Choose “**Select All**” from the “**Edit**” menu to pick all objects in the active image. When all objects are selected, they can be worked on as a group.



Note: If you select all and you hit the “Delete” key, you will delete **all** items.

Draw Menu Commands

The **Draw** menu contains commands to create the 3D geometry.

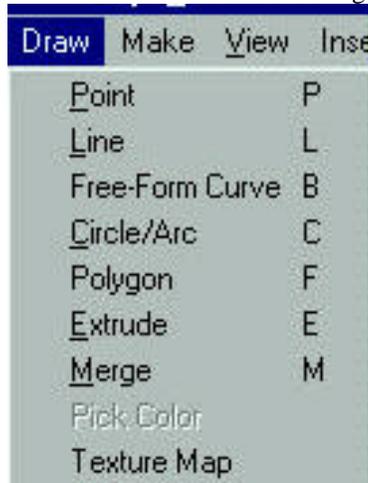
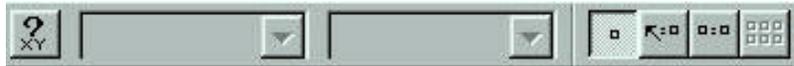


Figure 41 Draw Menu Commands

Draw/ Point (P)**Cursor**

Create Point

The “**Point**” command is used to place points on the image. Clicking on the point tool will bring up the point tool icons on the toolbar and allows you to select from different types of point types. You may also use the “**P**” shortcut key to access this command. Use the point tool to place points on the image. When the point tool is chosen, the cursor changes to a small square. Each time the mouse is clicked in a image, a new point is created. The location of the point is at the center of the small square. Be sure to use the merge tool or “same point” tool later to tell the program which points are really the same. The toolbar changes when the “Point Tool” is chosen by clicking on it. New tool icons appear on the lower part of the toolbar. These point icons give you a chance to choose among the different kinds of points to be drawn on the image.



- **Single Point Tool Icon:** This is used to create a new point in one image. This icon is the default icon and is the same as the point tool.



- **Same Point Tool Icon:** This is used to create a point in one image that already exists in another image.



- **Point Pair Tool Icon:** This tool is used to create the same point in two images.



- **Grid Point Tool Icon:** This tool is used to create a grid.



The “**Grid Point**” tool will be grayed out unless you have previously created a grid with the “**Insert**” Grid menu command. The Grid Tool window will then pop up . If you have created more than one grid you may choose the appropriate grid from the list. A picture of the grid will then appear. The cursor will create a point in the image on the grid corresponding to the red highlighted point showing in the grid window. Before locating a point in the image, click on the grid point from in the grid point tool.

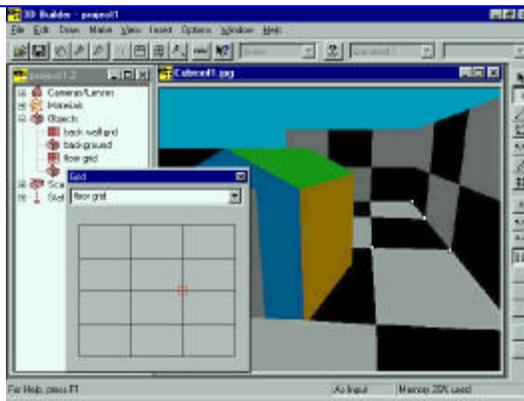


Figure 42 Grid Point dialog box

- **Approximate Point Tool Icon:** This is used to create a new point in one image which is an approximate location.



- **Object and Material Drop Down List Box Icon:** These list boxes are grayed out because a point does not have an object or a material assigned to it.

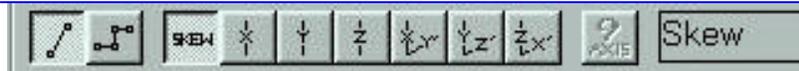


Draw/ Line (L)



The line tool, which appears as a straight line between two small squares on the toolbar, is used to create a straight segment at any angle. You may also use the “L” shortcut key to access this command. Use the line tool to draw a segment from one endpoint to another. The “**L**” command changes the cursor to draw a connected line from two points. The cursor rubber bands following the mouse actions. The Line command has an automatic “snap-to” feature. If the cursor is near an existing point, the line will start at that point. Otherwise a new point is created at the start of the line. The same is true for the end point of the line.

Clicking on the line tool will bring up the line tool icons on the toolbar and allows you to select from different types of line configurations.



- **Skew Line Tool Icon:** This is used to create a new line in one image that does **not** lie along an coordinate axis plane or along one of the horizontal or vertical coordinate axes. This icon is the default icon.



-
- **X Line Tool Icon:** This is used to create a new line in one image that does lie along the “X” coordinate axis line.



-
- **Y Line Tool Icon:** This is used to create a new line in one image that is lying along the “Y” coordinate axis line.



-
- **Z Line Tool Icon:** This is used to create a new line in one image that is lying along the “Z” coordinate axis line.



-
- **XY Line Tool Icon:** This is used to create a new line in one image that is lying along the “XY” coordinate axes plane.



-
- **YZ Line Tool Icon:** This is used to create a new line in one image that is lying along the “YZ” coordinate axes plane.



-
- **ZX Line Tool Icon:** This is used to create a new line in one image that does lie along the “ZX” coordinate axis.



- **?Axis Line Tool Icon:** This is used to create a new line in one image that lies **APPROXIMATELY** along a coordinate axis or coordinate axis plane. This is used to give a “Help” to the program in cases where an obstruction may hinder the actual sighting of the line or where a line is nearly “axial” (but is not “axial”).



- **Axis Plane List Box:** This is used to visibly indicate that a new line in one image lies along a coordinate axis or coordinate axis plane. The default is in the “skew” position. The list box will change if you select a different axis plane.



Cursor When the LINE tool is selected, the cursor changes to a symbol for a line. A line tool dialog box appears in the main window. If you know that the line that you are **going to create** is vertical or horizontal along one of the coordinate axes, then select the appropriate line type tool icon button. The same is true if you know that the line lies in one of the principle coordinate planes. Otherwise leave the line type as SKEW. Position the cursor arrow over the starting point for the line, then press the mouse button down. The message "Move to end of line then release button" will be displayed in the Status Bar at the bottom of your screen. Move the cursor over the ending point, holding the mouse button down. As you move the cursor a line will be rubber-banded on the screen from the starting point. Release the mouse button when the cursor is over the desired end point

Cursor



Create
Line



Create
Line

Draw / Line: Polyline Tool for Multiple Lines



A special kind of line has been added to **3D Builder** to link lines together. You can draw the line, click the left mouse button, and draw the next line. **3D Builder** keeps drawing lines on the image for you. This will save time in the 3D modeling process.

Draw / Line: Point on a Curve or Circle

Under the special circumstances involving drawing a line or a polygon that ends or begins on a curve or a circle, **3D Builder** now uses the “Point on a Curve or Circle” tool. If you have already created a circle or a curve, and you draw (or create) a polygon or a

line, then a special kind of point is created. This special point is “tied” or connected to the curve (or circle). This special point is displayed as a “circle” point rather than as the other types of points which are displayed as a “square”.

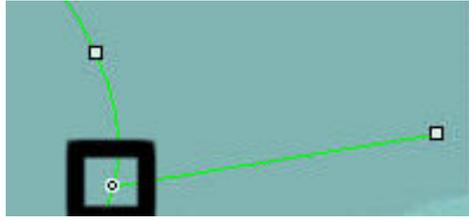


Figure 43 “Point on a Curve or Circle ”point shown as a special “circle” point. Note regular points above and to the right of the curve. The dark box has been added for emphasis in this manual and does not appear on your screen.

Draw /Free-form curve (B)



3D Builder has added a file menu item for drawing free form curves or Bezier spline curves. You may also use the “**B**” shortcut key to access this command. Use the “**Curve**” tool to draw an open or closed Bezier spline curve in one or more images. This tool is explained in greater detail in the chapter on “**Curves**” later in this “User’s Manual”.

Draw /Circle/Arc (C)



3D Builder has added a file menu item for drawing circles and circular arcs. You may also use the “**C**” shortcut key to access this command. Use the circle tool to draw an open or closed circles in one or more images. This tool is explained in greater detail in the chapter on “**Circles and Arcs**” later in this “User’s Manual”.

Draw/ Polygon (F)



The polygon tool appears as a series of short line segments between small squares. The polygon tool creates faces on the image. You may also use the “**F**” shortcut key to access this command. *In order to “texture” an object, you must first use the “polygon” or “face” tool to create a face(s) on the object.* You may create a polygon by placing points in either a clockwise or counterclockwise direction. Just remember **not** to create polygon points in a criss-cross or “bowtie” fashion. Clicking on the polygon tool will bring up the polygon tool icons on the toolbar and allows you to select from different types of polygon configurations:



- **3 Point Polygon Tool Icon:** A 3-point polygon is the default box button. Use this if you want to place a polygon face consisting of three points in the image.



- **4 Point Polygon Tool Icon:** Use the four point polygon tool if you want to place a polygon face consisting of four points that **do not** make a rectangle in the image.



- **4 Point Polygon RECTANGLE Tool Icon:** Use the four point polygon tool if you want to place a polygon face consisting of four points that **do** make a rectangle in the image.



- **Many Point Polygon tool icon:** Select this tool icon button if you want to place a polygon face consisting of more than four points.



Polygon Plane Tool Icons: Use this if you want to identify an axis plane in the polygon. The “Skew” plane is the default.



Polygon Object and Material Tool Drop Down List Boxes : A polygon can be assigned to an object and it can have a material assigned to it. Use these drop down boxes to assign either an object or a material to the polygon at the time of its creation. A “Blank” box is the default position.



Cursors1st Point
Cursor2nd Point
Cursor3rd point
CursorPoint
Number
Cursor

When the polygon tool is selected, the cursor changes to a symbol for a polygon. The display of "Select first point" appears in the status bar

1st Click: If cursor is near a point, highlight the point and change the status message to "Select second point".

2nd Click: If cursor is near a point, highlight the point and change the status message to "Select third point".

3rd Click: See if there is a point near the cursor. If so, create a new face connecting the three points.

The process would be expanded to include the number of points selected for the polygon, (four or more). When you are doing a many point polygon, the last point **must "close the loop"** and must be your first point again.

NOTE: If you place a point in error, click on the BACKSPACE key and this will delete the previous point. Then continue with the point placement of the polygon.

Draw /Extrusion (E)

3D Builder has added a file menu item for drawing extrusions of already created lines and faces. You may also use the "E" shortcut key to access this command. Use the line tool to extrude lines and faces that you have *previously created*. This tool is explained in greater detail in the chapter on "Extrusions", later in this "User's Manual".

Draw/ Merge (M)**Cursors**

Point Cursor

The "Merge" command ties two points together and indicates that the two points are the same in both images. You may also use the "M" shortcut key to access this command. If you do not already have two image windows open, the message area will ask you to do so. When there are two images visible, the message area in the status bar will display the message "SELECT FIRST POINT". Click on a point in one of the images. The point you have selected will highlight and the message will change to

"SELECT THIS POINT IN ANOTHER IMAGE". Click on the same point in another image. This process merges the two points together.

Semi-Automatic Point Matching

In order for **3D Builder** to locate each camera station, you will need to locate one or two known points and tie together a small number of points common to each image. These first points are tied together using the "Point Merge" tool as described in the **User's Guide** (Menus Chapter). Once you have done this you should use the "**File/Calculate 3D**" menu command to get **3D Builder** to locate the camera stations and points.

Once the camera stations have been calculated, the "Point Merge" tool switches to "semi-automatic" mode. In this mode you can rapidly tie together the remainder of the points in your model. With two or more pictures visible on the screen, you select a point in one picture. The other pictures are zoomed in on the most likely candidate points to match the selected point. This eliminates having to "roam" around the other photos, looking for the correct area. Other points that have *not* been merged together will still appear on the second photo, but they will be drawn as *small* dots. You will still be able to choose which point you want to merge, but **3D Builder** will offer its *best* choices for you by automatically making its choices appear in a *larger* size. **3D Builder** will *not* automatically choose the point for you. You will still need to choose the point to be merged by clicking once on it. But this feature will save you time and prevent modeling errors.

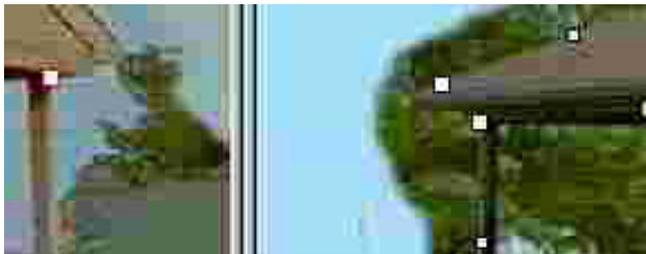


Figure 44 Semi-Automatic Point Matching Wizard.

Draw/ Pick Color



Use this command to pickup colors from images and assign them to the current material. Choosing "Pick Color" from the "Draw" menu will bring up the "Pick Color Dialog Box" and allow you to set the colors of materials to be used. The "Pick Color Dialog Box" may also be accessed by clicking on the "Pick Color" icon (which looks like an eye dropper) on the toolbar ribbon. More information on this topic is available in the chapter on "**Colors, Materials and Texture Mapping**", later in this "User's Manual". Since a "color" is associated with a "Material" and a "Material" belongs to a "face or polygon", the "Pick Color" menu item will be "grayed out" unless a "face" has been previously selected.

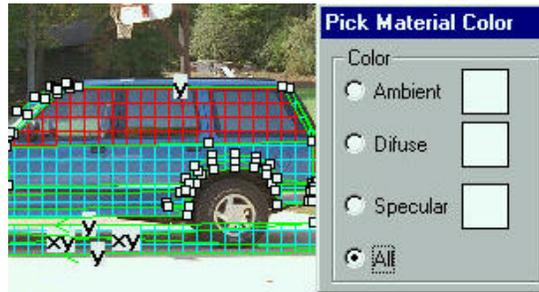


Figure 45 Draw menu "Pick Color" dialog box

Materials have different properties of colors:

- Ambient
- Diffuse
- Specular
- All

A window pops up which displays the colors of the currently selected material and lets you choose which properties, or all properties, to pickup from an image. "All" is the default radio box and appears in the "selected" position.

To assign colors to a different material, select the material from the "Material List" on the toolbar. This is the drop down list box at the upper right of your screen.

To assign colors to a new material, use the "**Insert**" menu, select "Material" command.

Setting the colors of a material from an image window.

Colors for that material may be lifted from one of the images using the "**Draw**" menu, "Pick Color" or by using the "Eye Dropper" icon from the toolbar. The cursor changes to an "Eyedropper" cursor and is used to pick a color directly from the image.

Draw/ Texture Map



Use this command to choose the texture pattern for a section of the project. This tool is accessed by clicking on the "Texture Pattern" under the "Draw" menu or by clicking directly on the "Texture Pattern" icon on the toolbar ribbon. Then draw a bounding box rectangle encompassing the area to be textured.



Creating texture maps with the "Texture Map Tool". See additional information in the Chapter on "Colors, Materials and Texture Mapping" in this "Users Guide"

1. From the **Draw** menu command, choose "Texture Map".
2. From the "Materials" list, choose a material from the drop down list box.
3. Click, drag and release to form a rectangle encompassing the portion of the image that is wanted for the texture map.
4. This brings up the "Texture Map" dialog box.
5. Set the desired pixel size from the spin control arrows.
6. Hit "OK" to save it as a .JPEG and as a .BMP file.

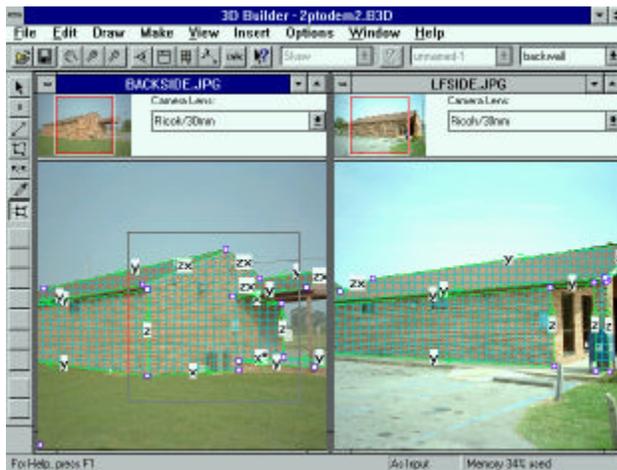


Figure 46 Draw "Texture Map", creating the bounding box around the area to be textured

Once the textured area has been drawn, the "Texture Map Dialog Box" will appear on your screen. This dialog box allows the user to give information concerning the

texture patterns for the image and type of file format in which to save the image.



Figure 47 Draw "Texture Map" dialog box, shown after drawing area to be textured

Make Menu Commands

The **"Make"** menu commands are used to apply constraints to currently selected points, lines, and/or faces. The "Make Behind" is not actually a constraint. This command is used to "make" or put one face behind another. Constraints are relationships that help in the "Calculate" process. Constraints are used to help the appearance of the model. A constraint acts as a "helper" to the "Calculate 3D" command.



Figure 48 "Make" menu commands

Constraints do not go into effect until you hit the “Calc” tool or “**F3**” shortcut key or “Calculate 3D” under the “**File**” menu. The program will then attempt to “satisfy” every constraint in the model. **3D BUILDER** gives you the option of several constraints.

Constraints are all created in the same manner. Once constrained, each constraint will appear in the “Project Window”. A single click will highlight your constraint. Double clicking on the “constraint” will take you to a dialog box about the selected constraint.

Constraints may be deleted from the “Project Window”.

Make/ Make Colinear



Colinear means lying in the same line. If several points and/or lines lie along the imaginary extension of a single line, then you should select these and use the “Make Colinear” constraint to force the calculate command to snap these lines and/or points to all lie along a single extended line in space. To declare that a point is colinear with other points and/or lines, do the following:



1. Select a point by clicking on it. The point will highlight.
2. Next, while holding down the “Shift” key, select the other points and/or lines which lie along the same line. These will also highlight.
3. Choose the “**Make**” menu, then select “Colinear”.
4. The result of this action is that all of the selected (highlighted) points and/or lines will be constrained to be colinear to one another.
5. If you were to edit one of these points by double clicking on it to bring up the “Point Dialog Box”, a check box would be checked indicating that the point is colinear to others.
6. If you have any dimensions, this information can be entered by double clicking on the “constraint” branch in the “Project” window. This action brings up the “Colinear Constraint” dialog box.

Following is an example of this constraint.

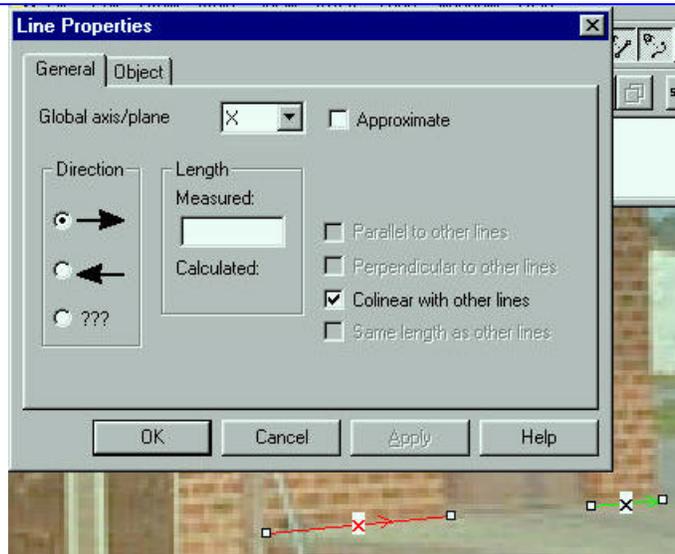


Figure 49 Make "Colinear" command showing 2 "X" lines constrained to be colinear

The "Make Colinear" command can also be accessed via the toolbar ribbon icon.

Make/ Make CoPlanar

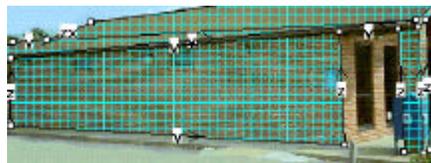


Coplanar means lying in the same plane. To declare that a point/ and or faces is coplanar with other points and/or faces, do the following:

1. Select a point by clicking on it. The point will highlight.
2. Next, while holding down the "Shift" key, select the other points of faces which share the same plane. These will also highlight.
3. Choose the "Make" menu, then select "Coplanar".
4. The result of this action is that all of the selected (highlighted) points and faces will be constrained to be coplanar to one another.
5. If you were to edit one of these points or faces by double clicking on it to bring up the "Properties Window", a check box would be checked indicating that the point or face is coplanar to others.
6. If you know what plane in which the points lie, or any dimensions, this information can be entered by double clicking on the "constraint" branch in the "Project" window. This action brings up the "Coplanar constraint" dialog box.



Coplanar "Y" line ⇒



Coplanar “Y” line ⇒



Figure 50 Points and Faces Constrained to be CoPlanar

The “Make CoPlanar” command can also be accessed via the toolbar ribbon icon.

Make/ Make Equal Length

To declare that a line is the same length as one or other lines, do the following:



1. Select the line by clicking on it. The line will highlight.
2. Next, while holding down the “Shift” key, select the other line (or lines) which share the same length. These additional lines will also highlight.
3. Choose the “**Make**” menu, then select “Equal Length” by clicking on it.
4. The result of this action is that all of the selected (highlighted) lines are now constrained to be of equal length to one another.
5. If you were to edit one of these lines by double clicking on it to bring up the “Line Dialog Box”, a check box would be checked indicating that the line is of equal length to others.
6. If you have any dimensions, this information can be entered by double clicking on the “constraint” branch in the “Project” window. This action brings up the “Equal Length Constraint” dialog box.

The “Make Equal Length” command can also be accessed via the toolbar ribbon icon.

Make/ Make Parallel

Parallel means going in the same direction at the same distance apart. To declare that a line is parallel to another line, do the following:



1. Select the line by clicking on it. The line will highlight.
2. Next, while holding down the “Shift” key, select the other lines which are parallel. These additional lines will also highlight.
3. Choose the “Make” menu, then select “Parallel” by clicking on it.
4. The result of this action is that all of the selected (highlighted) lines are now parallel to one another.
5. If you were to edit one of these lines by double clicking on it to bring up the “Line Dialog Box”, a checkbox would be checked indicating that the line is parallel to others.
6. If you have any dimensions, this information can be entered by double clicking on the “constraint” branch in the “Project” window. This action brings up the “Parallel Constraint” dialog box.



The “Make Parallel” command can also be accessed via the toolbar ribbon icon.

Make menu/ Make Perpendicular

3D Builder has added a file menu item for indicating that two or more lines are perpendicular to each other. It is accessed by selecting the “Make Menu” and clicking on “Make Perpendicular” menu command.



1. Select the line by clicking on it. The line will highlight.
2. Next, while holding down the “Shift” key, select the other lines (or lines) which you want to make perpendicular to the first.
3. These additional lines will also highlight.
4. Choose the “Make” menu, then select “Perpendicular” by clicking on
5. The result of this action is that all of the selected lines are perpendicular.
6. If you were to edit one of these lines by double clicking on it to bring up the “Properties” window, a check box would be checked indicating that the line is perpendicular to others.



This tool is explained in greater detail in the chapter on “Constraints”.

Make/ Make Behind (Behind/In Front Of Command)

Use this command to change the position of the active area on the main screen. This tool will be grayed out unless a face is selected. This tool takes the currently selected face and forces it to draw itself behind all other faces. For example, you had created a face for a

window. Later, you created a face for the entire wall. Because the wall was created later, it would obscure the window section. Use of this tool would put the wall “back” a level and thus make the window visible on top.

Click once to highlight the desired face. Then choose the “Make Behind” toolbar icon from the toolbar ribbon or select the “**Make**” menu, choosing “Behind”. This action moves the currently active layer back one layer.

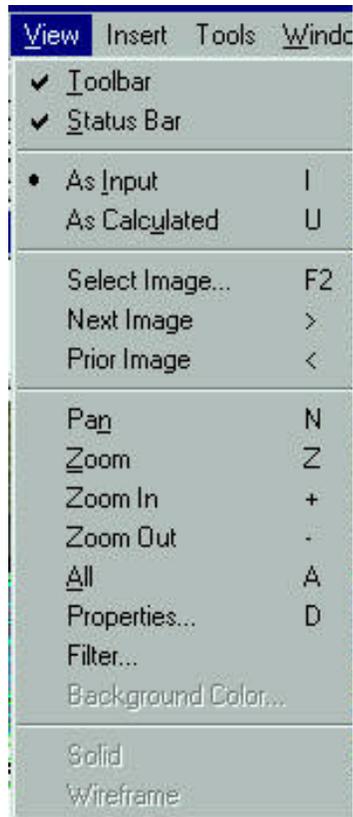
Constraint Project Tree:



All constraints can be viewed from the “Project Window”. The “Project Window” can be accessed by clicking on the “Project Window” tool icon on the toolbar. Click once on “Constraints” to expand the tree. Clicking once on the individual constraint will highlight the points, lines and/or faces constrained. Double clicking on the constraint in the project tree will bring up a dialog box which tells you about the constraint.

View Menu Commands

The “**View**” menu commands control the “view” windows (image view and 3D preview). Use these commands to select which portion of an image or 3D space is displayed in the window, and/or to select which types of objects are displayed.



Menu Commands

Figure 51 View

View/ Tool Bar

The “**Tool Bar**” command opens and closes the toolbar ribbon of tool icons. Using the tools icons is a faster method of accessing the tools. To set a visible display of the toolbar, select “**Toolbar**” under the “**View**” menu. A check mark will appear to the left of the word “**Toolbar**”. To remove the tool bar from visible view, select “**Toolbar**” under the “**View**” menu. The check mark is removed. The toolbar is no longer visible near the top of the main project window. The toolbar may be docked to the left side of the screen, the right side of the screen or may be “floated” on the screen. The toolbar may be displayed as icons, text, or both. For a more detailed explanation of the toolbar command, please refer to the “Toolbar” reference section later in the user’s manual.

View/ Status Bar

The “**Status Bar**” command opens and closes the Status Bar. The Status Bar features a hint line for displaying help on many items, such as tools and commands. This information appears on your screen when you pass the mouse pointer over an item on the screen. To set a visible display of the status bar, select “**Status Bar**” under the “**View**” menu. A check mark will appear to the left of the word “**Status Bar**”. To remove the status bar from visible view, select “**Status Bar**” under the “**View**” menu. The check mark is removed. The Status Bar is no longer visible at the bottom of your main program window.

View/ As Input (I)

The “**As Input**” command is a toggle switch which gives you an opportunity to add any information about an image that you may choose, such as the creation of points, lines or faces. A “bullet” to the left of the words “**As Input**” indicates that the data is visible in the image as you drew it. To set a visible display of the “**As Input**” menu, click once on “**As Input**” menu. A “bullet” will appear to the left of the word “**As Input**”. To switch out of input mode and into “**As Calculated**” mode, select “**As Calculated**”. The “bullet” is removed. The mode has now switched to the “**As Calculated**” mode. If your “Status Bar” is visible, you can verify which mode you are in by checking for the words “As Input” or “As Calc” on the “Status Bar”. The keyboard shortcut key for the “**View As Input**” image is the “**I**” key on your keyboard.



Note: You must be in the “As Input” mode to edit any points, lines, and/or faces.

View/ As Calculated (U)

The “**As Calculated**” command is also a toggle switch which gives you a view of the image as the program has last calculated it. A “bullet” to the left of the words “**As Calculated**” indicates that the data is visible in the image as **3D BUILDER** calculated it. To set a visible display of the “**As Calculated**” menu, click once on “**As Calculated**” menu. A “bullet” will appear to the left of the word “**As Calculated**”. To switch out of calculated mode and into “**As Input**” mode, select “**As Input**”. The “bullet” is removed. The mode has now switched to the “**As Input**” mode. If your “Status Bar” is visible, you can verify which mode you are in by checking for the words “As Input” or “As Calc” on the “Status Bar”. The keyboard shortcut key for the “**View As Calculated**” image is the “**U**” key on your keyboard.

View/ Select Image (F2)



The “**Select Image**” command allows you to select an image for display in the active “Image Window”. Clicking on the “image list” tool will bring up the “Select Image” dialog box displaying the name and thumbnail pictures of each image photo in the active project. Clicking on a photo image will display that photo in the “Image Window”. The “Image list” dialog box also gives the file name of the image, and the drive and directory of where the image is being stored on your hard drive. The image itself is not affected by using this tool. The “Select Image” Dialog Box may be closed using the “Close” caption bar. It may also be resized or move about your screen as any other dialog box in **3D Builder**. Clicking on the “Image List” tool icon also activates this tool from the toolbar ribbon of icons. The keyboard shortcut key for the “**Select Image**” is the “**F2**” key on your keyboard.

View/“Next” Image (>)

Use the “**View/Next Image**” when you want to quickly review your project and see the next image. The keyboard shortcut key for the “**Next**” image is the “>” on your keyboard.

View/“Prior” Image (<)

Use the “**View/Prior Image**” when you want to quickly review your project and see the prior image. Similarly, the keyboard shortcut key for quickly viewing the “**Prior**” Image is the “<” key on your keyboard.

View/ The Pan Tool (N)



The pan tool, which appears as a hand, is used to scroll the image. The image may be scrolled both vertically and horizontally at the same time. The keyboard shortcut key for the “**View/Pan**” tool is the “**N**” key on your keyboard.

View/ Zoom (Z)



The “**Zoom**” command allows you to magnify the entire image for closer examination. The keyboard shortcut key for the “**View/Zoom**” image is the “**Z**” key on your keyboard.

View/ Zoom In (+)



The “**Zoom In**” command allows you to magnify an area for closer examination. The keyboard shortcut key for the “**View/Zoom In**” image is the “+” key on your keyboard.

View/ Zoom Out (-)



The “**Zoom Out**” command allows you to “step” back from the image, as if from a greater distance. The keyboard shortcut key for the “**View/Zoom Out**” image is the “-” key on your keyboard.

Placing Points Outside an Image

There are times when you need to draw a line or face that extends beyond the border of an image. To do this, use the “**View/Zoom Out**” menu command or toolbar button to get sufficient white space around the image. Then draw your point or line or face. The point(s) drawn outside the image border will automatically marked as approximate.

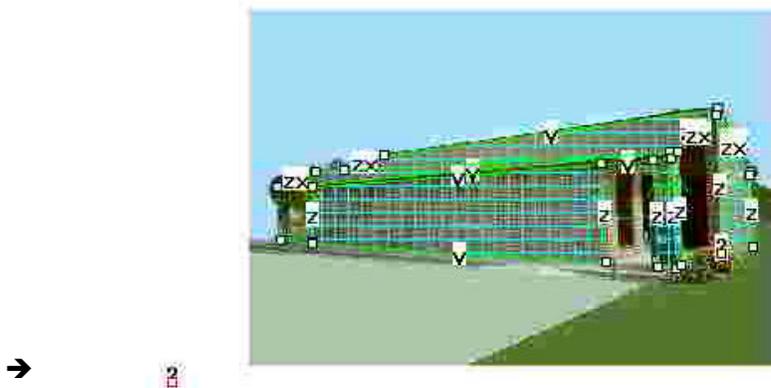


Figure 52 Viewing Points Outside the Image.

View/All (A)

To view an entire image select the “View/All” menu command. This will fit the image to the current window. **3D Builder** has added a file menu shortcut key “A” for viewing all the images in a project.

View/ Properties... (D)

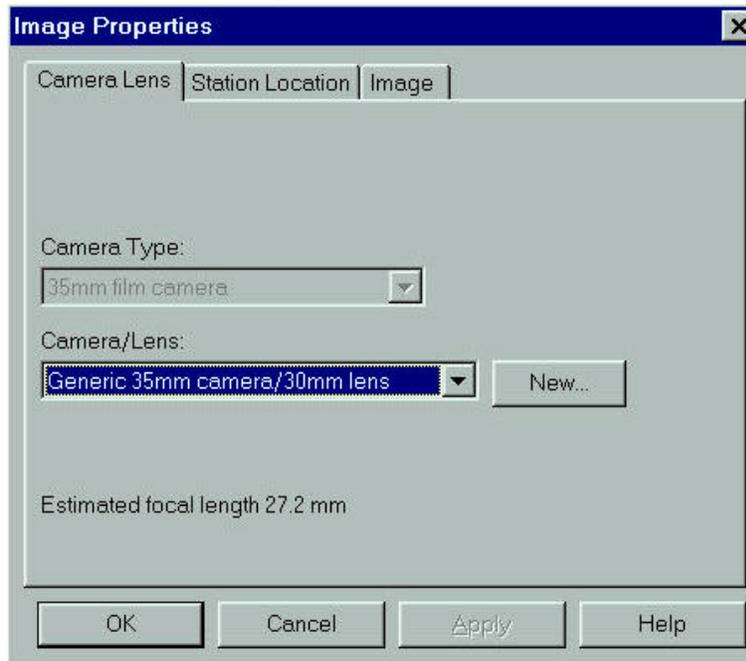
Use the “Properties” command to view and edit information about the camera lens, the camera station locations and the properties of the active image. The keyboard shortcut

key for the “**View Properties**” of the image is the “**D**” key on your keyboard. Clicking on the **View** menu, “**Properties**” command opens the “**Image Properties**” tab page.

The “**Properties**” command tabbed page, gives you the options of the following:

- Camera Lens
- Station Location
- Image Properties

The first tab page is the “**Camera Lens**” dialog box, which allows you to give information relating to the type of camera and the lens focal length. It will also show the “**Calculated focal lens length**” by **3D Builder**. If you want to create a new camera lens, click on the “**New...**” button to the right of the “**Camera Lens**” drop down box. This action brings up the “**Camera Lens Properties**” dialog box, allowing you to give information concerning the new camera.



*Figure 53
View
Properties,
Image
Properties
Camera
Lens Tab
Page*

Clicking on “**New...**” camera button brings up the “**Camera Lens Properties**” dialog box, allowing you to give information relating to the

type of camera and the lens focal length.



Figure 54 Insert Camera, "Camera Lens Properties" dialog box

If you do not know the camera lens, you may estimate it by clicking once on the "Estimate" box to the right of the words "Target Film Height and Width". This action brings up the "Estimate Camera Target Size Dialog Box". The "Estimate Camera Lens Dialog Box" allows you to give information about the following:

- Focal Length (in Millimeters)
- Distance of the camera from the screen.
- Visible Height shown on the screen when looking through the camera lens.
- Visible Width shown on the screen when looking through the camera lens.

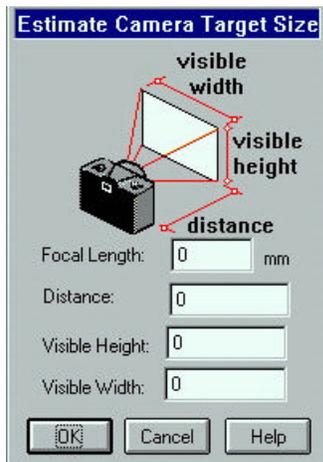


Figure 55 Estimate Camera Target Size dialog box

In most cases, **3D Builder** can estimate the camera focal lens for you.

The second tab page under View Image Properties is the “Station Location” tab page. The “Station Location” tab page, allows you to give information relating to the camera station number. If you have any known information about the measured location of the camera station, you can type in the “X”, “Y” and “Z” locations. The camera height, or “Z” location is often an easy measurement to record. The “Station Location” tab page will also show the “Calculated Camera location” by **3D Builder**.

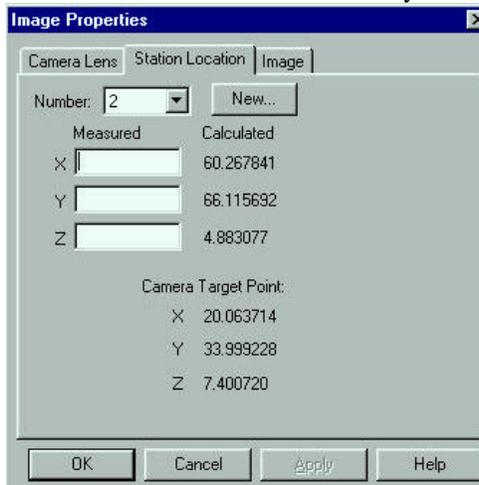


Figure 56 View Properties, Image Properties "Station Location" tab page

If you want to create a new camera station location, click on the “New...” button to the right of the “Number” drop down box. This action brings up the “Camera Station” dialog box, allowing you to give information concerning the new camera station.

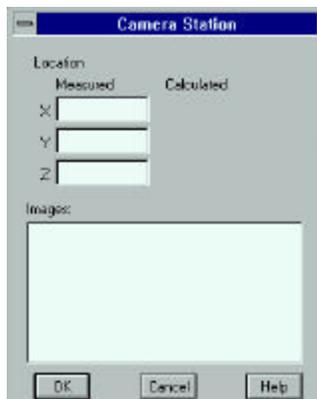


Figure 57 View Properties, Camera Station, "New Camera Station" dialog box

Camera Target Point

3D Builder calculates the camera location and orientation for each photo in the project. This information may be used to set a rendering program, such as 3D Studio, to reproduce one or more images in your project. The coordinates of the camera location and of a point in the direction that the camera is looking are available from the camera station tab of the image properties window. The image properties window is accessed from the “**View/Properties**” menu or by “right mouse clicking” in an empty area of the image.

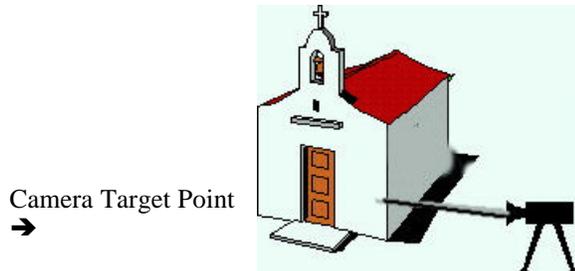


Figure 58 Camera Target Point.

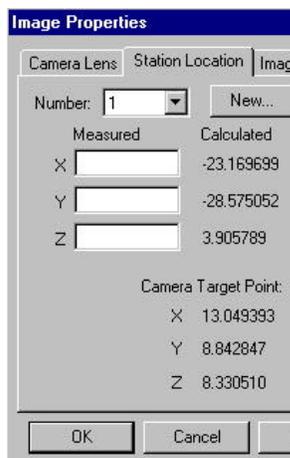


Figure 59 Camera Station Location Tab Page.

The third tab of the View Image Properties page is the “Image” properties tab page.

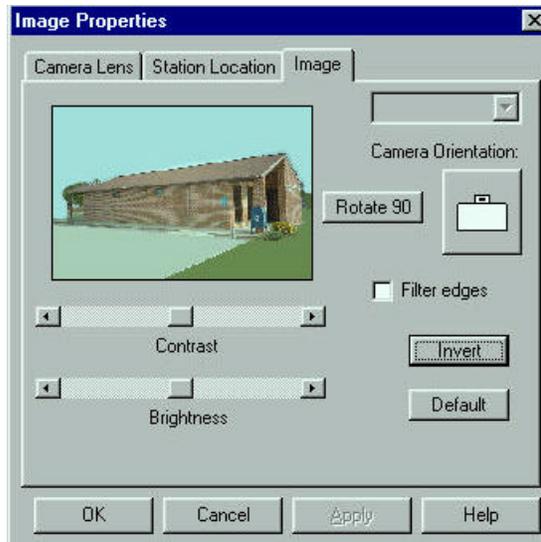


Figure 60 View Properties, Image Properties, "Image" tab page

This "Image" tab page allows you to give information about the following:

- **Contrast/Brightness:** Use this tool to lighten, darken, or sharpen the contrast of the image for optimum viewing.
- **Invert to the Negative:** Use this tool to "invert" the image properties (what was black is now white). This tool may be used to improve or sharpen the contrast for optimum viewing.
- **Rotate:** Use this tool to turn the image by 90 degree increments. Clockwise is the direction. Each click will rotate the image 90 degrees clockwise. This tool may be used to improve viewing range.
- **Photo CD Select Resolution Size Box:** Photo CD has five sizes of images. If you are using Photo CD, this box will be active, giving you a choice of resolutions for the images. The default position for this drop down list box is "grayed out" or inactive position.
- **Camera Orientation:** Use this tool to tell the program the orientation of the camera when the pictures were taken.

- **Default:** Use this tool if you want to revert back to the original settings of the image. Otherwise the changes you have made will be in effect after you click on the “OK” button.
- **Filter Edges:** Use this tool to provide a more concentrated view of the edges of an image, as shown:

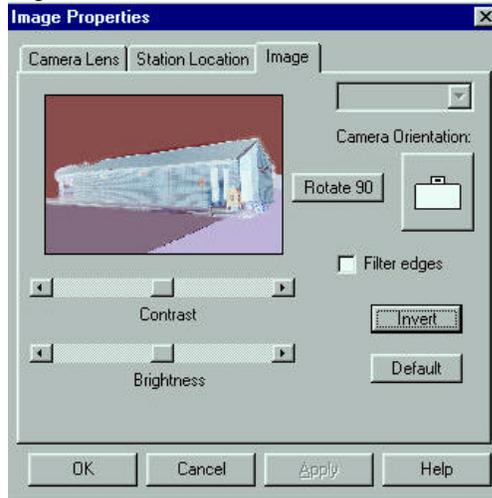


Figure 61 Edge Detection Filter Shown.

View/ Filter...

The Filter can also be accessed via the “View Menu” on the menu.



View Filter

By using the “Filter”, you can choose which viewing options are to be visibly displayed on the image. For example, if you only want to see the “lines” which you have created on the image, mark a check in the “lines” check box. Turn off the “points” and “faces” check boxes. Only the “lines” are visibly displayed on the image.

Select the “**View Filter**” option by clicking on the “View Filter” tool icon (an eye shape) or click on the “**View**” menu and select “Viewing Filter”.

The “Filter” menu determines whether points, lines, curves, and/or faces in your 3D model are displayed on top of the images.

This action brings up the “**Filter View**” dialog box. This dialog box is a series of check boxes which are explained in greater detail below the image of the “View Filter” dialog box.



Figure 62 View Filter Dialog Box

Points: All created points will be visibly displayed on the image when this box is checked. The default position is in the “checked” position, showing all previously created points.

Lines: All created lines will be visibly displayed on the image when this box is checked. The default position is “checked” position, showing all previously created lines.

Curves: All created curves will be visibly displayed on the image when this box is checked. The default position is “checked” position, showing all previously created curves.

Faces: All created faces (polygons) will be visibly displayed on the image when this box is checked. A polygon mesh is displayed on the image. The default position is to be “checked” position, showing all previously created faces (polygons).

Axis Planes: Choose the axis planes which you want to be visibly displayed on the image. This tool is useful in locating modeling errors, such as a “Y” line that has been marked with an “X” in error.

Only Show:

Unlocated Points: Only the points or lines that have one or more coordinates that have not been successfully calculated will be visibly displayed on the image when this box is checked.

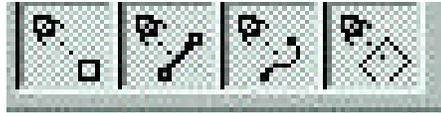
Locked: Only the points or lines that have been indicated as “measured” will be visibly displayed on the image when this box is checked.

Problems: If this box is checked, then only lines and faces which were flagged as having problems in the last **File/Calculate 3D** command will be displayed. This tool is very helpful in finding and fixing modeling problems.

Note: Only one of these can be checked at one time. Before closing the “Filter” box, turn these back off.

3D Builder has added new, independent, mini-toolbars to control what you see on the image. You may now turn off the *visible display* of lines, points, curves, and/or faces from the toolbar. This mini-toolbar is independent from the main toolbar and may be docked anywhere on your screen. The ViewFilter mini-toolbar icon buttons let you quickly select a choice of viewing only the points in the image, only the lines in the image, only the curves in the image, or only the faces in the image. Select by clicking directly on the toolbar button icon.

The “Display mini-toolbars” determines whether points, lines, curves, and/or faces in your 3D model are displayed on top of the images.



View/ Background Color

This is used to select a background color for the 3D Preview window to increase optimum viewing of the *calculated* 3D model.

View /Solid

The “Solid” command is used to select a rendered, shaded mode for the 3D Preview window to display the *calculated* 3D model.

View/ Wireframe

The “Wireframe” command is used to select a wireframe mode for the 3D Preview window to display the *calculated* 3D model.

Insert Menu Commands

Use the “Insert” menu commands to add to your project.



Figure 63 "Insert" Menu Commands

Insert/ Insert Photo... (Ins)

Using this menu command brings up the "Insert Photo" dialog box, allowing the user to give information about the photo to be inserted into the **3D Builder** project file. The shortcut key for this tool is the “**Insert**” key on the keyboard.



You may also click on the “Add Image to the Project” toolbar icon button.

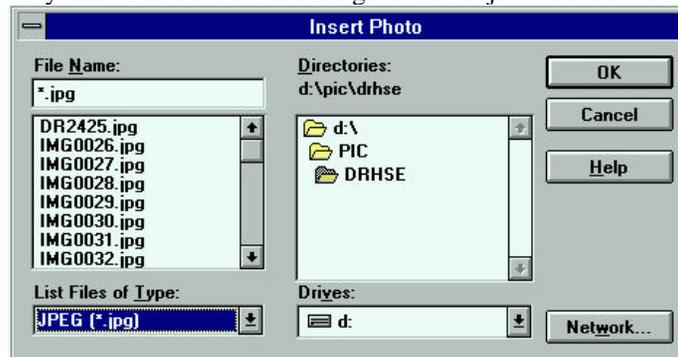


Figure 64 Insert Photo File Requestor Box

- Select the file name by clicking on it from the file list.
- Choose the type of file from the “List files of type” drop down list box.
- Choose the directory of your choice.
- Select the drive from the “drives” drop down list box.

- If you were accessing the file from a network, you would click on the “Network” button. This would bring up the standard windows browser for files.
- To accept the currently selected item, click on “OK”.
- To return to the main screen, click on “Cancel”.
- If you need to access the help engine, click on “Help”.



Note: If you have an empty image window on your screen, the photo will be displayed there. Otherwise the photo is added to your project, but not immediately displayed on the screen

Select Image



New Window



To display the photo, use “**View**” menu command “Select image” from an existing window or use the “**Window**” menu command “New window” to bring up a new window to display that photo in that window. Both of these commands can be accessed via the toolbar ribbon icons.

3D Builder provides a set of components that can accept over 36 different file formats into the program. The following formats can be imported into **3D Builder**:

TIFF	JPEG	PCX	TGA	DIB	DCX
GIF	GMP	WMF	PICT	WPG	EPS
KFX	RLE	LV	CALS	G3	G4
ATT	CLP	XWD	IMG	IFF	SUN
XBM	ICO	ICA	GX2	XPM	ASCII
CUT	BRK	MAC	MSP	PSD	PCD

3D Builder provides the key components to read Photo CD directly. There is no need to convert the files to another format

Insert/ Insert Object...

Using this command brings up the " Object" dialog box, allowing you to give information relating to the object.

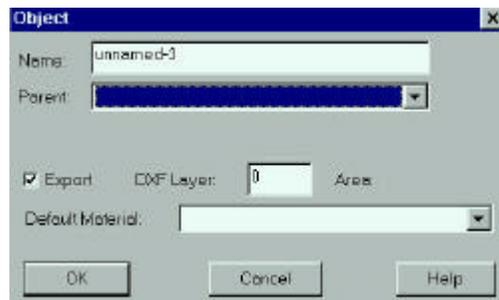


Figure 65 Insert "Object" Dialog Box

The Object Dialog box allows the user to give information concerning the following:

- **Name of the Object:** Each object must be assigned a unique name. Type in the name of the object if you are modeling several objects from one set of photographs. “**Unnamed-1**” is the **default name** assigned.
- **Parent Object:** If you are planning to export the project files to a modeling program that uses a hierarchy structure (knee-bone connected to thigh bone), you may choose to have the named object be a child of some other object. This is declared by selecting the other object as the parent.
- A drop down list box is provided for you to choose the name of the parent object if you are modeling several objects from one set of photographs.
- **Export check box:** A check box is provided for you to declare whether the object is to be exported with the model. In this way, you can “throw-away” any background objects or other :reference target” aids that you may have used for better accuracy of the model.
- **DXF layer:** Objects can be tagged by layers. DXF export has a type-in box allowing you to assign a layer to the object. Objects may be tagged by layers.
- **Color/Texture Check Boxes:** Materials may be assigned to the overall object (default material) and to faces. If a material is assigned to a face it **will override** the default material assigned to the object.
- **Name of Material Box:** Give the name of the material to be used or Check box to use the "Face" for obtaining the color/texture.
- **Area Calculations:** Gives the calculated area of all the faces of the object.

Insert/ Insert Grid...



Using this menu command will bring up the “Insert Grid” dialog box which will allow you to give information concerning the use of a grid in your project. Grids are a type of object and will show up in the “Project Window” under “Objects”.

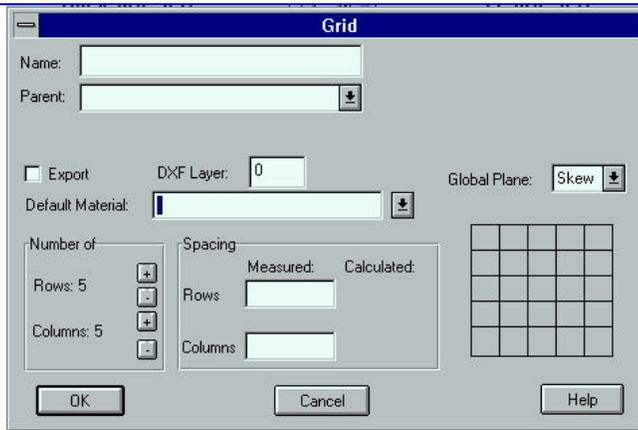


Figure 66 Grid dialog box

A grid is like any other object in that has a name, may be tagged for export, and may optionally be assigned to a parent object. All points on a grid object lie in a plane and have a uniform spacing between each other. The amounts of numbers of row and columns on a grid have a maximum setting of 40 and the minimum is 1.



Use the “+” and “-” buttons to set the rows and columns for the appropriate amount. If you know the spacing between the rows and columns for the grid, enter it under measured spacing. Otherwise, **3D Builder** will calculate the spacing during the “Calculate 3D” command. If the grid spacing is accurately known, you should enter it as grid spacing. If the grid plane is parallel to one of the global coordinate planes, you should select the plane from the global plane list.



If you need to change the settings on the grid alter you have created it, go to the “**Window**” menu, select “**Project**”. Expand the “objects” tree and you will see your grid object there. Double click on it and that action will bring you back to the same properties window where you may change the grid properties. You may also access the “Project Tree” by clicking on the “Project” toolbar icon.

A picture of the grid will appear in the “Properties” window.

Insert/ Insert Material...

The Insert Material menu is accessed by selecting “Material” from the Insert menu. Use this menu command to define a new surface properties material. This command brings up the “Material” dialog box which allows you to give information about the following:

- Name of the Material
- Set the Ambient color from the Color Page
- Set the Diffuse color from the Color Page

- Set the Specular color from the Color Page
- Work with the Texture Pattern

The default settings are usually appropriate and do not need to be changed.

If you have a face created on the image, you can right mouse click on the face (this highlights the face). A list will appear on your screen. Choose “Material Properties”.

This action brings up the same “Materials” dialog box.

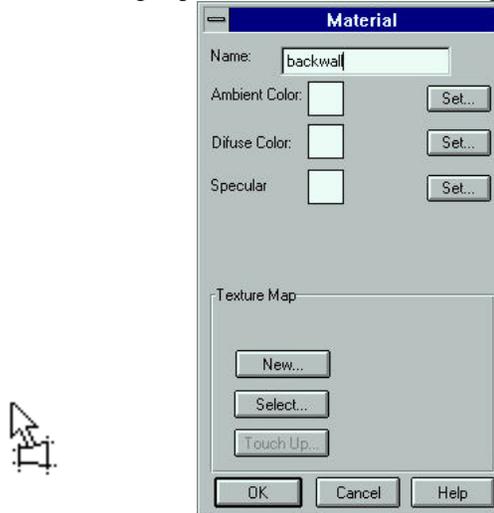


Figure 67 Insert "Material" dialog box

Creating a texture map from the photo.

1. From the “**Insert**” menu, choose “Material”.
2. From the “Materials Property Box”, give the material a name.
3. In the texture map section of the material box, choose “New”.
4. In the image, click, drag, release a rectangle encompassing the portion of the image that is wanted for the texture map.
5. Give the texture a name and then click on “OK” to give the cropped texture file a name and it is automatically saved it as a **.BMP** and a **.JPG** file.

Insert Material Message Box

3D Builder has added a “safety” check when you “save” a project. This additional action is a “message box” which pops up at the “Exit” command to ask about adding a material to the master “Material.dat” file. This would occur after using the “Insert Material” command, if you add a new “non-textured” material, such as a blue color for a water section of the model. **3D Builder** comes with a small starter set of materials, but, using the “Insert Material” command, you can add to the set of materials. The message box is displayed as follows:

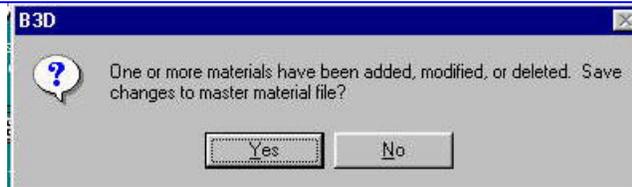


Figure 68 Message Confirmation Box for "master materials" file.

Insert/ Insert Station...

Using this menu command will bring up the "Insert Camera Station" dialog box which will allow you to give information concerning the addition of a camera station to the **3D Builder** project file. If you wish to insert to station directly, use the "Insert Station" command. If any of the camera stations coordinates are known, they should be entered into this dialog box. Camera height is particularly easy to measure and could be input here if known.

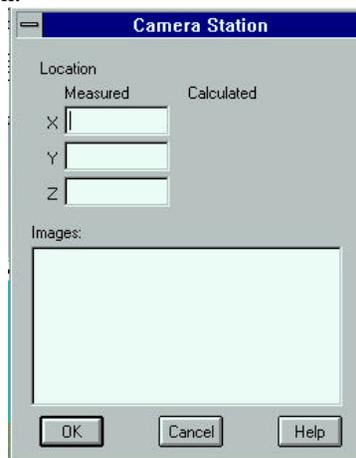


Figure 69 Insert "Camera Station" dialog box

If you have selected “new camera station” for each image under the “Project settings” as the default, new camera stations will be created automatically each time you insert a photo.

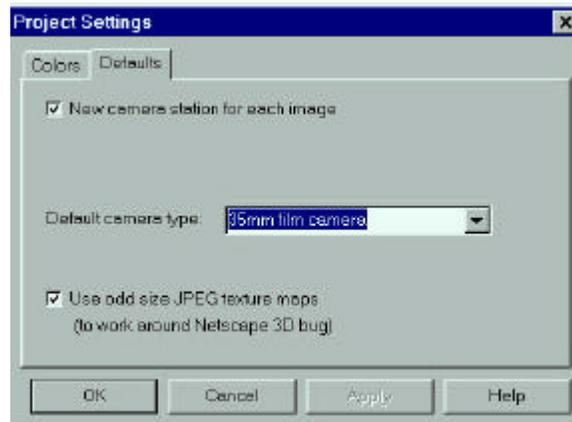


Figure 70 Project Settings Camera Station default settings

After images have been assigned to the “camera station”, they will appear in the “Camera Station Properties” window if it is brought up again. When the “Camera Station Properties” window appears for the first time from the “Insert Station” command, the list of images will be empty.

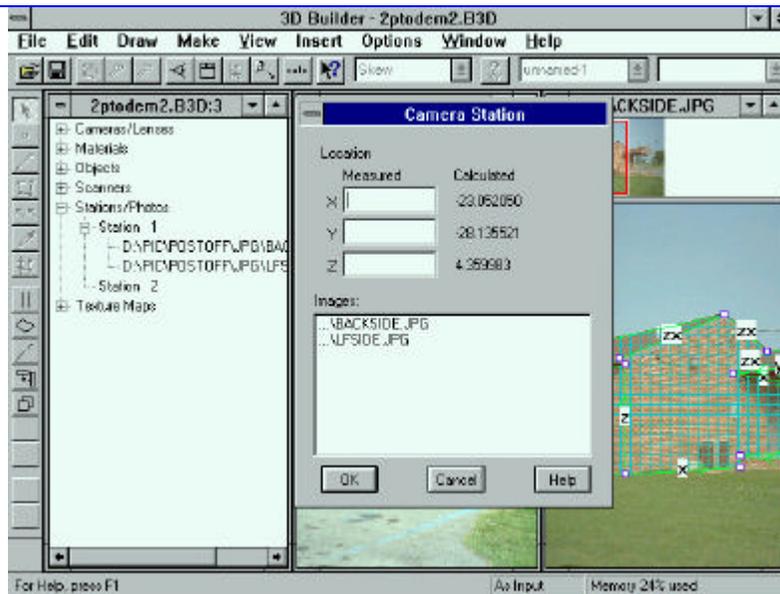


Figure 71 Camera Station Properties Window showing images assigned to camera station 1

Introduction to the Camera lens Wizard

In order to calculate a 3D model with any accuracy, **3D Builder** needs some information about the camera and lens combination used to take the pictures. In order to simplify this procedure, **3D Builder** has created a new feature, the “Insert camera wizard”. This wizard will step you through a series of simple questions designed to calculate the focal lens of the camera.

Insert/ Insert Camera Lens...

Using this command brings up the "Camera Lens Wizard", allowing the user to give information relating to the type of camera and the lens focal length. This wizard will guide you through a series of questions relating to your camera and help you determine the best settings to use in **3D Builder**.

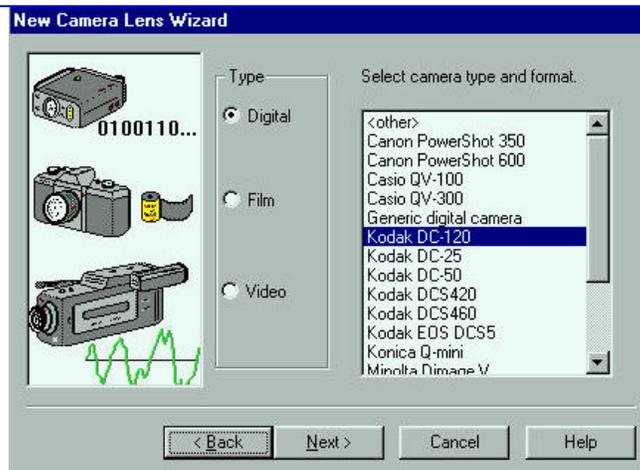


Figure 72 Insert Camera, "Camera Lens Wizard".

Choose the type of camera that you are using for the project by clicking in the appropriate radio box. This action will activate the drop down list of camera types. **3D Builder** has already prepared information on several of the leading camera types. If your camera is not listed here, choose the selection labeled "other". Then click on the "Next" button.

In the unlikely event that you have a film camera type that does not appear on the list, a window will appear asking for the film size (in millimeters).

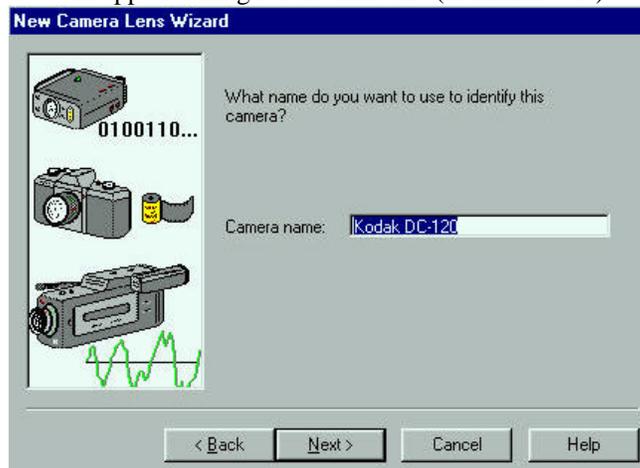


Figure 73 Camera Name Screen.

Choose a name for your camera type by typing the information in the "camera name" box. Then click on the "Next" button.

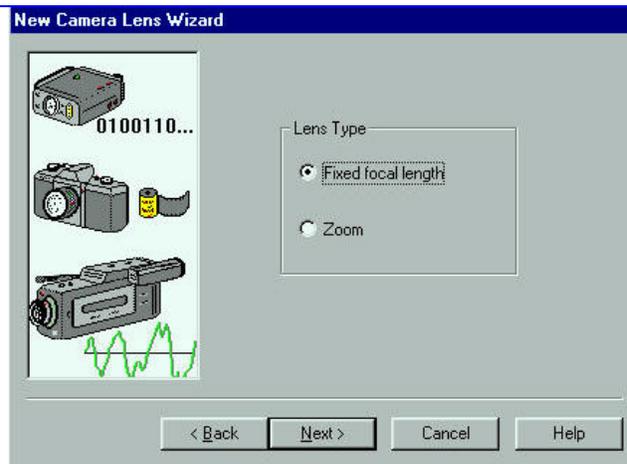


Figure 74 "Zoom" Lens Screen.

Tell **3D Builder** whether or not you are using a "Zoom" lens. **3D Builder** will work with zoom lenses, but you will need to zoom the lens all the way in (telephoto) or all the way out (wide angle) lens, and treat these as if they were two separate lenses.

Click on the "Next" button to advance the wizard.

For film cameras, there will be just two more screens, one asking the lens focal length in millimeters. The second screen will ask what name you want to use for the camera lens. We recommend names of the type camera/focal length, for example, "CanonAE/50mm".

For digital cameras and video cameras, the following screens will appear:

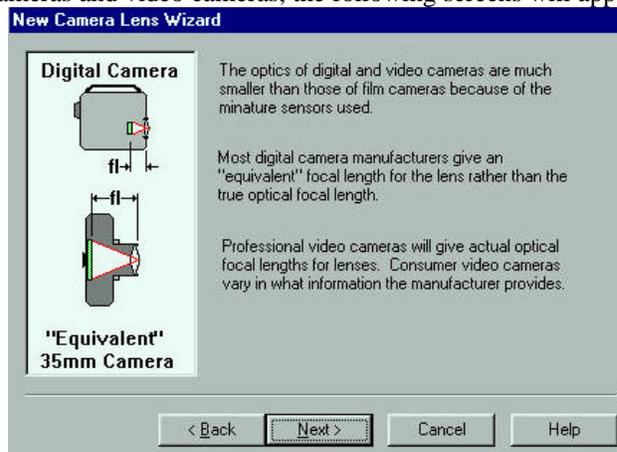


Figure 75 Screen for the optics of digital and video cameras.

Most digital cameras use miniature sensors in the camera. These make the optics of the digital camera smaller than the optics of a 35mm camera. Most digital camera manufacturers give an “equivalent” focal length of the lens rather than the “true optical” focal length. Professional video cameras will give actual focal lengths for lenses. Consumer video cameras will vary in what information the manufacturer provides. Click on the “Next” button to advance the wizard to the next screen.

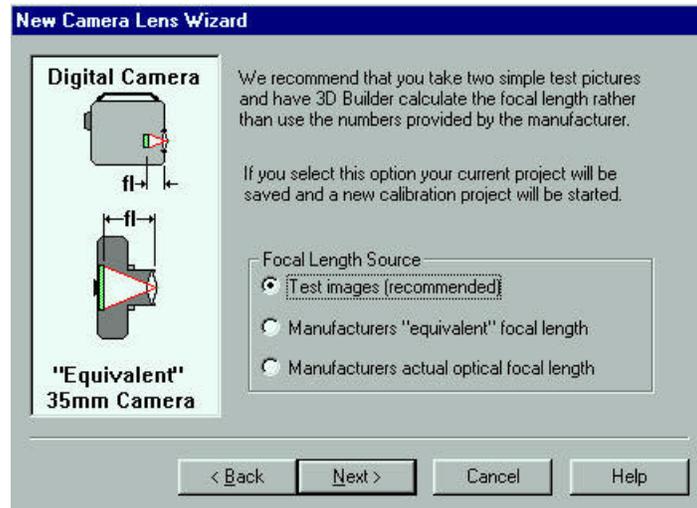


Figure 76 Screen for selecting option for focal length source.

You are now given a choice of selecting the source of your focal length. If you choose the “test images” option, your project will be saved and a “calibration” project will be opened for you.

3D Builder *strongly recommends* this choice. It is listed as the “default”. This choice involves taking two simple test pictures and then have **3D Builder** calculate the focal length of the lens for you rather than use the numbers provided by the manufacturer. Your accuracy will be improved by taking the time to do this simple test. The approximate time to perform this test is 45 minutes. This does not include the time to set up the project or the time to take the pictures and download them into the computer.

We will proceed through the Wizard using this option, then go back and pick up the other two options and describe their actions. Click on the “Next” button to advance the wizard to the next screen.

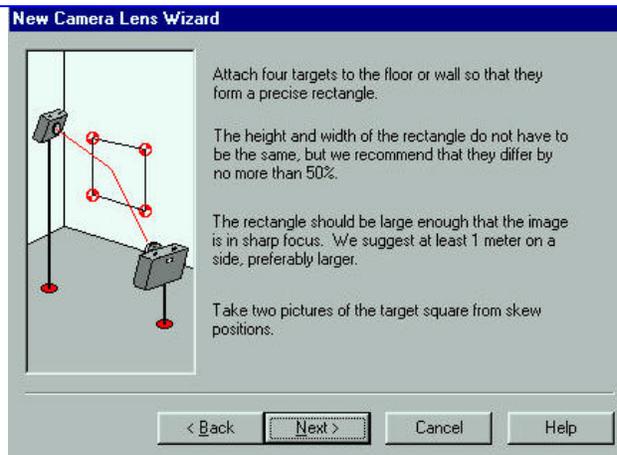


Figure 77 Screens showing positioning of targets.

Attach four targets to either the floor or the wall so that they form a precise rectangle. The height and width of the rectangle do not have to be the same, but we recommend that they differ by no more than 50%. The rectangle should be large enough that the image is in sharp focus. We suggest at least 1 meter on each side. Larger is better. Take two pictures of the “target square” from skew positions. Click on the “Next” button to advance the wizard to the next screen.

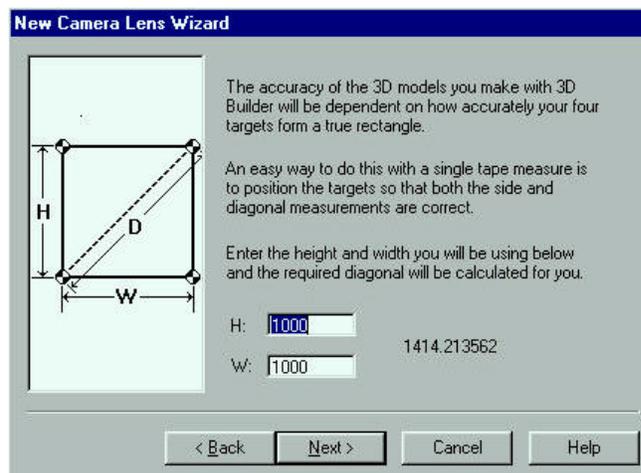


Figure 78 Targets should form a rectangle for better accuracy.

The accuracy of the 3D model that you make with **3D Builder** will be dependent on how accurately your four targets form a “true rectangle” An easy way to do this is to use a tape measure. Measure the side and the diagonal measurements. Enter the height and

width you will be using in the boxes labeled, “H” and “W”. Click on the “Next” button to advance the wizard to the next screen.

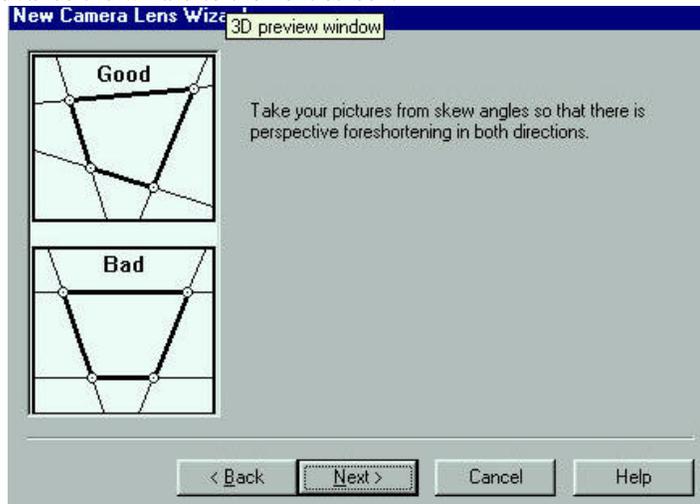


Figure 79 Pictures should be taken from skew angles.

Take the pictures from skew angles as shown in the figure above. Click on the “Next” button to advance the wizard to the next screen.

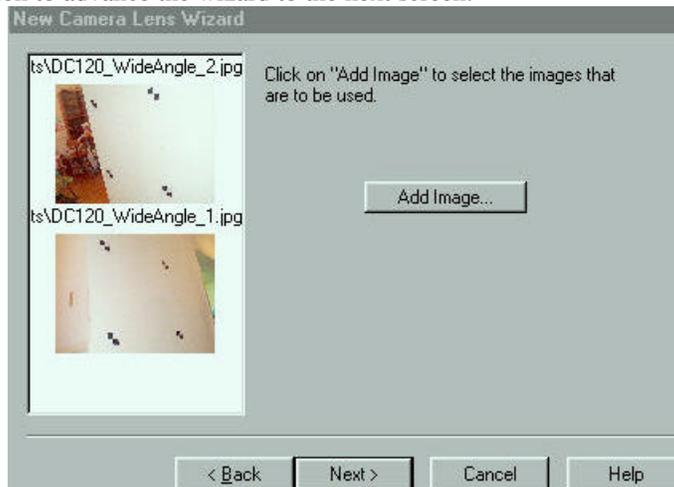


Figure 80 Select the images for the calibration process.

Click on the “Add Image” button which will bring up a file requestor. Select the images for the calibration. Click on “Next” to advance the wizard.

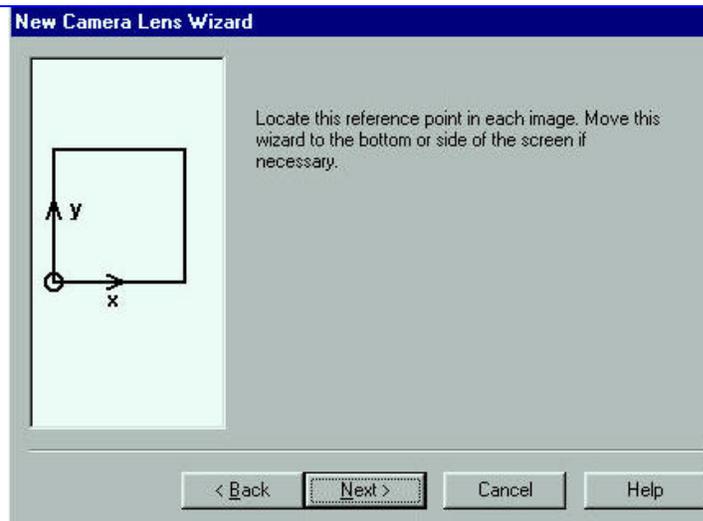


Figure 81 Locating the reference points in the image.

Locate the indicated point on each picture. Then click on “next” which will advance to the next of the four points. Locate each indicated point in each image. Continue in this manner until you have done all four points in all pictures. Click on “next” to advance the wizard.

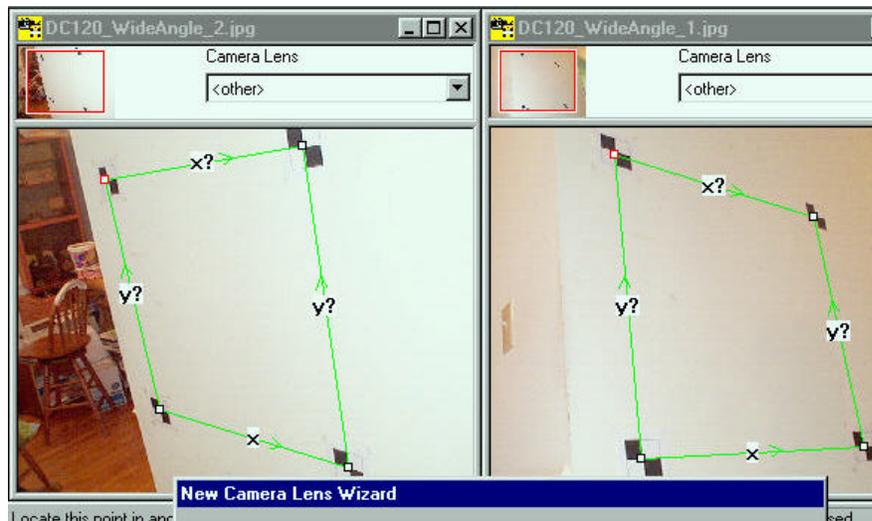


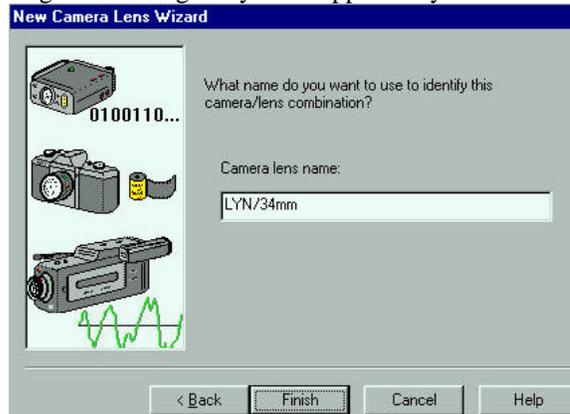
Figure 82 Target Points identified.

Next **3D Builder** will do the calculations for you to calibrate the lens focal length.

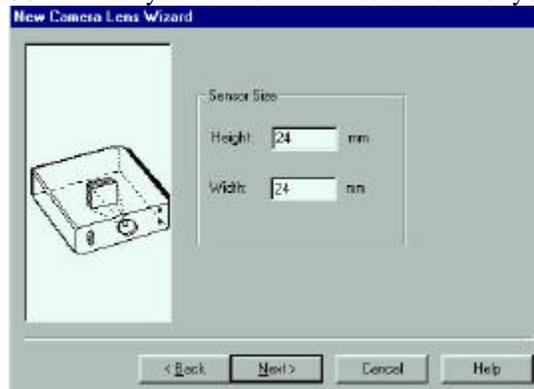


Figure 83 3D Builder does the calculations for you.

Clicking on “Next” gives you an opportunity to name the camera lens.



If you did not elect to take the camera test pictures and do a camera calibration, **3D Builder** will ask you for the internal sensor size of your digital or video camera.



If you have reliable manufacturer's data on the sensor size, enter it in the sensor size boxes. Otherwise, we ***strongly recommend*** using the test pictures, as described above. If you are not willing to take the test pictures, or you do not have any other data, use "32" millimeters wide and "24" millimeters high as the "equivalent" 35mm sensor size. Click on "next" to advance the wizard.

You will be asked to assign the camera lens a name. Then select "Finish" to create the lens.

Your newly created lens will not actually be saved to the master "lens.dat" file until you close the **3D Builder** project. At this point, you will be told that camera lenses have been added or modified and you will be asked whether or not you want to save them. Select "Yes" to save the lens.

Editing A Camera Lens:



You can edit a camera lens at any time. To edit a camera, open the "**Project**" window using the "**Window/Project**" menu command or the "**Project**" window icon on the toolbar. Click on the "+" by the word "cameras", and then double click on the desired camera lens. This action brings up the "Camera Lens Property window" as shown below:

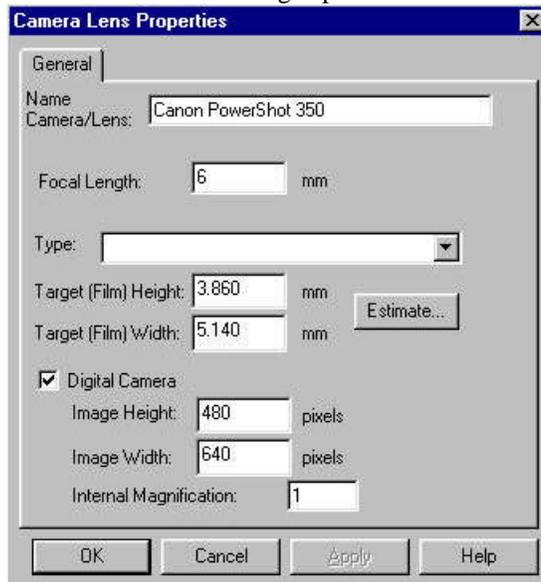


Figure 84 Insert Camera, "Camera Lens Properties" dialog box

Because of the widespread growth of digital cameras, **3D Builder** has added a lot of information concerning various types of digital cameras. The camera lens combo box now displays available camera types with known camera magnification and other parameters. *Note* that there is now a new entry for “Generic digital camera”. If you know the camera lens that took the image, be sure to specify the camera lens in addition to the type of camera. If you do not know the camera lens that took the picture, try to at least specify the type of camera.

When using a digital camera that is not already on the **3D Builder** list of digital cameras, type in the name of your digital camera in the “Name/Camera Lens” box. Next, fill in the camera focal length, and other information requested in the dialog box. The following dialog box shows the information fields completed for the “Canon PowerShot 350” digital camera.

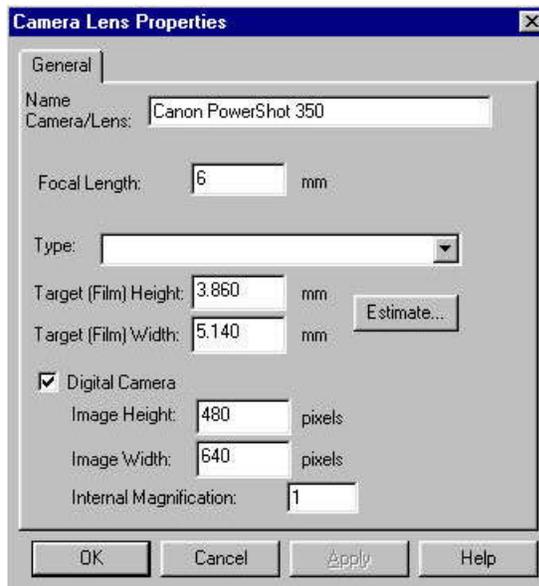


Figure 85 Camera Lens Property Box, General Page.

On the next page is a list of some of the most widely used digital camera information.

Digital Camera Information Sheet

Name	Focal Length mm	Target (Film) Height mm	Target (Film) Width mm	Image Height pixels	Image Width pixels
Canon PowerShot 350	6.0	3.860	5.140	480	640
Canon PowerShot 600/Normal	7.5	3.940	5.400	608	832
Canon PowerShot 600/Wide	4.2	3.940	5.400	608	832
Casio QV-100	5.8	3.860	5.140	480	640
Casio QV-300/Wide	6.6	3.860	5.140	480	640
Casio QV-300/Tele	15.0	3.860	5.140	480	640
Kodak DC-25	5.9	3.026	4.000	373	493
Kodak DC-50/Wide	7.0	4.528	6.792	504	756
Kodak DC-50/Tele	21.0	4.528	6.792	504	756
Kodak DC-120/Wide	7.0	4.974	6.632	960	1280
Kodak DC-120/Tele	21.0	4.974	6.632	960	1280
Konica Q-Mini	6.0	3.480	4.640	480	640
Minolta Dimage V/Wide	4.8	3.750	5.000	480	640
Minolta Dimage V/Tele	13.0	3.750	5.000	480	640
Olympus D-200L	5.0	3.750	5.000	480	640
Olympus D-300L	5.0	3.750	5.000	768	1024
Ricoh RDC-1/Wide	7.0	3.780	5.040	576	768
Ricoh RDC-1/Tele	21.0	3.780	5.040	576	768
Ricoh RDC-2/Wide	3.7	2.750	3.660	576	768
Ricoh RDC-2/Tele	5.6	2.750	3.660	576	768
Sony DCS-F1	4.8	3.675	4.900	480	640
Sony DKC-ID1/Wide	5.4	3.860	5.140	576	768
Sony DKC-ID1/Tele	65.7	3.860	5.140	576	768

Tools Menu Commands

The “**Tools**” menu commands are used to make choices about preferences, such as settings, licensing, calibration, and the editing of points. The Project Settings command sets up operating defaults for **3D Builder**. This command displays the “Project Settings” and allows you to choose the color, fonts, and other settings.



Figure 86 “Tools” menu commands

Tools/Verify Points...

Use the Verify Point Tool (**Tools/Verify Points menu**) to carefully fine tune each point. Clicking on the “Verify Points” brings up the “Verify Points Wizard” which will help you



determine which points need to be verified. Clicking on the “Verify Points” command will launch the Wizard to cycle you through fine tuning the placement of each point or set of points. This tool is especially useful in multiple photo projects to check for merging point accuracy. It can be used to help find modeling errors, especially in the “same point” or “merging” of points in several images.

The wizard will cycle through either all the points in your project or just the “unverified” points in your projects. An “unverified” point is a point that has not been edited—or one that not been “fine tuned”.

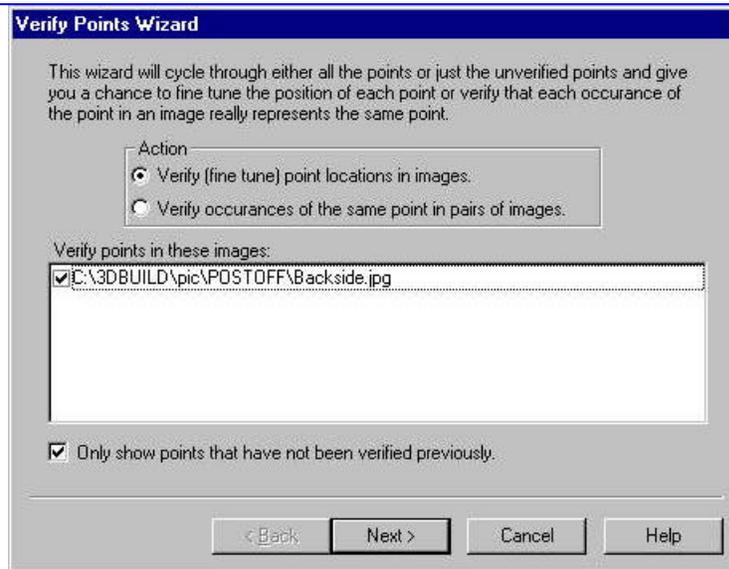


Figure 87 Verify Points Wizard.

The “Action” section of the first dialog box of the “Verify” Wizard is used to determine whether you want to verify (fine tune) each point location in each image in your project **or** whether you want to verify that each occurrence of the point in an image really represents the same point (merged points) in additional images. The default action is to use the “Verify Point” wizard to fine tune each point location in each image of your project.

The second section of the first dialog box in the “Verify Point” wizard gives a list of images in your project.

The third section of the first dialog box in the “Verify Point” wizard is a check box whose default is to only show points that have not been “verified” or fine tuned previously.

The bottom section of the first dialog box in the “Verify Point” wizard gives you a choice of four buttons: Back, Next, Cancel or Help. Clicking on the “Next” button will begin cycling of the wizard through the points of the first image in your project.

Action: Verify, fine tune point locations in images

This is the default action for the “Verify Points” wizard. Use the “Verify Point” wizard to fine tune each point location in each image of your project.

As you edit or place each point, you are “verifying” that you want to place the point at a certain location in the image. Use the “up, right, down, or left” buttons to move the point location.

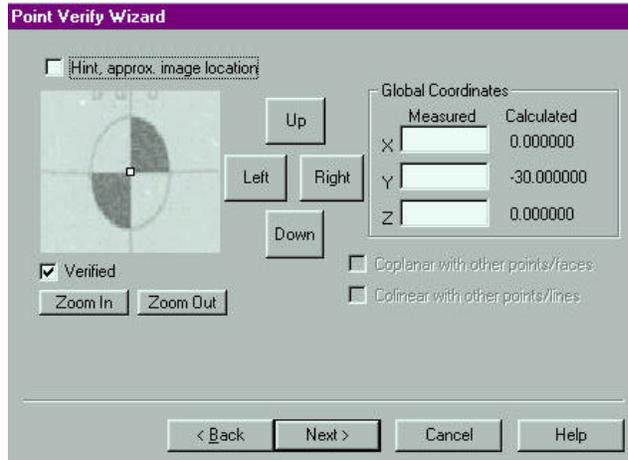


Figure 88 Verify Points Wizard, fine-tuning of point locations.

The “Wizard” will cycle through all the points. When finished, the “Finish” button will replace the “Next” button. Clicking on the “Finish” button will close the “Verify Points” Wizard.

Action: Verify occurrences of the same point in pairs of images

Clicking in the other radio button of the first dialog box of the “Verify Points” wizard will begin the wizard checking the points which you have identified as being “the same” point (merged) in pairs of images.

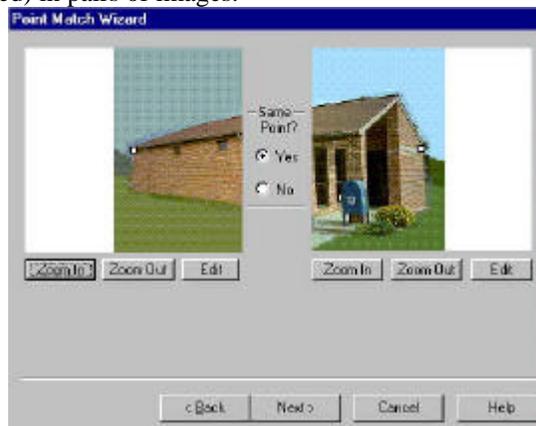


Figure 89 Verify Points, Point Matching Screen.

The “Verify Points” wizard checks the points which you have identified as being “*the same*” point (merged) in pairs of images. The bottom section of the this dialog box in the “Verify Point” wizard gives you a choice of four buttons: Back, Next, Cancel or Help. Clicking on the “Next” button will begin cycling of the wizard through the points of the first image in your project.

In between the two pairs of images, is a radio box section asking the question: “Same point?”. The default is “Yes”. If the occurrence of the point is the “same point” in both images, click on the “Next” button to continue the wizard.

Use the buttons at the base of each image to zoom in to magnify the image for better viewing; zoom out to gain a better perspective of the point location; or to edit the point location for better accuracy. Clicking on “Edit” will bring up the following dialog box to fine tune or change the point location.

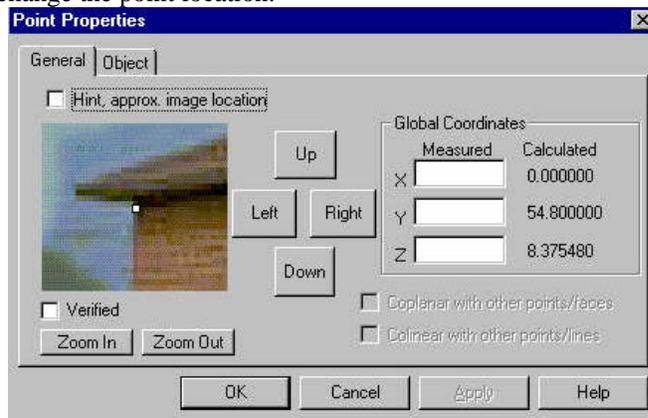


Figure 90 Point Properties Tab Page

The “Wizard” will cycle through all the points. When finished, the “Finish” button will replace the “Next’ button. Clicking on the “Finish” button will close the “Verify Points” Wizard.

Tools/ Settings...

Using this menu command brings up the "Project Settings" command which will allow you to give information concerning choices about the project options such as:

- Color Settings
- Default camera settings and camera stations
- Toolbar

The first tab page is the “Colors” settings which allows you to set choices of colors for selected objects, points, and lines. You can also set your choice of fonts. To change a color or font, click on the “Set...” button which is located on the right side of the tab page.

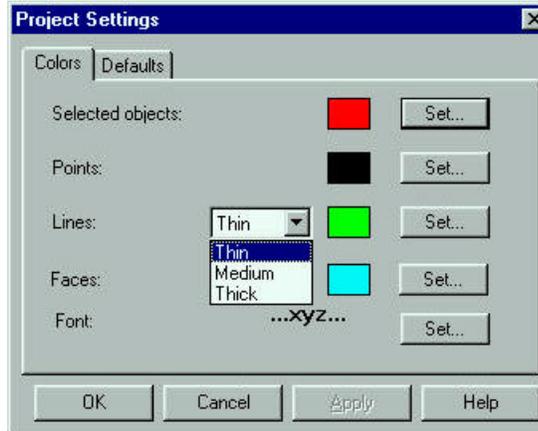


Figure 91 Project Preferences for Setting Colors

Clicking on the “Set...” button will bring up the “Color” dialog box, with a palette of custom colors from which you can choose. When you finish adjusting the colors, choose “OK” to apply the colors.

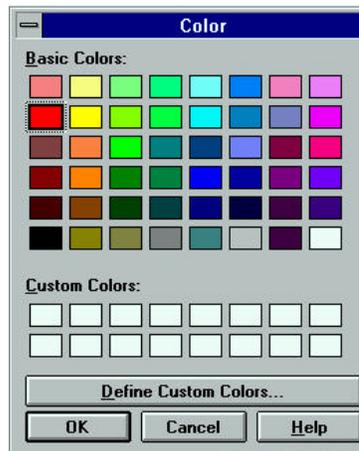


Figure 92 Setting Custom Colors for Project Preferences

Tools/Settings/Line Weight...

3D Builder has added an option under “Colors” for weighing the size of a displayed line and a displayed curve. You may now choose either a single or double weight for the display of the line. This is to improve the visibility of the lines in curves.

Tools/Settings/Defaults...

The second tab page is the “Defaults” page, which allows you to set defaults for having a new camera station added with each new image added to your project. This page also gives you a choice of setting a default camera type for your entire project. Choose from a drop down list of cameras. There is also a checkbox for using an “odd size .JPEG texture map” size. This is necessary to work around a Netscape 3D bug. When the check box is in the checked position, an odd sized texture map is created. If you experience difficulty in your texture map using Inventor or Wavefront, be sure to “uncheck” this box as both of these files expect an even number of pixels in the texture maps.



Figure 93 Project Preferences Setting Defaults

License

If **3D Builder** has not been fully licensed for unrestricted use, it will display the License Wizard when it starts up. The License Wizard will guide you through a series of questions and will prepare a form to be faxed or Emailed (preferred). 3D Construction Company will then send you an authorization code which unlocks the program.

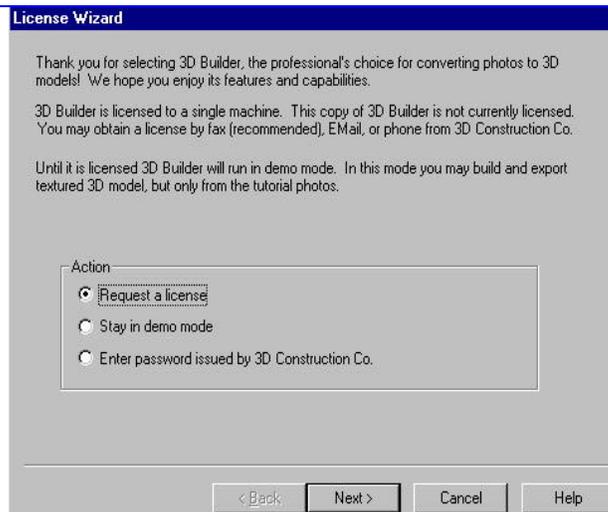


Figure 94 License Wizard Screen.

- **3D Builder** is licensed to an individual machine and to a specific location on a machine.
- **3D Builder** automatically defaults to running in a “*demo mode*”. Using the demo mode, you can run the tutorials and learn about **3D Builder’s** program tools and features, but you are limited to working with the supplied tutorial image files.
- **3D Builder** can be turned on for a free 30 day trial period or it can be turned on for full unrestricted use.

To activate the program for either a 30 day trial evaluation or for full unrestricted use: Run the License wizard (under **Tools/License menu**). The License Wizard will lead you through a series of short questions.

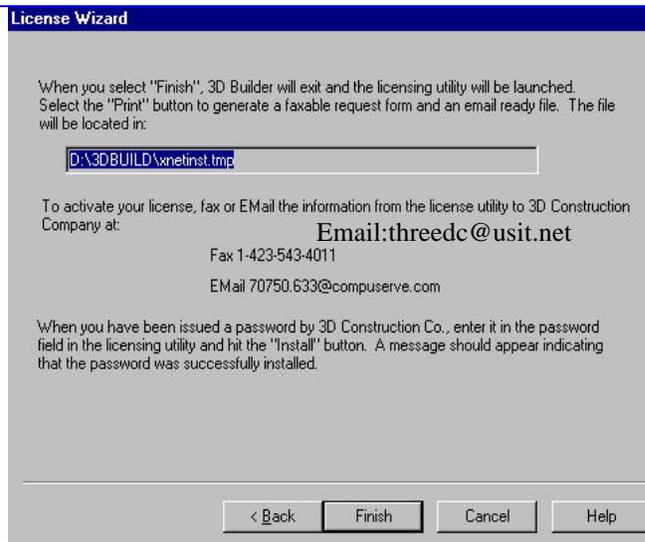


Figure 95 License Wizard showing the machine ID location.

When you click on the “Finish” button, a new window appears which will assign you a “**Machine ID number**”. This number will be requested for the license authorization form.

Fax or Email 3D Construction Company the information form provided by the License Wizard to receive your authorization code. Not all configurations of machine can print the “License Wizard” file. If yours can not print the license form correctly, you will need to “copy and paste” to a text file and then print from the “text” file.

Calibrate Camera Lens



There is now a “**Camera Calibration Wizard**” to guide you through all the steps required for calibrating the camera/lens combination. This is done to help you determine the camera focal length. The Camera Calibration Wizard will “walk you through” the steps. The “Calibrate Camera Lens” command begins the calibration process. Calibration of the camera/lens needs to be done **ONLY ONCE**.

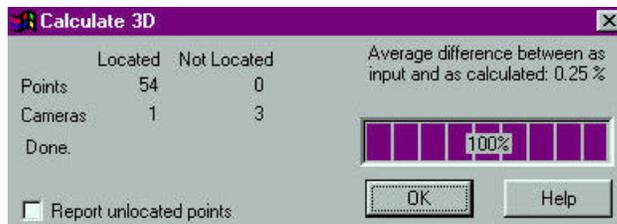


Figure 96 Progress Reporter Box

- A progress reporter shows the percentage of calculations. Click on “Finish” when the calculate calibration process is completed.
- Lastly, start the **3D Builder** program and open a project (**File/Open menu**) using the camera/ lens settings that you have calibrated. When you click on “Calc 3d” (**File/Calc 3d menu**), **3D Builder** will use this new calibration data in making the 3D model. The results will be more accurate and well worth the time taken in calibrating the camera lens.

Window Commands

The Windows commands indicate which windows are in your work space and how they are arranged. The Windows menu contains the following commands:

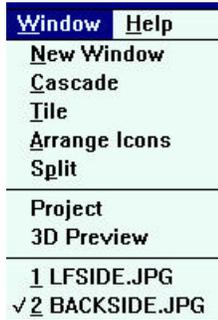


Figure 97 Window Menu Commands

Window/ New Window



The “**New Window**” command opens brings up a new image window. “**New Window**” creates a new image window and chooses a photo that is not being displayed to be shown in the window. To choose a different image to be displayed in the new window, choose the “**View**” menu, “Select image” command. The “New Window” tool can also be accessed via the toolbar ribbon icon.

Window/ Cascade

The “**Cascade**” command overlaps the open image windows diagonally in the creation order.

Window/ Tile

The “**Tile**” command spaces the screen with open image windows and adjusts sizing to fit the available space in the window.

Window/ Arrange Icons

The “**Arrange Icons**” command spaces the icons evenly across the window. If you have collapsed several icons to miniatures (which is not recommended) the “arrange icon” command will arrange them neatly across the bottom of the main screen area.

Window/ Split

If an image window is active, the Windows “**Split**” command attaches the splitter bar to the mouse cursor. You may use this instead of picking the splitter bar from the window. When you do a left mouse button down, the window will be rearranged at the new splitter bar location.

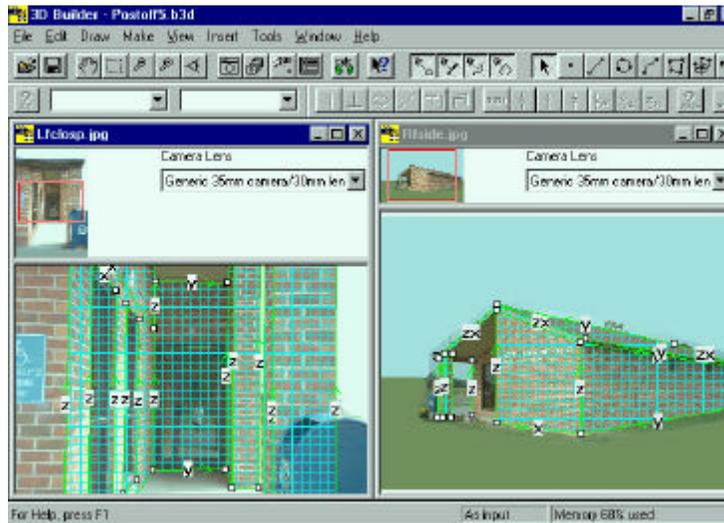


Figure 98 Windows “Split” command changes the cursor to control the splitter bar in the active window

Window/ Project



The Project Window gives you an overview of the objects in your project. This window displays tree listings of:

- cameras and camera lenses
- constraints
- materials

- objects
- stations/photos
- texture maps

Click on the box with the “+” sign to expand each of these categories. Double click on any of the items or objects to bring up its property window. The Project window is the **3D Builder** "control center" for the project files. It gives an overview, showing the files contained in the project. You can have only one project open at a time.

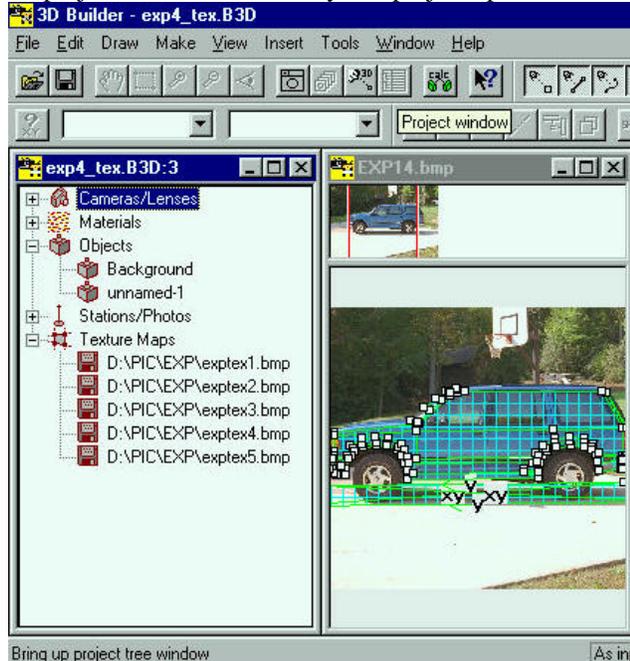


Figure 99 Project Tree with some tree branches expanded

The Project window shows a tree control system, with branches to view the following:

- **Cameras/ lenses:** Gives a list of the cameras and lenses. Click on the + sign to expand the tree control level.
- **Constraints:** The constraint section lists any geometric constraints. If you click on a constraint, the constrained points, lines, and/or faces will highlight in any image views that are open. Constraints will only appear in the project tree if you have assigned them to any points, lines and/or faces.
- **Materials:** Gives a list of the materials identified in the project. Click on the + sign to expand the tree control level.
- **Objects:** Gives a list of the objects identified in the project. Click on the + sign to expand the tree control level.
- **Stations/Photos:** Gives a list of the camera stations and individual photos identified in the project. Click on the “+” sign to expand the tree control level.





Note: The images are listed under the “camera station” branch of the tree. Remember that if several images were taken from the same camera location, they should be assigned to the same station (This is done from the “Image Properties” window).

- **Texture Maps** Gives a list of the texture maps that have been applied to the project faces. The tree branch also lists the drive, directory, and file names of each texture map. Click on the “+” sign to expand the tree control level. Texture maps will only appear in the project tree if you have assigned them to any faces.

Window/ 3D Preview Window (F4):



After calculating the 3D model, it can be viewed through the “3D Preview Window”. Click on the “**Window**” menu and select “**3D Preview**”. Or you may click on the “**3D Preview**” tool icon button on the toolbar. The shortcut key for this command is “**F4**” on the keyboard. This action brings up the 3D View window and the 3D model appears in the center. This is a full 3D model which can be rotated and viewed from any angle. The 3D Previewing window can be resized. Resizing the window smaller makes for a faster rotation speed. The background color of the 3D Preview window can be changed by selecting the “**View/Background Colors**” menu command. The 3D Preview window can be changed to display a rendered, shaded 3D model by selecting the “**View/Solid**” menu command. The 3D Preview window can be changed to display a wireframe 3D model by selecting the “**View/Wireframe**” menu command. The 3D Preview window can also display both a rendered, shaded 3D model and a wireframe by selecting both the “**View/Solid**” menu command and the “**View/Wireframe**” menu commands.

Note: You need to have either “solid” or “wireframe” or both checked in order to see the model. If using the “wireframe” mode only, be sure your background color is *not* white.

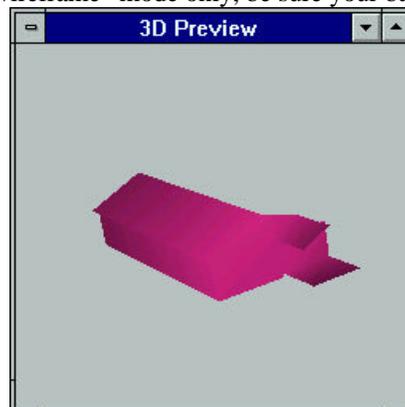


Figure 100 3D Preview Window

3D Builder has added a warning message when you have created more than 15 separate textures. The warning message says that it is “OK” to have more than 15 different materials, but that only the first 15 will be displayed in the 3D Preview window.

Window/ Recent Files

The “**Recent File**” command displays a list of recently-opened files. This command lets you quickly access the most recently active files

Help Menu



Figure 101 Help Menu

The **Help** menu provides commands to assist you in using the on-line help. Help. Help information is also available about the dialog boxes in **3D Builder**. Clicking on the Help button brings up the help information. Context sensitive help information is also available by clicking on the Help tool icon. For more information about context sensitive help, refer to the Toolbar section of this manual.

For information about using help, press **F1** or choose How To Use Help From The Help Menu.

Help/ Index

The “**Index**” command displays the table of contents for the on-line help.

Help menu/Tutorials

An addition to the File/Help command has been made.

3D Builder gives you several tutorials to help you up the learning curve. These tutorials are launched from your Internet Browser. Each tutorial is designed to be used together

with **3D Builder** in a hands-on learning session. Click on the desired tutorial title from the Help menu to launch the tutorial. **3D Builder** recommends that you give the tutorials approximately one-third of the screen space and run **3D Builder** tutorial project on the remaining two-thirds of the screen. Do this by resizing your Internet Browser.

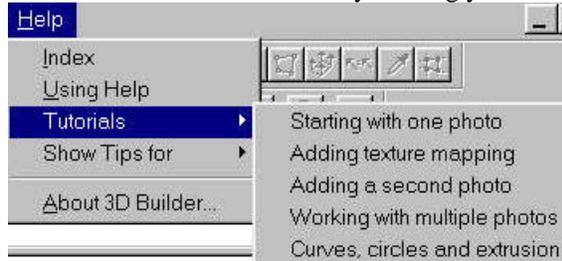


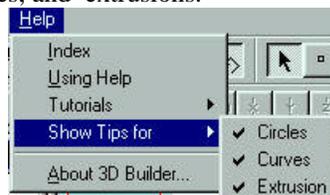
Figure 102 Help Tutorials.

Help menu/Show Tips for...

3D Builder has added a file menu item for “on screen, just-in-time” helpful tips for the following:

- Show Tips for Circles
- Show Tips for Curves
- Show Tips for Extrusion

Each of these helpful tip sheets is explained in greater detail in the individual chapters on circles, curves, and extrusions.



Help/ About 3D Builder

The “**About 3D Builder**” command opens a dialog box containing the version number, copyright materials and other information about 3D Construction Company.

ToolBar

Chapter 7

The toolbar provides easy access to **3D Builder**'s main tools.



Figure 103 Toolbar Icons, shown here "docked" to the top of the screen

The numerous tools included in the **3D Builder** toolbar are displayed above and each tool is described in the following text. The toolbar consists of a series of icons. Moving the mouse pointer on top of an icon displays information about that icon. Clicking on the icon makes it the active tool for your use.

3D Builder for Windows has added and changed several of the toolbar icon buttons, both in appearance and in behavior. The layout is now optimized for 800 by 600 (or larger) SVGA screens. The **3D Builder** program still runs on 640 by 480 VGA screens, but there may need to be a rearrangement of the toolbars to best fit the individual screen. Each toolbar is independent and can be docked in several areas on the screen.

Docking Toolbar:

3D Builder gives you the option of a docking or "movable" toolbar. To change the position of the toolbar, click once with the left mouse button on the toolbar and drag the toolbar to either the side of the window, the top, or the bottom of the window. When you release the mouse button, the toolbar stays "docked" to the side of the window or to the bottom of the window. This action allows you some flexibility in working with the toolbar which provides shortcuts for the power user.

Toolbar/ Selector Tool



Select Tool

The selector tool or pointer tool, which appears as an arrow on the toolbar, is a commonly used tool in **3D Builder**. Use the selector tool to select a point, line, or object for editing.



NOTE: If points are difficult to select because they are close together, use the "Zoom" option to enlarge the image and then select .

Changes in Behavior of the Selector tool (Arrow tool)

The most important change is in the behavior of the “Selector” tool or the “Arrow” tool. First, it displays in a larger size for easier visibility. More importantly, however, is the new “drag and drop” action for editing or moving a point to a new location.

To move a point, click once on the point to select it. Click again and continue holding the left mouse button down, then drag the point to its new desired location. There will be a “rubber-band” action. The lines and faces will move also.

Note: *This is a different clicking action than a “quick double clicking” action.*

Note: *Helpful hint: Turning off the visible display of faces will speed up the dragging movement.*

This action also applies to points that were used to define circles or curves. The “special” points on the circle will also be moved since they are connected to the circle or the curve.

Gone is the “drop down list” where you would change the “axis plane”. These are now located on the toolbar, saving mouse clicks. The axis plane of the selected object appears in the “depressed” or “pushed in” position. The axis hint icon is also located on the toolbar for lines which were in question as to their axis plane. To change the axis plane, choose the toolbar icon button of choice.

Note: *You can also multiple select and change the axis plane of lines and faces.*

Multiple Select: To select more than one item in the image, hold down the shift key while making additional selections.

Toolbar/ Point Tool



Point Tool

The point tool appears as a small square on the toolbar. Use the point tool to place points on the image. When the point tool is chosen, the cursor changes to a small square. Each time the mouse is clicked in a image a new point is created. The location of the point is at the center of the small square. Be sure to use the merge tool later to tell the program which points are really the same.

Cursor



Point Tool

The toolbar **changes** when the “Point Tool” is chosen by clicking on it. New tool icons appear on the lower part of the toolbar. These point icons give you a chance to choose among the different kinds of points to be drawn on the image.

- **Single Point Tool Icon:** This is used to create a new point in one image. This icon is the default icon and is the same as the point tool.





- **Same Point Tool Icon:** This is used to create a point in one image that already exists in another image.



- **Point Pair Tool Icon:** This tool is used to create the same point in two images.



- **Grid Point Tool Icon:** This tool is used to create a grid.



The “Grid Point” tool will be grayed out unless you have previously created a grid with the “**Insert**” Grid menu command. The Grid Tool window will then pop up . If you have created more than one grid, you may choose the appropriate grid from the list. A picture of the grid will then appear. The cursor will create a point in the image on the grid corresponding to the red highlighted point showing in the grid window. Before locating a point in the image, click on the grid point from in the grid point tool.

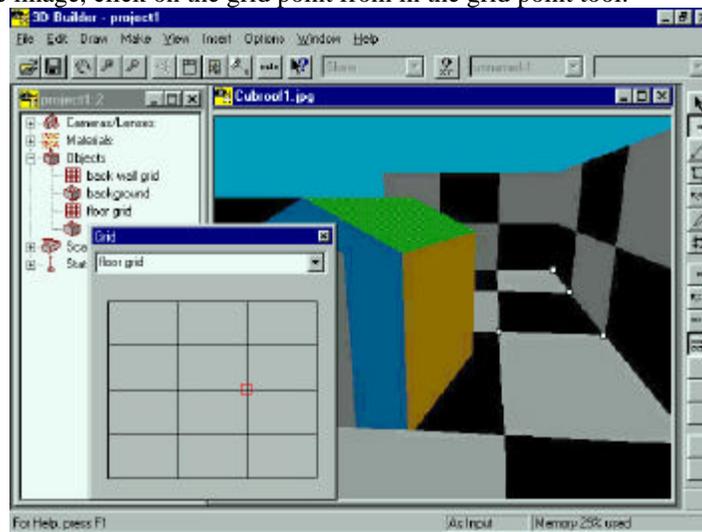


Figure 104 Grid Point dialog box

To Edit A Point



Click on the “Selector” tool icon, which looks like an arrow, from the toolbar ribbon icon. Double click on the desired point or right mouse button click. This action brings up the “Point” tab page.

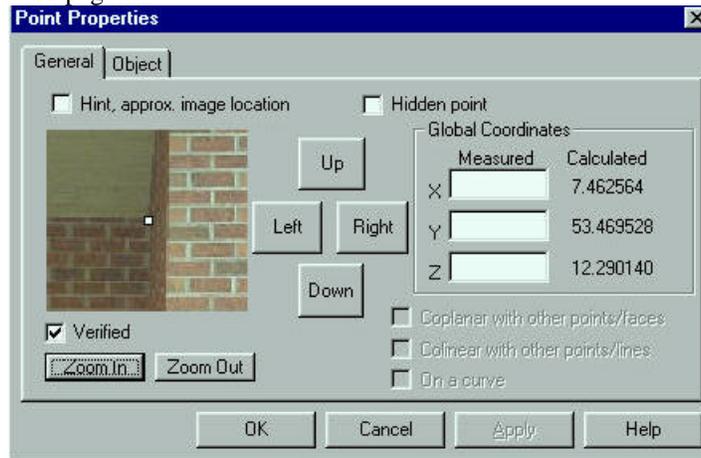


Figure 105 Edit Point “General” Tab Page

The “General” tab page of “Edit” Point allows you to give information about the following:

- Hint, approximate image location check box:** This check box indicates whether the point has been declared as an “approximate” position. There are times when you need to place a point in an image to connect lines or to complete a face, but the point is obscured by something else in the image by something else, such as a bush. You need to mark points like this as “approximate” so that the **3D Builder** solver will not try to force an exact solution through these type points. Failure to mark the points as “approximate” so can throw off the entire 3D model.
- Hidden Point:** Objects that are created with the “Extrusion tool” will usually have several points that are not really visible in the image because they are hidden by other extruded faces. **3D Builder** tags these points as “approximate” (see above) and “hidden”. Lines to these “hidden” points are shown in “dashed” form. The purpose for showing points like this, rather than just deleting them entirely, is so that you can go to another image where the back side of the object is visible and use the “**Same Point tool**” to tie the points together. If **3D Builder** has incorrectly marked the point as “hidden”, you may click on the check box to clear the “flag”.
- Image Area:** This area displays a small portion of the image, enlarged to zoom in on a detailed area.
- Up, Down, Left, Right buttons:** These buttons are used to “fine-tune” or to reposition the point for a more exact location.



- **Verified check box:** This check box indicates whether the point has been zoomed in previously for editing or repositioning. It is designed to help you keep track of which points you have already “fine-tuned”.
- **Zoom In and Zoom Out buttons:** Use these buttons to enlarge or shrink the area.
- **Global Coordinates input boxes:** These boxes give you an opportunity to input any known data about the point. If you know or have measured any of the coordinates of the point, type in the “X”, “Y” and/or “Z” locations.
- **Coplanar constraint check box:** This is used to show if the point has been marked as being coplanar with other points/faces. This will be grayed out unless a constraint has been applied.
- **Colinear constraint:** This check box indicates whether the point has been constrained to be colinear with other points/lines. The default position for this check box is in the grayed out position.
- **On A Curve:** Use this check box to indicate that the point is located on a curve.

The second tab of the “Point Properties” page is the “Object Local” tab. This is used to attach points to objects, and/or grids, and to optionally specify the “local” coordinates of a point in the axis system of the object.

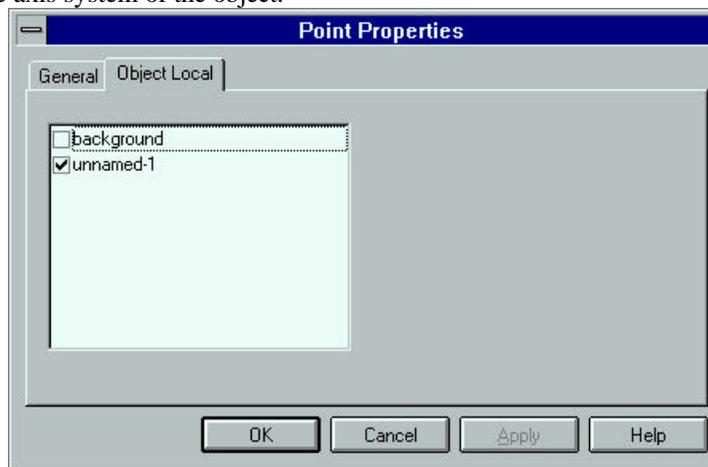


Figure 106 Edit Point Properties, “Object Local” dialog box

Since points may be shared a number of objects, a list of the objects in the projects appears on the left, with a check mark by the ones in which the point is already assigned (or attached to). Clicking on one of the objects will bring up a display of the local objects.

For a grid object, this action brings up a picture of the grid, with a red highlighted box for the point to which the selected point corresponds. To change the grid location, simply click on the appropriate grid spot. If two grids intersect, this may also be used to

assign a point to two or even three grids. This would be used , for example, when a vertical grid and a horizontal grid intersect and they have a common point, as shown in the following example:

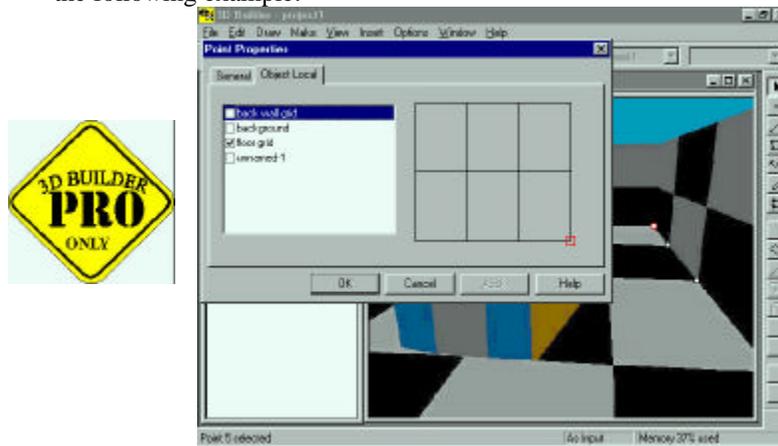


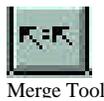
Figure 107 Edit Point, "Local Object" tab page, shown with two grids intersecting.

In the above described case, you would select the other grid object and then click in the grid picture on the grid point that corresponds to the grid. Other than grids, object local coordinates are not presently used by **3D Builder**.



NOTE: These changes take effect **immediately**. Cancel will not undo these changes. You will need to select the point and call it back up to re-edit.

Toolbar/ Merge Point Tool



Merge Tool



Cursors

The merge point tool appears on the toolbar as two arrows with an equal sign between them. The “Merge” command ties two points together and indicates that the two points are the same in both images. If you do not already have two image windows open the message area will ask you to do so. When there are two images visible, the message area in the status bar will display the message "SELECT FIRST POINT". Click on a point in one of the images. The point you have selected will highlight and the message will change to "SELECT THIS POINT IN ANOTHER IMAGE". Click on the same point in another image. This process merges the two points together.

Semi-Automatic Point Matching

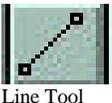
In order for **3D Builder** to locate each camera station you will need to locate one or two known points and tie together a small number of points common to each image. These first points are tied together using the “Point Merge” tool as described in Chapter 5 of the **User’s Guide** (Menus). Once you have done this you should use the “**File/Calculate 3D**” menu command to get **3D Builder** to locate the camera stations and points.

Once the camera stations have been calculated, the “Point Merge” tool switches to “semi-automatic” mode. In this mode you can rapidly tie together the remainder of the points in your model. With two or more pictures visible on the screen, you select a point in one picture. The other pictures are zoomed in on the most likely candidate points to match the selected point. This eliminates having to “roam” around the other photos, looking for the correct area. Other points that have *not* been merged together will still appear on the second photo, but they will be drawn as *small* dots. You will still be able to choose which point you want to merge, but **3D Builder** will offer its *best* choices for you by automatically making its choices appear in a *larger* size. **3D Builder** will *not* automatically choose the point for you. You will still need to choose the point to be merged by clicking once on it. But this feature will save you time and prevent modeling errors.



Figure 108 Semi-Automatic Point Matching.

Toolbar/ Line Tool



Line Tool

The line tool, which appears as a straight line between two small squares on the toolbar, is used to create a straight segment at any angle. Use the line tool to draw a segment from one endpoint to another. When the LINE tool is selected, the cursor changes to a symbol for a line. A line tool dialog box appears in the main window. If you know that the line that you are going to create is vertical or horizontal along one of the coordinate axes, then select the appropriate line type. The same is true if you know that the line lies in one of the principle coordinate planes. Otherwise leave the line type as SKEW. The message "Move to end of line then release button" is displayed in the message area. Position the cursor arrow over the starting point for the line, then press the mouse button

down. Move the cursor over the ending point, holding the mouse button down. As you move the cursor, a line will be rubber-banded on the screen from the starting point. Release the mouse button when the cursor is over the desired end point.

To Edit A Line



Click on the “Selector” tool icon, which looks like an arrow, from the toolbar ribbon icon. Double click on the desired line or right mouse button click. This action brings up the “Line” dialog box.

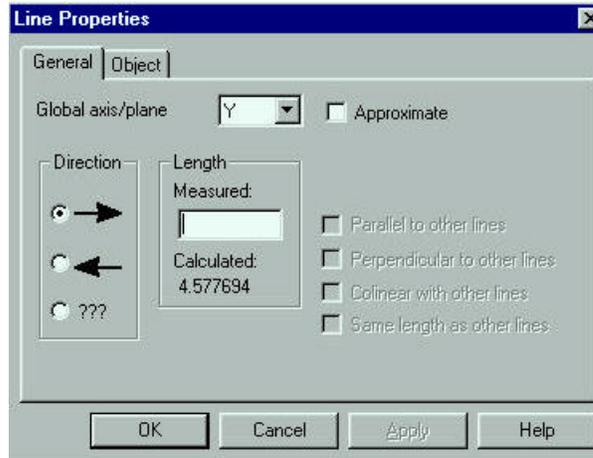


Figure 109 Edit "Line" Dialog Box

The “Line” Dialog Box consists of the following elements:

- **Global axis/plane drop down list box:** The global list box should be selected if the line lies along one of the global coordinate axes lines. Choose from a drop down list box.
- **Approximate check box:** This check box is grayed out unless the line has been marked as an approximate location.
- **Direction indicator arrows:** This set of arrows is used to indicate the direction that the coordinate axis line should go.
- **Measured Length input box:** This box gives you an option of typing in any known measured lengths of lines. If you know the measured length of a line, you could type it in .
- **Constraint check boxes:** These check boxes are grayed out unless the line has been constrained. A line may be parallel to other lines, perpendicular to other lines, colinear to other lines and/or the same length as other lines. If a constraint has been marked, a check will appear in the constraint box



Toolbar/ Polygon Tool

Polygon Tool

The polygon tool appears as a series of short line segments between small squares. Use the polygon tool to create faces or polygons on an image. You may create polygon points in either a clockwise or counterclockwise direction. Remember, however, do **NOT** go in a crisscross or “bowtie” direction. Clicking on the polygon tool will bring up the polygon tool icons and allows you to select from among the following types of polygon configurations:

- **3 Point Polygon Tool Icon:** A 3-point polygon is the default box button. Use this if you want to place a polygon face consisting of three points in the image.
- **4 Point Polygon Tool Icon:** Use the four point polygon tool if you want to place a polygon face consisting of four points that **do not** make a rectangle in the image.
- **4 Point Polygon RECTANGLE Tool Icon:** Use the four point polygon tool if you want to place a polygon face consisting of four points that **do** make a rectangle in the image.
- **Many Point Polygon tool icon:** Select this tool icon button if you want to place a polygon face consisting of more than four points.

Cursors1st Point
Cursor2nd Point3rd point

Point Number

When the polygon tool is selected the cursor changes to a symbol

for a polygon. The display of "Select first point" appears in the status bar

1st Click: If cursor is near a point highlight the point and change the status message to "Select second point".

2nd Click: If cursor is near a point highlight the point and change the status message to "Select third point".

3rd Click: See if there is a point near the cursor. If so create a new face connecting the three points.

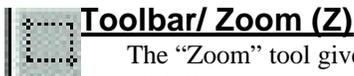
The process would be expanded to include the number of points selected for the polygon, (four or more). When you are doing a many point polygon, the last point **must “close the loop”** and must be your first point again.



Note: If you make a mistake during the creation of a polygon, click on the **backspace key** to delete the last point placed. To delete all of the points, go to the “selector” arrow tool. Click on it once with the left mouse button and all of the points in the face will be deleted.

Toolbar/ Pan Tool (N)

The pan tool, which appears as a hand, is used to grab a portion of the image and scroll the image. The image may be scrolled both vertically and horizontally at the same time.



Toolbar/ Zoom (Z)

The “Zoom” tool gives you the opportunity to magnify the entire image for better visibility.



Toolbar/ Zoom In Tool (+)

The “zoom in” tool appears as a magnifying glass with an inset plus sign. Use the zoom in tool to expand the view size. The image itself is not affected by this tool. It allows you to zoom in on a detail.



Toolbar/ Zoom Out Tool (-)

The zoom out tool appears as a magnifying glass with an inset minus sign. Use the zoom out tool to zoom out to contract or shrink the view size. The image itself is not affected by this tool. It allows you to zoom out to take in the “big picture” of a segment of the image. Another way of zooming out is to select “**Window/Tile**” menu command. Then grab the “side bar” of the window and “shrink” the window, effectively zooming out on the photo.

Toolbar/ Insert Photo (Add image to the Project)Tool



The “insert photo tool”, which appears as an opened file folder on the toolbar, is used to add a new image or photograph to the project. Clicking on the insert photo tool opens up at the “Insert Photo” dialog box and allows you to add a new photo image from your selected file and directory.

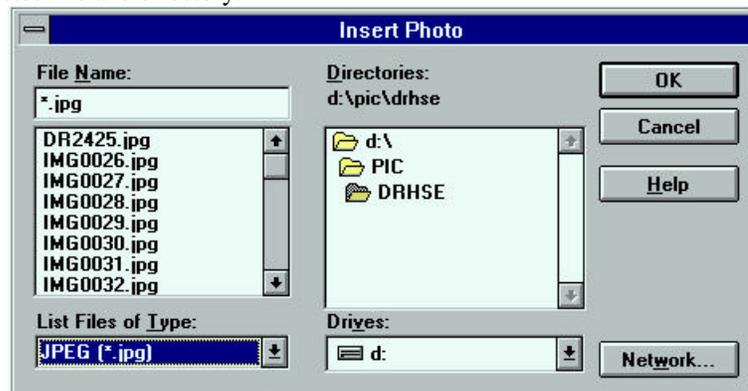


Figure 110 Insert Photo Dialog Box

- Select the file name by clicking on it from the file list.
- Choose the type of file from the “List files of type” drop down list box.
- Choose the directory of your choice.
- Select the drive from the “drives” drop down list box.
- If you were accessing the file from a network, you would click on the “Network” button. This would bring up the standard windows browser for files.
- To accept the currently selected item, click on “OK”.
- To return to the main screen, click on “Cancel”.
- If you need to access the help engine, click on “Help”.



Note: If you have an empty image window on your screen, the photo will be displayed there. Otherwise the photo is added to your project, but not immediately displayed on the screen

Toolbar/ New Window Tool



New Window

The “add window” tool appears as a small window on the toolbar. Clicking on the “add window” tool will add another window to the active project.



Note: If you want to add an additional image to the project and **have it be displayed in the main window area**, you need to click on the new window tool to create a window for the image. It is used to create a space (window) for the new image. You will need to do this any time you want more than one image displayed at the same time.

The “**New Window**” command is also available by choosing the “**Window**” menu and then selecting “New Window”.

Toolbar/ Select Image List Tool (F2)



Select Image

The “image list” tool appears as a series of images on the toolbar icon. Clicking on the image list tool will bring up the “Select Image” list and thumbnail pictures of each image photo in the active project. Double clicking on a photo image will bring that photo image to the front and it becomes the active photo image. Clicking on the tool icon activates this tool. Use the “Select Image List” tool to bring up the “Select Image” dialog box which gives a list of images in your project. The list gives the file name of the image, and the drive and directory of where the image is being stored on your hard drive. The image itself is not affected by using this tool. The “Select Image” Dialog Box may be closed using the close caption bar. It may also be resized or move about your screen as any other dialog box in **3D Builder**. You may also access “Select Image List” by right mouse clicking in an open area of the screen. Then choose “Select Image”. You may also access “Select Image List” by selecting the “View”, and selecting “Select image...”.



Figure 111 Select Image List Dialog Box

Toolbar/ Save Tool



Save Tool

The save tool, which appears as a computer floppy disk on the toolbar, allows you to quickly save active data to the hard drive.

Toolbar/ Calculate Tool (F3)



Calc 3D
Tool

The calculate tool appears as “Calc” on the toolbar. Use the calculate tool to begin the **3D Builder** calculation process for converting the information given about the photo image to a 3D model.

The “**Calculate**” commands begins the **3D Builder** calculate process. **3D Builder** does the complicated math for you and figures the “X”, “Y”, and “Z” coordinates. A progress reporter box shows you what is happening as **3D Builder** converts your photos to 3D models. A “Calculate” dialog box appears and displays the results. The dialog box will show the number of points calculated and the number of points unreachable. The dialog box will also show the number of cameras positions calculated and the number of cameras unreachable. For more information on the “details” in the Calculate dialog box, see “**Appendix A**” near the end of this user’s guide.

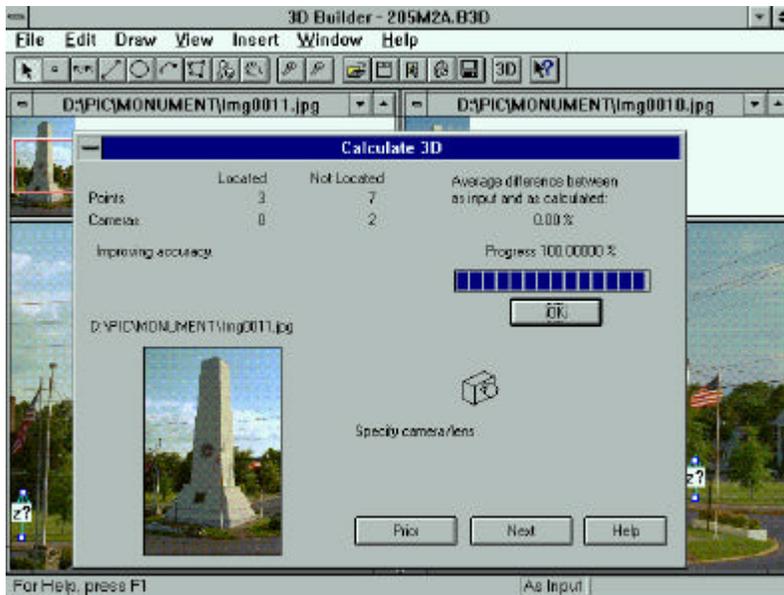


Figure 112 Calculate 3D Progress Reporter Dialog Box

Toolbar/ Help Tool



Help Tool

The help tool appears as a diagonal arrow and question mark on the toolbar. Clicking on the context sensitive help tool allows you to access on-line information from the help files to help you in answering questions or clarifying details. Move the help tool icon over an area in question and click on the left mouse button. This opens up the help information about that section and provides you with more information.

New Independent mini-toolbars

Display mini-toolbar:

3D Builder has added new, independent, mini-toolbars to control what you see on the image. You may now turn off the visible display of points, lines, curves, and faces from the toolbar. This mini-toolbar is independent from the main toolbar and may be docked anywhere on your screen.



Points Lines Curves Faces
 Display Mini-toolbar icon buttons

Circles mini-toolbar:

3D Builder has added new, independent, mini-toolbars to the new circle/arc tool. This mini-toolbar is independent from the main toolbar and may be docked anywhere on your screen.



The circle/arc mini-toolbar is explained in greater detail in the chapter on circles.

Curves mini-toolbar:

3D Builder has added new, independent, mini-toolbars to the new curve tool. This mini-toolbar is independent from the main toolbar and may be docked anywhere on your screen.



The curve mini-toolbar is explained in greater detail in the chapter on curves.

Extrusion mini-toolbar:

3D Builder has added new, independent, mini-toolbars to the new extrusion tool. This mini-toolbar is independent from the main toolbar and may be docked anywhere on your screen.



The extrusion mini-toolbar is explained in greater detail in the chapter on extrusions.

Changes in the line mini-toolbars:

Flip Line/Curve Sense Tool:

3D Builder has added a “Flip Line/ Curve Sense” tool to the “Line” toolbar. You can now change the direction of a line by using the “Flip Line/ Curve Sense” tool, thus eliminating the need to double click on the line to bring up the “Line Properties” box. Now the direction of the line can be changed directly from the toolbar with a single click. This is done *after selecting* the line with the “Selector” (arrow) tool. The “Line Flip” tool *only applies to axis lines* (lines that have been designated as being along one of the axis planes.)



Hint: Remember, a line can have three states: one direction, the other direction, or a third state which is “no direction” or the questionable state in which you do not which direction the line is.

It is very important that you mark the direction of each line. Because if you get a line, even one line, that is going in the wrong direction, the calculations can suffer drastically!

Note: With the creation of curves, this line direction is also very important. If you want to merge curves (saying that this curve in image “a” is the same as this curve in image “b”) you need to be sure the curves are going in the same direction. Use the “Flip Line/ Curve Sense” tool to change the “sense” or “direction” of the curve. *You need to do this before merging the curve.* After you merge the curve, flipping the direction of the curve will flip both curves.

Object and Material Assignment from the Toolbar

“Setting the object” to which lines and faces belong or “assigning the material” for faces may be done *directly* from the toolbar by simply selecting the desired lines and/or faces and then selecting the object and/or material from the “combo boxes” in the toolbar. This is faster than double clicking on the line and/or face and selecting the object or material from the line or face property window. Both combo boxes show a “blank” box as the “default” position.



WORKING WITH PHOTOGRAPHS

Working with photographs is a key component in **3D Builder**. The program works with all important sources of images.

Getting Images Onto Your Hard Drive

3D Builder can use images from many sources, including 35mm cameras, digital cameras, video cameras, scanners and from Photo CD directly. Although there are many models of each type available, the program works to integrate the many different ways of accessing image information. Each source has advantages and disadvantages, ranging from price considerations to length of turn-around time for processing images.

Importing File Formats

3D Builder offers you flexible and high performance in working with file formats for your photographs. **3D Builder** provides a set of components that can accept over 36 different file formats into the program. The following formats can be imported into **3D Builder**:

TIFF	JPEG	PCX	TGA	DIB	DCX
GIF	GMP	WMF	PICT	WPG	EPS
KFX	RLE	LV	CALS	G3	G4
ATT	CLP	XWD	IMG	IFF	SUN
XBM	ICO	ICA	GX2	XPM	ASCII
CUT	BRK	MAC	MSP	PSD	PCD

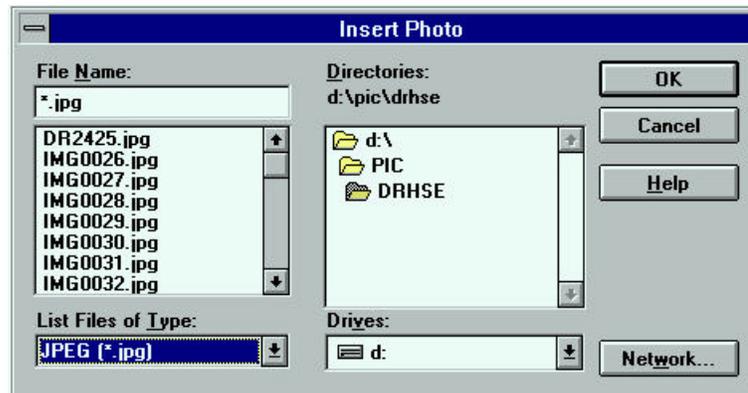
3D Builder provides the key components to read Photo CD directly. There is no need to convert the files to another format.

Adding Photos to a Project by “Inserting” them in a Project



You may add photos to a **3D Builder** project by the menu or by the toolbar icon. Click on the “**Insert**” menu, “Add Image to Project” command. The insert photo tool, which appears as an opened file folder on the toolbar, is used to add a new image or photograph to the project. Or use the “**Insert**” shortcut key on your keyboard.

Clicking on the insert photo tool opens up the “**Insert Photo**” dialog box and allows you to add a new photo image from your selected file and directory.



- Select the file name by clicking on it from the file list..
- Choose the type of file from the “List files of type” drop down list box.
- Choose the directory of your choice.
- Select the drive from the “drives” drop down list box.
- If you were accessing the file from a network, you would click on the “Network” button. This would bring up the standard windows browser for files.
- To accept the currently selected item, click on “OK”
- To return to the main screen, click on “Cancel”.
- If you need to access the help engine, click on “Help”.

Add Images All At Once To Your Project.

One way of saving time is to add several images at once to your project.

You can “**multi-select**” images to add to your project in the same way as you would multiple select files for any Windows program. This method will vary depending on whether you are using Windows 95, or Windows NT.

File Menu/ Add image to Project

3D Builder has added a file menu item for adding an image to the project. Click on the File menu, “Add image to Project”.

Add New Window And More Photos

The “**New Window**” command opens a new window. It is used to create a space (window) for the new image. The “New Window” tool icon appears as a miniature window box on the toolbar. The “New Window” command is also available by



choosing the “Window” command and then selecting “New Window”. The “New Window” command creates a new image window and chooses a photo that is not being displayed to be shown in the window. To choose a different image to be displayed in the new window, choose the “View” menu “Select image” command.

Manipulate The Image On The Main Screen

Resize it by moving splitter bar

You can resize the image on your screen by moving the splitter bar in an upwards direction. Move your mouse to the upper line of the large image on your main viewing screen. When the pointer cursor changes into a double line, click, drag and release the left mouse button to enlarge the main image.

The Pan Tool



Pan Tool

The pan tool, which appears as a hand on the toolbar, scrolls the image. The image may be scrolled both vertically and horizontally at the same time. Clicking on the tool icon activates this tool. You may also access “Pan” by right mouse clicking in an open area of the screen. Then choose “Pan”. Additionally, you may also access “Zoom In” by selecting the “View” menu, and selecting “Zoom In”.



Zoom Tool

View/ Zoom

The “Zoom” command allows you to magnify the entire image for closer examination.

The Zoom In Tool



Zoom In

The zoom in tool appears as a magnifying glass with an inset plus sign on the toolbar. Clicking on the tool icon activates this tool. Use the zoom in tool to expand the view size. The image itself is not affected by this tool. It allows you to zoom in on a detail. You may also access “Zoom In” by right mouse clicking in an open area of the screen. Then choose “Zoom In”. Additionally, you may also access “Zoom In” by selecting the “View”, and selecting “Zoom In”.

The Zoom Out Tool



Zoom Out

The zoom out tool appears as a magnifying glass with an inset minus sign on the toolbar. Clicking on the tool icon activates this tool. Use the zoom out tool to zoom out to contract or shrink the view size. The image itself is not affected by this tool. It allows you to zoom out to take in the “big picture” of a segment of the image. You may also

access “Zoom Out” by right mouse clicking in an open area of the screen. Then choose “Zoom Out”. You may also access “Zoom Out” by selecting the “**View**” menu, and selecting “Zoom Out”.

Enlarge an area of the image in the Splitter thumbnail

You can quickly and easily zoom in to enlarge any area of the image in the main viewing window by choosing the desired area in the thumbnail window image near the top of your screen. Zooming in on a section of the photo is done by moving the cursor into the thumbnail image in the upper section of the active window. Click, drag and release to form a “bounding box” around the desired area. This action will enlarge and zoom in on the selected region of the photo.

Properties

The “Properties” command is available under the “**Edit**” menu by choosing “Properties”. You may also access “properties” by right mouse clicking in an open area of the screen. The “Properties” command opens up a tabbed page. Choose “Image”, giving you the options of the following:

- **Contrast/Brightness** Use this tool to lighten, darken, or sharpen the contrast of the image for optimum viewing.
- **Negative** Use this tool to “invert” the image properties (what was black is now white). This tool may be used to improve or sharpen the contrast for optimum viewing.
- **Rotate** Use this tool to turn the image by 90 degree increments. Clockwise is the direction. Each left mouse click rotates the image 90 degrees clockwise. This tool may be used to improve viewing range.
- **Filter** Use this tool to help increase the visibility of the lines.
- **Orientation** Tells you which way the camera was positioned when you took the picture.
- **Photo CD Size** This button lets you choose the size resolution of the Photo CD image.

Resize the Image Window using the Maximize/Minimize Boxes

Use the Windows maximize or minimize buttons to enlarge or reduce the image window. The frame around the window is also used to resize the window.

Close The Image

The “Close” command closes the active image. Closing the project frees the memory that was used by the project. If the project contains unsaved information, **3D Builder** will display a confirmation message box. When the confirmation message box appears, choose

- “Yes” to save changes
- “No” to discard the changes
- “Cancel” disregards the Close command.

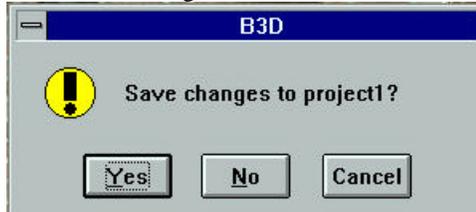


Figure 113 Close Command Dialog Box

Working With Multiple Images

How many images at a time?

You may work with one image at a time on the main viewing screen or you may work with any desired number of images at one time. **3D Builder** will allow you to automatically work with as many images at once as you wish. Each time you choose “New Window” from the “**Window**” menu, a space is created for the new image.



Cascade

The “**Cascade**” command overlaps the open image windows diagonally in the creation order. You may access “Cascade” by selecting the “Window”, and selecting “Cascade”.

Tile

The “**Tile**” command spaces the screen with open image windows and adjusts sizing to fit the available space in the window. You may access “Tile” by selecting the “Window” menu, and selecting “Tile”.

Take one or more images down to an icon

Each image may be reduced to an icon by clicking on the Windows “Minimize” button located in the upper right hand corner of each image window. The image is enlarged again by clicking on the icon near the bottom of your screen.

Close One Photo

You may close any image at any time by clicking on the Windows Close caption button located in the upper left hand corner of the image Window.

Resize one image

You can quickly resize an image by moving your mouse to the line separating the images horizontally on your main viewing screen. When the pointer cursor changes into a double arrow, click, drag and release the left mouse button to resize the desired image.

Image Select Viewing Window Tool

Select Image
List tool icon



The “Select Image List” tool appears as a filmstrip viewer on the toolbar. Clicking on the tool icon activates this tool. Use the “Select Image List” tool to bring up the “Select Image” dialog box which gives a list of images in your project. The list gives both a thumbnail sketch of the image, the file name of the image, and the drive and directory of where the image is being stored on your hard drive. The image itself is not affected by using this tool. The “Select Image” Dialog Box may be closed using the close caption bar. It may also be resized or move about your screen as any other dialog box in **3D Builder**. You may also access “Select Image List” by right mouse clicking in an open area of the screen. Then choose “Select Image”. You may also access “Select Image List” by selecting the “**View**” menu, and selecting “Select image”.



Figure 114 Select Image List Dialog Box



Project Tree

The Project window is the **3D BUILDER** "control center" for the project files. While a project window is open, the Project Window is displayed, showing the files contained in the project. You can have only one project open at a time. The Project window shows a tree control system, including branches to view the camera stations and images in the project. Click on the "Project Tree" button icon from the toolbar **OR**

- From the "**Window**" menu, choose "Project".
- Expand the project control tree to show the "Stations/Photos" branch.
- **Stations/Photos** Gives a list of the camera stations and individual photos identified in the project. Click on the + sign to expand the tree control level.
- Click on camera stations, click on the photo brings up the image as the active window on main viewing screen.

Delete a Photo from a Project

You may delete a photo from the project from the "Project Window".

- From the "**Window**" menu, choose "Project".
- Expand the project control tree to show the "Stations/Photos" branch.
- **Stations/Photos** Gives a list of the camera stations and individual photos identified in the project. Click on the + sign to expand the tree control level.
- Click on camera stations, select the photo and click on the "Delete" key.

Saving A Project And Re-opening It Next Time



Use the “Save” tool to save a project. The save tool, which appears as a computer floppy disk on the toolbar, allows you to quickly save active data to the hard drive. If this is the first time you have requested to save the project, the “Save As” dialog box will appear, allowing you to select the drive, directory, file name and type of file. The “Save As” command saves the active file using a new name, file type, directory and drive.



Figure 115 Save As Dialog Box

Summary

Working with photographs will become very comfortable for you within a few projects. There are a lot of capable tools and rich features in the program to help you. **3D Builder** allows you a lot of flexibility in image management.

EXPORTING YOUR

3D BUILDER PROJECT

Introduction

Exporting a good 3D model is the primary goal of **3D Builder**. Offering you a variety of export file formats helps accomplish this goal. **3D Builder** will allow for a seamless integration with the family of rendering, animation, CAD, or the Internet Web choices. In most cases, all you will need to do is open your rendering, CAD, or animation program and choose the “Import file” command. The **3D Builder** export files transfer all of the key components of your 3D model.

Export File Formats

3D Builder can export the following file formats:

- **DXF** Data Exchange Format, used by many CAD packages, including AutoCAD 3D. **(Both Pro and PowerLite)**
- **3D Studio** File format **(3D Builder Pro Only)**
- **IGES** Initial Graphics Exchange Specification, used by many mechanical CAD packages. **(3D Builder Pro Only)**
- **Wavefront** **(3D Builder Pro Only)**
- **Inventor** **(3D Builder Pro Only)**
- **VRML 1 & 2**, Virtual Reality Modeling Language, used by the Internet Browsers. **3D Builder** allows you to harness the power of the Internet. Exporting the VRML .wrl file will allow your model to be taken directly to the Web. This also allows you to quickly introduce 3D elements on your Web pages, evolving them from static pages. **(Both Pro and PowerLite)**
 - **STL** Stereo Lithography (used in rapid prototyping machines) **(3D Builder Pro version only)**



Beginning The Export Process

To begin the Export of your 3D model, make sure you have **calculated it** by clicking on the “Calc” tool icon accessed via the toolbar ribbon or by selecting “Calculate 3D” under the “**File**” menu. Then select “Export” under the “**File**” menu.

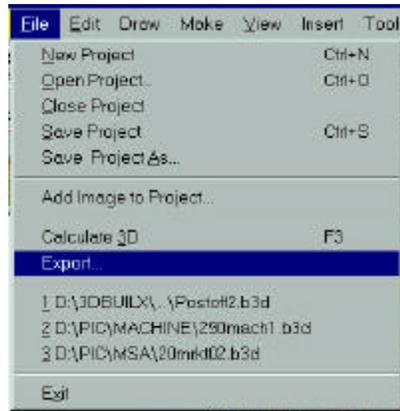


Figure 116 The "Export" menu command is accessed via the File menu

Clicking on the "Export" command under the "File" menu opens up the "Export Options" tab page allowing you to quickly choose where to export the files or project.

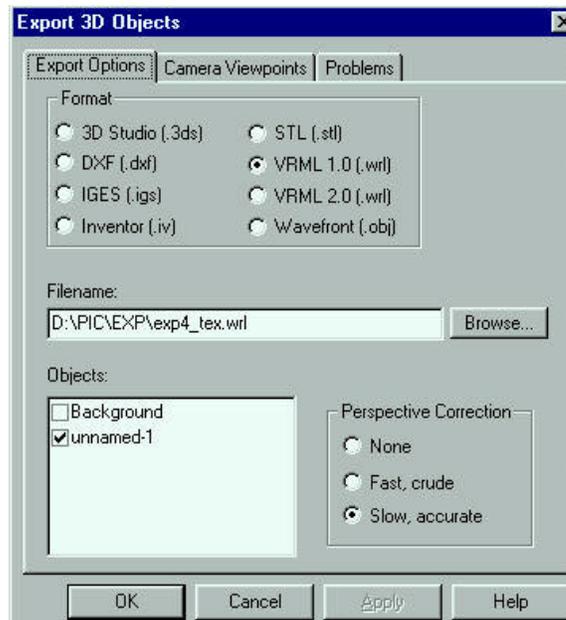


Figure 117 The "Export" Options tab page

The Export Options Tab Page provides details for you to make choices concerning the file to be exported.

- In the Section labeled format, choose the type of file format to be exported. Simply click on the radio box to the left of the desired format.
- Under “File name”, choose the selected file name, directory and drive or click on the button labeled “Browse”. This action will open up a standard Windows browser to select drive, directory and file name.
- Under “Objects”, choose the objects you would like to have exported. Make sure that at least one object is checked. The default object is “unnamed-1”.

Problem Reporter

If there appears to be a problem with exporting the desired file format file in 3D Builder, a tab page labeled “Problem Area” will appear upon the selection of “Export”. The problem is identified for you and explained. You may choose to return to your project and correct the problem. Or you may choose to continue on with the export procedure.

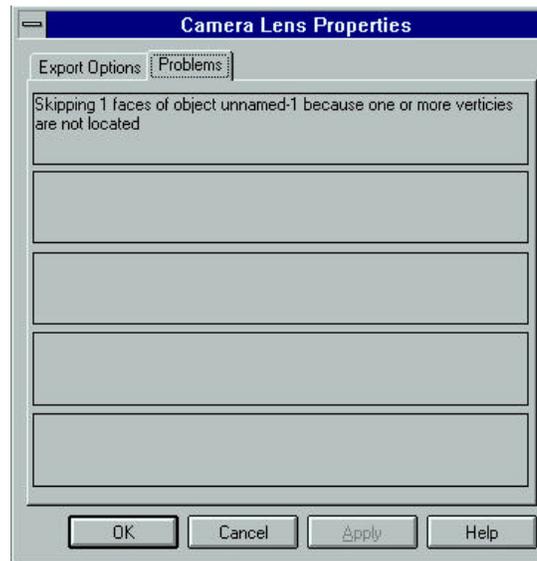


Figure 118 "Export" Problems Tab Page

Texture Exporting



Texture maps are also exported with the files and these are automatically corrected for perspective distortions. Automatic corrections are in **3D Builder Pro Only**.

3D Studio, Inventor, VRML (Both Pro and PowerLite), and Wavefront export files will include references to texture maps if the objects are textures. That is the export files will

have the texture file name embedded in the file in one or more places, and perspective corrected texture coordinates will be contained in the file.

You will need to copy the texture map images that you have previously created with the “**Draw**” menu texture map command to whatever directory is required by whatever rendering tool package (3D Studio, VRML browser, etc.) you plan to use. When you select “OK”, the texture map image file will be created and saved to disk at the location indicated. You will need to remember this location when you export files to other rendering programs. You may need to move or copy the image somewhere else, particular if you need to copy and export the project file to another machine for a rendering program. You will need to make sure you copy the texture map files at the same time. **3D Builder** does not automatically do this for you.

COLORS, MATERIALS, TEXTURE MAPS

Overview

3D BUILDER uses the same metaphor as most rendering programs. The color, texture, and other visual attributes of the faces are defined by “material”. A small starter set of materials is supplied with **3D BUILDER**. All faces are assigned to an object. Materials (colors or texture maps) are applied to objects and faces. If a face does not have a material assigned, it will, by default, use whatever material was assigned to its object. Colors can be picked from a list of “material colors” or new colors can be made by either “setting” or “picking” a color off the image.

If a texture map is to be used as the material, the texture map is “cut” out of the image and saved as a small **.BMP** and a **.JPG** file and is associated with the material name. If possible, **3D BUILDER** recommends the use of a naming convention that is closely related to the object. For example, if the front of a building makes up an object named “FRONT”, name the material “FRONT” and name the bitmap “FRONT.BMP”.

JPEG Texture Maps

3D Builder now saves texture maps as both **.BMP** and **.JPG** files. The **.BMP** file is required for the 3D Builder “**3D Preview window**”, accessed via the “**Window/3D Preview**” menu, and may be exported to 3D Studio and other modeling programs. The **.JPG** file is used for VRML and Inventor exports. The **.JPG** file is much smaller which is one reason that it is the preferred standard for VRML. Valid filenames must be given for both the **.BMP** and **.JPG** files. **3D Builder** will generate default names using the directory the project **.B3D** file is in and the name of the material to which the texture is assigned. 8 character filenames work best, especially if you are using 3D Studio.

If you have edited the **.BMP** file with a paint program, be sure to go back to the texture map properties window (accessed from the “**Window/Project**” menu) and select the “Refresh” button to regenerate the **.JPG** file.

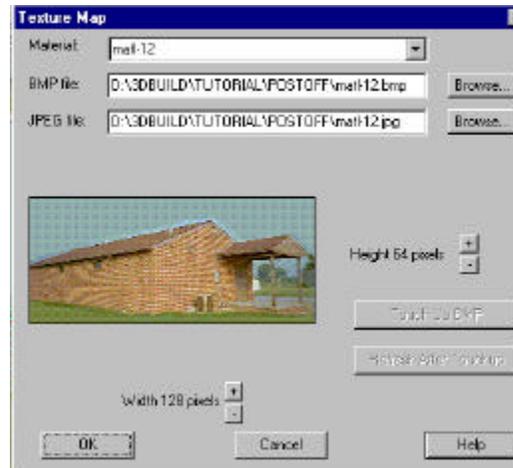


Figure 119 Texture Map Dialog Box.

Functions

Texture is associated with “materials”.

Creating materials with the “Insert” menu command.

1. From the “Insert” menu, choose “Materials”.
2. Give the material a name.
3. Choose to create a texture or set a color from the “Materials” box.

Creating texture maps with the “Texture Map Tool”.

1. From the “Draw” menu command, choose “Texture Map”.
2. From the “Materials” list, choose a material from the drop down list box.
3. Click, drag and release to form a rectangle encompassing the portion of the image that is wanted for the texture map.
4. This brings up the “Texture Map” dialog box.
5. Set the desired pixel size from the spin control arrows.
6. Hit “OK” to save it as a .BMP and a .JPG file.

Creating a texture map from the photo.

1. From the “Insert” menu, choose “Material”.
2. From the “Materials Property Box”, give the material a name.
3. In the texture map section of the material box, choose “New”.
4. In the image, click, drag, release a rectangle encompassing the portion of the image that is wanted for the texture map.



5. Click on “OK” to give the cropped texture file a name and it is automatically saved it as a .BMP and a .JPG file.

Assigning a material to a face.

1. Double click on the face to bring up the “Properties Box” for that face.
2. Select material from the “Materials” drop down list box.

Setting or changing a material for an object from an image window.

1. Use the right mouse button and click somewhere over the object.
2. Select “Properties” from the pop-up menu. This action brings up the object properties box.
3. Select material from the drop down list box.

Setting a material for an entire object from the “Project Window”.

1. From the “Window” menu, choose “Project”, bringing up the “project window”.
2. Open the “Objects” branch.
3. Double click on the desired object. This action brings up the object properties box.
4. Select material from the drop down list box.

Setting the colors of materials from the “Project window”.

1. From the “Project window”, choose “Project”.
2. Open the “materials” branch, choose “materials” from there.
3. Double click on a material brings up the “Material Box” and edit the colors.

Setting the colors of a material from an image window.

1. Colors for that material may be lifted from one of the images using the “Draw” menu.
2. Selecting “Pick Color” or by using the “Eye Dropper” icon from the toolbar. The “Eyedropper” tool is used to pick a color directly from the image.

Touching Up Textures

With **3D Builder**, you can edit or touch-up textures. **3D Builder** can launch whatever “Paint” program is registered in your “Windows” directory. Select the “**Edit**” menu, then choose “Material Properties”. This action brings up the “Material” dialog box, which should contain a thumbnail of the texture map in the “texture map” section near the bottom of the dialog box, as shown on the following page.

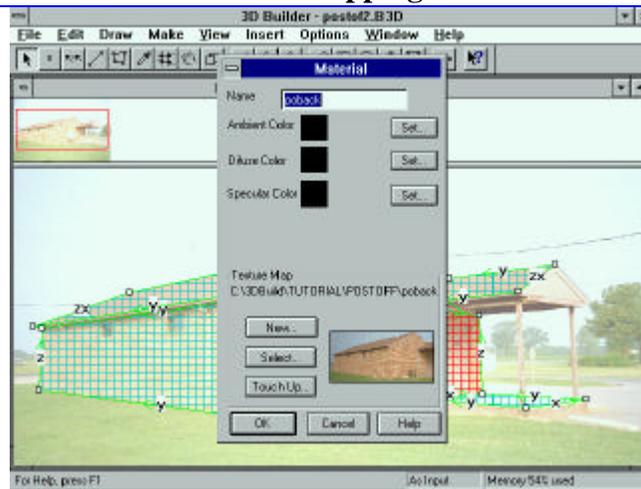


Figure 120 Edit Material Properties Dialog Box

Clicking on the button marked “Touch Up...” in the texture map section of the “Material” dialog box will automatically take the texture to whatever program has been “registered” or associated in Windows as the tool for .bmp files (Example, Microsoft Paint). This action also brings up an “Information Box” with a reminder **NOT** to resize the texture image in your paint program.

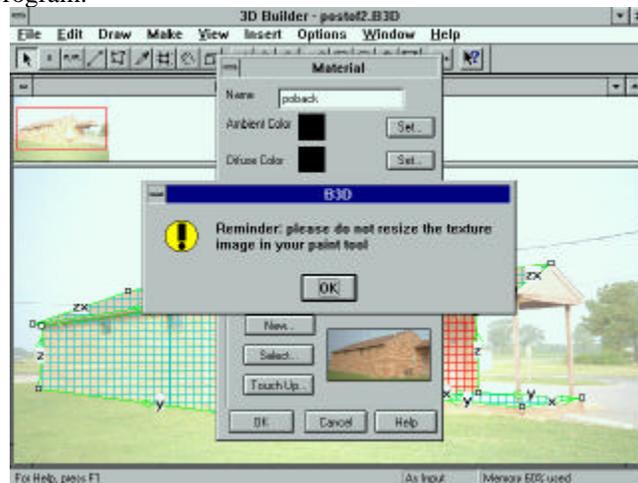


Figure 121 Information Box

Clicking on the “OK” button in the information box launches the “Paint” program, as shown:



Figure 122 Editing through the Paint Program.

- Use the tools in your Paint program to zoom in, select colors, erase portions and perform other types of editing operations on your texture.
- Save the touch-up work. Exit the paint program by clicking on “Exit”.
- This action closes the Paint program and returns to the main screen of **3D Builder**. The “Materials” dialog box is still active on your main viewing screen. Click on “OK” to close this dialog box.

Reviewing the Touch-Up Texture Map

To review the touched-up texture map, go to the “**Window**” menu and select the project file. This action reopens the “3D Preview” window and displays the texture map as it is “glued” to the 3D model.

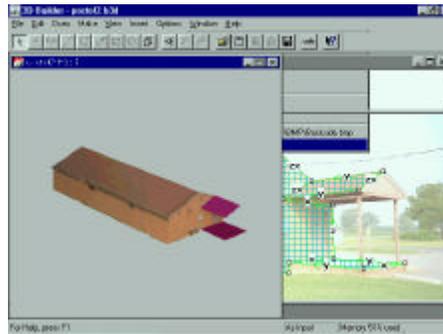


Figure 123 3D Preview window with textures touched up in Paint program



Note: If the changes are not displayed on your screen, close down the “3D Preview” window and reopen it to “refresh” your screen.

Exporting Textures



3D Studio, Inventor, VRML*, and Wavefront export files will include references to texture maps if the objects are textures. The export files will have the texture file name embedded in the file in one or more places, and perspective corrected texture coordinates will be contained in the file. You will need to copy the texture map images that you have previously created with the “**Draw**” texture map command, to whatever directory is required by whatever rendering tool package (3D Studio, VRML browser, etc.) .

When you select “OK”, the texture map image file will be created and saved to disk at the location indicated. You will need to remember this location when you export files to other rendering programs as you may need to move or copy the image somewhere else. This is especially important if you need to copy and export the project file to another machine for a rendering program. You will need to make sure you copy the texture map files at the same time. **3D Builder** does not automatically do this for you.

*VRML export available for both **3D Builder** Pro and PowerLite versions.

Perspective Correction for Texture Maps

By default **3D Builder** applies perspective correction to the 3D Preview window and to all exported 3D models. This improves the visual quality of the 3D models but does increase their size. You may choose a lower quality perspective correction or you may turn off perspective correction altogether. The option is selected from the “Options” tab in the “Export” window, which is activated from the “**File/Export**” menu.

The options are:

- no correction
- fast, but crude correction
- slow, but accurate perspective correction (Pro version only)

If you want to change the perspective correction for the 3D Preview window but do not need to do an export, use the “**File/Export**” menu command, set the option, then select “Cancel” from the Export window—the perspective correction option will be remembered even though Cancel has been selected.





This chapter applies to Pro Version Only

Chapter

11

CONSTRAINTS

Introduction

Constraints are relationships that help in the “Calculate 3D” process. Constraints are used to help the appearance of the model. A constraint acts as a “hint” to the “Calculate 3D” command. Constraints do not go into effect until you hit the “Calc” tool or “Calculate 3D” under the “File” menu. The program will then attempt to “satisfy” every constraint in the model.

3D BUILDER gives you the option of several constraints. These are all located under the “**Make**” menu of the main program screen. The constraints include:

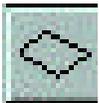
- Make CoLinear
- Make Coplanar
- Make Equal Length
- Make Parallel
- Make Perpendicular

Functions

Constraints are all selected in the same manner, which is described in detail below. Once selected, each constraint appears in the “Project Window. Clicking on the “constraint” branch in the project window will take you directly to the selected constraint.

Make CoPlanar

CoPlanar means lying in the same plane. To declare that a point is coplanar with other points and/or faces, do the following:



1. Select a point by clicking on it. The point will highlight.
2. Next, while holding down the “Shift” key, select the other points of faces which share the same plane. These will also highlight.
3. Choose the “**Make**” menu, then select “Coplanar”.
4. The result of this action is that all of the selected (highlighted) points and faces will be constrained to be coplanar to one another.

5. If you were to edit one of these points by double clicking on it to bring up the “Point Dialog Box”, a checkbox would be checked indicating that the point is coplanar to others.

Make Equal Length

To declare that a line is the same length as one or other lines, do the following:

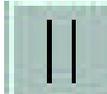
1. Select the line by clicking on it. The line will highlight.
2. Next, while holding down the “Shift” key, select the other line (or lines) which share the same length. These additional lines will also highlight.
3. Choose the “**Make**” menu, then select “Equal Length” by clicking on it.
4. The result of this action is that all of the selected (highlighted) lines are now constrained to be of equal length to one another.
5. If you were to edit one of these lines by double clicking on it to bring up the “Line Dialog Box”, a check box would be checked indicating that the line is of equal length to others.



Make Parallel

Parallel means going in the same direction at the same distance apart. To declare that a line is parallel to another line, do the following:

1. Select the line by clicking on it. The line will highlight.
2. Next, while holding down the “Shift” key, select the other lines which are parallel. These additional lines will also highlight.
3. Choose the “**Make**” menu, then select “Parallel” by clicking on it.
4. The result of this action is that all of the selected (highlighted) lines are now parallel to one another.
5. If you were to edit one of these lines by double clicking on it to bring up the “Line Dialog Box”, a check box would be checked indicating that the line is parallel to others.



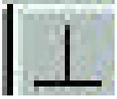
Make CoLinear

Colinear means lying in the same line. If several points and/or lines lie along the imaginary extension of a single line, then you should select these and use the “Make Colinear” constraint to force the calculate command to snap these lines and/or points to all lie along a single extended line in space To declare that a point is colinear with other points and/or lines, follow the same steps as above.



Make menu/Perpendicular

3D Builder has added a file menu item for indicating that two or more lines are perpendicular to each other.



1. Select the line by clicking on it. The line will highlight.
2. Next, while holding down the “Shift” key, select the other lines which are perpendicular. These additional lines will also highlight.
3. Choose the “**Make**” menu, then select “Perpendicular” by clicking on it.
4. The result of this action is that all of the selected (highlighted) lines are now perpendicular to one another.
5. If you were to edit one of these lines by double clicking on it to bring up the “Line Dialog Box”, a check box would be checked indicating that the line is perpendicular to others.

Constraint Project Tree

All constraints can be viewed from the “Project tree”, under the “**Window**” menu. Select “**Project**” from the “Windows” menu. Click once on “Constraints” to expand the tree. Clicking once on the individual constraint will highlight the points, lines and/or faces constrained. Double clicking on the constraint in the project tree will bring up a constraint properties window.



This chapter applies to Pro Version Only

Chapter

12

CIRCLES and ARCS

3D Builder Pro features new tools for circles and circular arcs. **3D Builder's** new circle tool lets you model real world circles without having to have reference targets along the circle. Without the "circle tool", these objects would be very difficult to model.

Introduction

The "circle" tool is used to create three dimensional circles and circular arcs. An object that is a circle in the real world usually appears as an ellipse in a photograph unless the picture has been taken in a "straight on" camera station position.

Circles are always in a plane and the default plane is "skew" in **3D Builder**. Otherwise, if the circle is in one of the three coordinate planes (Like horizontal on the ground and in the "XY" plane, for example) you only have to locate the circle in one image. You will need to locate the circle or circular object in two or more images and then "merge" the circles just as you "merge" points in different images.

Draw Menu/ Circle Tool



The Circle tool can be accessed from the "Draw/Circle" menu or from the "Circle Tool" icon located on the toolbar. Located under the "Draw" menu, each menu item is activated by clicking on it.

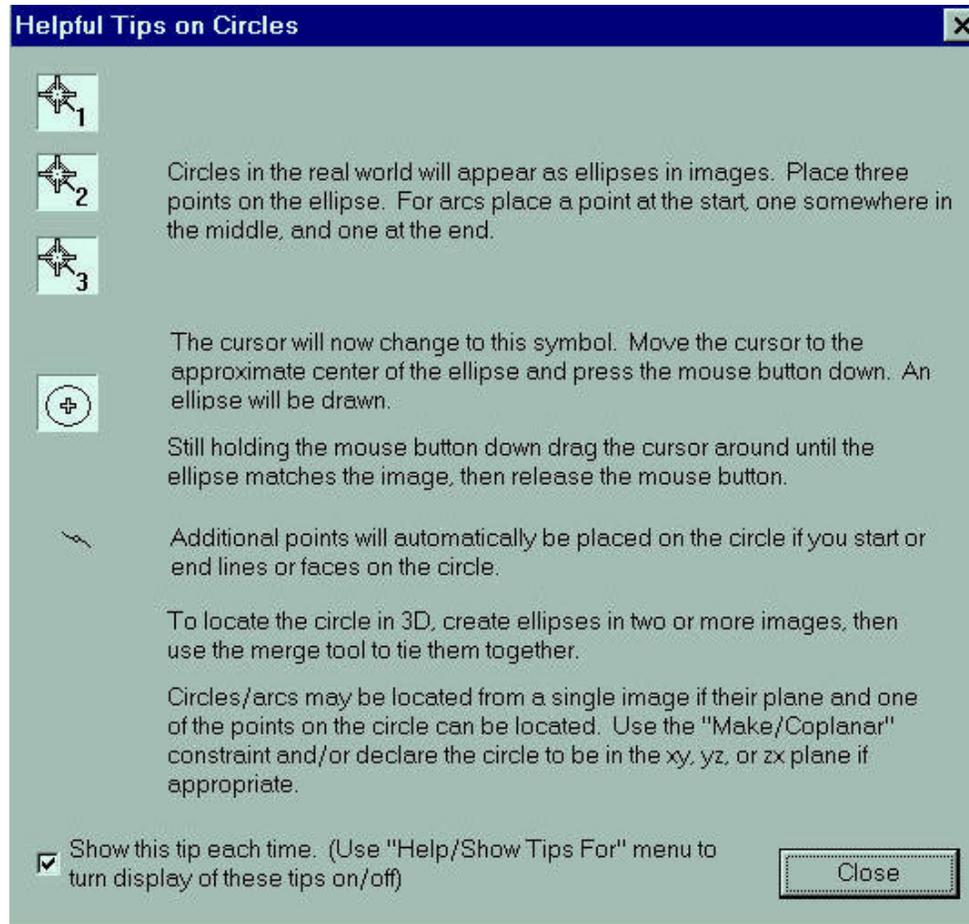
Clicking on the "Draw/Circle" menu item or the "Circle Tool" icon located on the toolbar will activate the "Circle Tool" mini-toolbar, giving you a choice of the type of circle to be created and the plane of the circle, as shown below:



“Just-In-Time” On-Screen Helps for the Circle Tool

The first time you choose the “Circle Tool”, the “Helpful Tips on Circle” window appears on your main viewing screen. It gives an explanation of the process used in creating a circle. There is an option to turn off “Show Tips for Circles” in the “Helpful Tips” window in the lower left corner of the window.

To turn the “Show Tips for Circle” window back on and make it come up on your viewing screen again when you choose the “Circle Tool”, go to the “Help” menu. Choose the “Show Tips for” menu item, then choose “Circles”.



How the Circle Tool Works

Choose the type of circle you want to create. **3D Builder** gives you a choice between a full circle (closed) or a circular arc (open circle or partial circle). Click on either the circle tool or the circular arc tool from the mini-toolbar.



Full
Circle



Circular
Arc

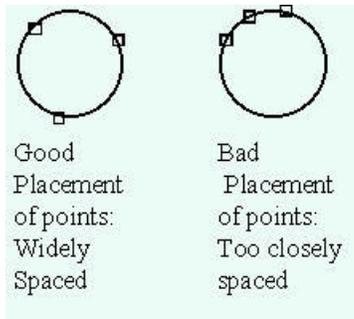
Next, if you know the plane of the circle, indicate this by clicking on one of the plane indicator icon buttons. The default is “skew” plane.

Drawing a Full circle



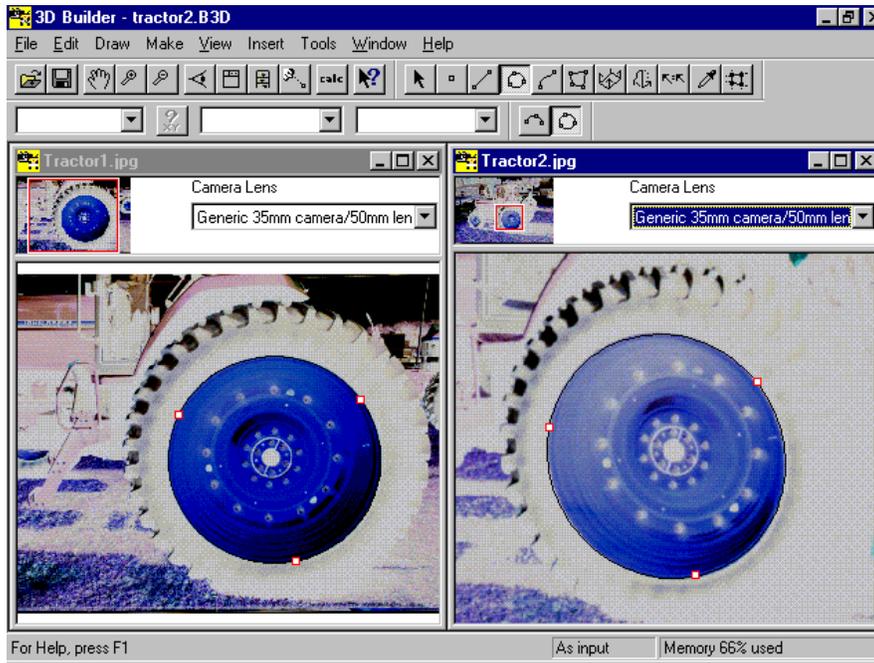
(Closed circle):

Making a full circle takes four mouse clicks. First, place three widely spaced points around the circle.



After the 3rd point, the cursor changes to a special symbol for “Circle center”. (The next action will be a “button down, move, button up” operation.) Looking at the image, decide where you think the center of the circle is. Click there with the left mouse button on the center of the circle. While holding down the left mouse button, drag the center of the circle until the visual display of the circle mostly closely matches the circle on the image. Then release the left mouse button and the circle is created on your image. The center of the circle appears as an “x” mark on your image.

Note: The circle is completed with the “mouse up” action.



At this point, you can continue making more circles, or, go back to the toolbar and select a different tool or another operation.

Locating the Circle in 3D from two or more images:



Locating the circle in 3D space requires creating circles (or ellipses) in two or more images and then, using the “Merge” tool to tie the circles (or ellipses) together.

Locating the Circle in 3D from a single image:

Circles (ellipses) and circular arcs can be located from a single image *if their plane and one of the points on the circle (ellipse) or circular arc can be located*. If the circle was in the “XY”, “YZ”, or “ZX” plane, then you only need to locate it in one picture *if at least* one point on the circle (or the center of the circle) can be located. If you created the circle as “skew” and then wish to change it to a plane, select the circle with the arrow tool. It will highlight. Then click on the appropriate plane in the “select circle” tool bar.

Placing Additional Points on the Circle:

Additional points will automatically be placed on the circle if you start or end a line or a face on the circle. Double clicking on the point will bring up the “Point Dialog Tab Page” and will show the

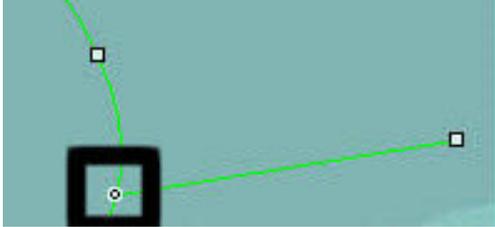
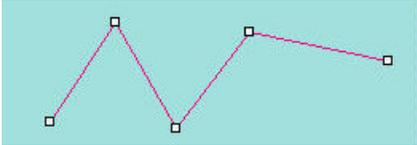


Figure 124 A point which starts or ends on a curve or circle are a different shape. Note regular points above and to the right of the circle point. The dark box has been added for emphasis in this manual and does not appear on your screen.

Polyline Tool:



The “Polyline Tool” lets you create multiple lines, one right after another. This is a timesaving feature when you need to make a lot of lines. To access the “Polyline” tool, select the “Line” tool. The “Line” tool mini-toolbar buttons appear on your screen. The “Polyline Tool” is activated by clicking on the “Polyline” tool button icon on the “Line tool mini-toolbar”. Click on the desired end point location, then draw the line. Click again to end the line. Then upon the next click, another line will be started, as shown:



Drawing a Circular Arc (Open Circle):



Drawing a circular arc is identical to drawing a full circle except that you click on the “circular arc” button on the toolbar. The first point is the circular arc “start” and the third point is the circular arc “end”.

Editing a Circle or Circular Arc

You may edit a circle or a circular arc at any time. Select the “Selector Tool” (Arrow tool) and select a point on the circle. Then click, drag, and release the left mouse button to fine tune points or the circle.

Exporting a Circle or Circular Arc

To export the circle, you will need to either put a “face” or a set of “lines” around the circle. If you use the “polyline” tool or the “multi-point” face tool, the circle will automatically be faceted into a series of small, straight lines.

Texturing a Circle or Circular Arc

To texture a circle or circular arc, you will need to first create a “face” on the circle using the “multi-point” face tool. If you just click twice on a point on the circle, **3D Builder** will automatically put a face on the circle. This face can then be textured using the “Draw Texture” tool.

Useful Notes on the Circle Tool

1. The movement of the circle center cursor is an exaggerated movement. The location of the circle center will most likely *not* be the visual center of the circle.
2. Remember when choosing the circular arc to declare the “plane” of the arc.
3. Be sure to check the direction of your circles *before* merging the circles. Before you merge the circles, you can use the “line flip” tool to change the direction of the circle so that both circles are going the *same direction*. If you have one circle going one direction and the other circle going the other direction and you merge them, the line flip tool cannot correct the direction.

Free-Form Curves

Bezier Spline Curves



This chapter applies to Pro Version Only

3D Builder features new tools for free-form (Bezier spline) curves. Many objects in the real world are composed of curved surfaces. Using the new “free form curve” tools lets you model shapes without the extensive use of reference targets. Without these curve tools, curves would be very difficult to model.

Introduction

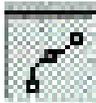
The “curve” tool is used to create any type of curve. You can create an “Open Curve” or a “Closed Curve”. Also, you can create a curve that is “flat” and in one plane or a curve that is not in a plane.

If the curve is flat and in one of the three coordinate planes (xy , yz , or zx), then it may be located from a single image. Otherwise, the curve needs to be modeled in two or more images.

The creation of a curve is different from the creation of a circle in that (1) the curve *does not get created* until you click on the “OK” button on the curve mini-toolbar button and (2) the curve may be created in two or more images at the same time, eliminating the need to “merge” the curves.

Caution: Non-Planar curves are not very stable. 3D Builder recommends the use of planar curves.

Draw Menu/ Curve Tool



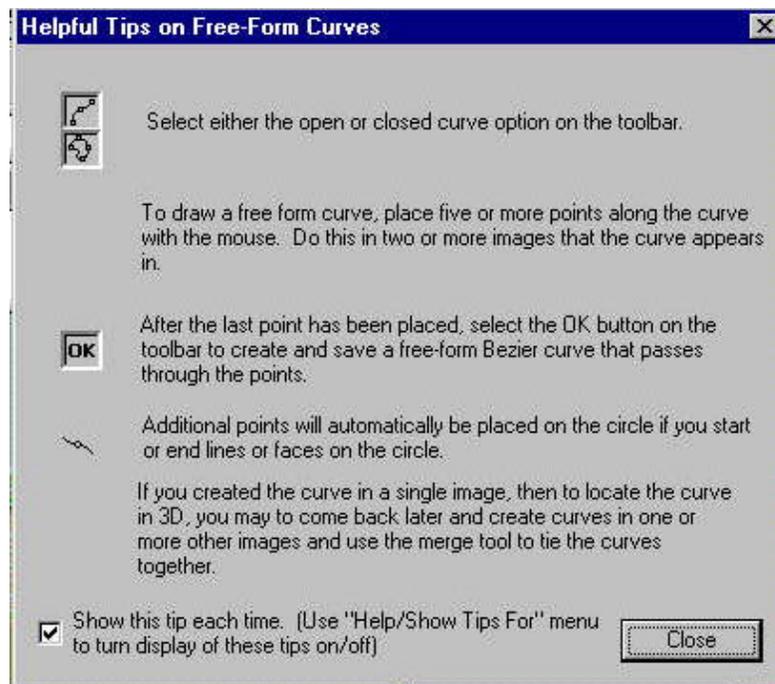
The Curve tool can be accessed from the “Draw/Curve” menu or from the “Curve Tool” icon located on the toolbar. Clicking on the “Draw Menu/Draw Curve” or the “Curve Tool” icon located on the toolbar will activate the “Curve Tool” mini-toolbar, giving you a choice of the type of curve to be created and the plane of the curve, as shown:



“Just-In-Time” On-Screen Helps for the Curve Tool

The first time you choose the “Curve Tool”, the “Helpful Tips on Curves” window appears on your main viewing screen. It gives an explanation of the process used in creating a curve. There is an option to turn off “Show Tips for Curve” in the “Helpful Tips” window in the lower left corner of the window.

To turn the “Show Tips for Curve” window back on and make it come up on your viewing screen again when you choose the “Curve Tool”, go to the “Help” menu. Choose the “Show Tips for” menu item, then choose “Curves”.



How the Curve Tool Works



Choose the type of curve you want to create. **3D Builder** gives you a choice between a full curve (closed) or an open curve. If you know the plane of the curve, indicate this by clicking on one of the plane indicator icon buttons. The default is “skew” plane.



Drawing a Free-Form (Bezier spline) Curve:

Making a curve takes four or more points—a minimum of four points must be used for each curve.

To draw the free-form curve, do the following:

1. Click on the “curve tool”. The cursor changes to a “point cursor” with the number “1”. Place the first point on the beginning of the curve in your image.
2. Next, the cursor changes to a “point cursor” with the number “2”, indicating the program is ready for you to place the second point on the curve.
3. Then the cursor changes to a “point cursor” with the number “3”, indicating the program is ready for you to place the third point on the curve.
4. Next, the cursor changes to a “point cursor” with the number “N”, indicating the program is ready for you to place the fourth point on the curve.
5. After the fourth point, the cursor remains with the “N”, indicating that the program is ready for you to place as many points on the curve as you choose.
6. If the curve is in one of the principal coordinate planes, click on the “XY”, “YZ” or “ZX” toolbar icons.
7. If the curve is visible in multiple pictures, lay out the points for the curve in both pictures. ***Be sure to start the curve at the same point in both pictures.*** Then click on the “OK” button to tell the program that you have finished the curve”.
8. Click on the “OK” button icon on the “curve” mini-toolbar to display the curve.

Helpful Tip: Be sure to locate the points along the curve in order. The first two points along the curve and the last two points along the curve influence the curve the most.



Note: The curve is not completed until you hit the “OK” button and the curve is visibly displayed. Clicking on the “OK” button ***creates and saves*** a free-form Bezier curve that passes through the points on the curve.

At this point, you can continue making more curves, or, go back to the toolbar and select a different tool or another operation.

Locating the Curve in 3D from two or more images:

Locating the curve in 3D space requires the creation of curves in two or more images. The best way to locate the curve in 3D is to have both images up at the same time and create the curve in *both images before* clicking on the “OK” button. However, you can use the “merge” tool later to merge the curves. Then, use the “Merge” tool to tie the curves together.

Note: Both curves must have common “start” and “end” points, i.e., you will need to merge the “start” and the “end” point in both pictures before merging the curves.

Locating the Curve in 3D from a single image:

Curves may be located from a single image *if their plane and one of the points on the curve can be located.*

Placing Additional Points on the Curve:

Additional points will automatically be placed on the curve if you start or end a line or a face on the curve. If you have already created a curve and you draw (or create) a polygon or a line, then a special kind of point is created. This special point is “tied” or connected to the curve (or circle). This special point is displayed as a “circle” point rather than as the other types of points which are displayed as a “square”.



Figure 125 A special “curver” point. Note regular points above and to the right of the point on the curve. The dark box has been added for emphasis in this manual and does not appear on your screen.

If you edit the curve, then the curve point will also be moved. Double clicking on the point will bring up the “Point Tab Page”. The tab page will show the point to be located on a curve.

**Drawing a Closed Curve:**

The steps for the closed curve are the same as above, except that you would choose the “Closed Curve” tool.

Editing a Curve

You may edit a curve at any time. Select the “Selector Tool” (Arrow tool) and select a point on the curve. Then click, drag, and release the left mouse button to fine tune points on the curve.

Note: The shape of the curve is heavily influenced by the first two points created, and the last two points created. If you do not like the curve that is displayed, you can select it and delete it. Then repeat the creation of the curve, ***adding more points*** to the curve. In particular, the first two points and the last two points determine the shape of the curve. Do not have a lot of space between the first two and the last two points on the curve.

Note: You can change your mind about open/closed curves up ***until*** you hit the “OK” button.

Texturing a Curve

Same as for the Circle. See more details in the Circle Chapter.

Useful Notes on The Curve Tool

1. Remember to choose which plane in which to locate the curve (or declare it to be skew).
2. Check the direction of your curve ***before*** you merge the curves. Use the “line flip” tool to change the direction of the curve before you merge the curve. After the curves are merged, the “line flip” tool does not change the direction of the curve.
3. You can save steps by locating the curve in one image, then going directly to the second image and doing the same curve. Both curves will be merged and become the “same” curve.

Extrusions



Chapter

14

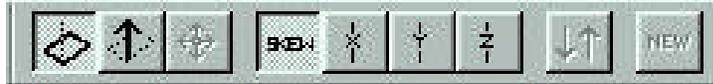
This chapter applies to Pro Version Only

3D Builder features new tools for creating extrusions from lines *you have previously created*. With one command, the extrusion tool creates dozens of lines and faces, saving time in the modeling process.



Draw Menu/Extrusion Tool

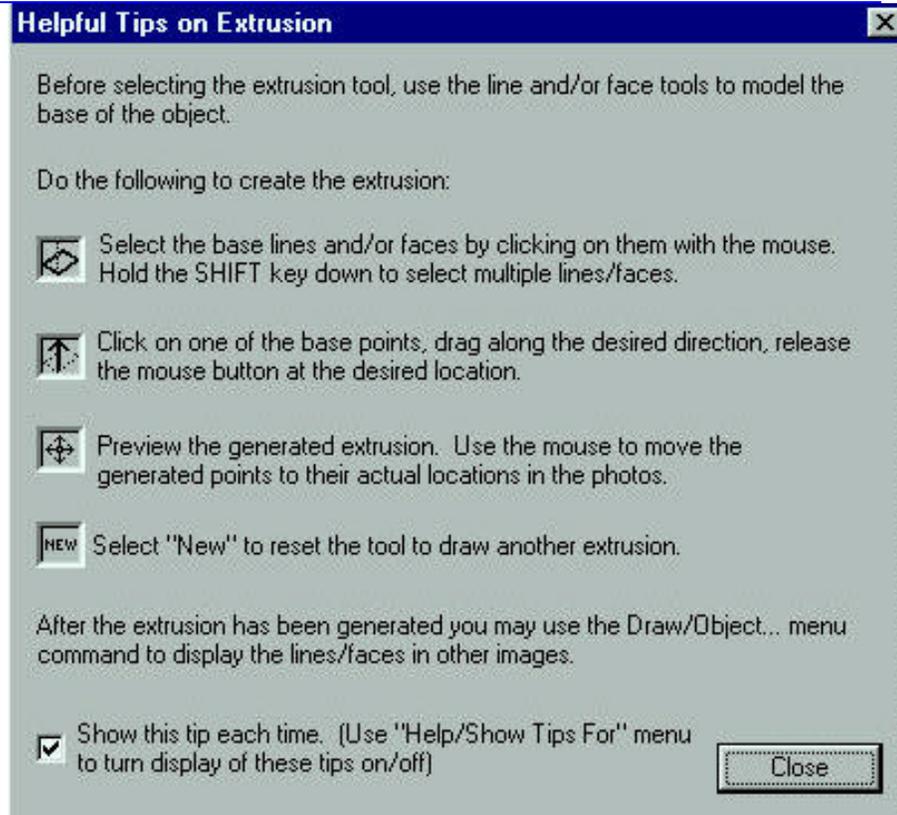
The Extrusion tool can be accessed from the “Draw/Extrusion” menu or from the “Extrusion Tool” icon located on the toolbar. Clicking on the “Draw/Extrusion” menu item or the “Extrusion Tool” icon located on the toolbar will activate the “Extrusion Tool” mini-toolbar, giving you a choice of the type of extrusion to be created, as shown:



“Just-In-Time” On-Screen Helps for the Extrusion Tool

The first time you choose the “Extrusion Tool”, the “Helpful Tips on Extrusion” window appears on your main viewing screen. It gives an explanation of the process used in creating an extrusion. There is an option to turn off “Show Tips for Extrusion” in the “Helpful Tips” window in the lower left corner of the window.

To turn the “Show Tips for Extrusion” window back on and make it come up on your viewing screen again when you choose the “Extrusion Tool”, go to the “Help” menu. Choose the “Show Tips for” menu item, then choose “Extrusion”.



How the Extrusion Tool Works

Since the extrusion tool works with lines you have *previously created* and then extrudes them, it is important to *create the lines or faces that you want to extrude first*. This is done with the "Line" or "Face" tool. The tools can also be accessed from the "Draw" Menu.

Create the base (top or bottom) of the object that is to be extruded.

Note: You do not have to use the "File/Calc3D" command before extruding, but you will save time and get a much better extrusion if you do. More specifically, the "extrusion" tool will *automatically* place the extruded points in the correct locations in the image if the image camera and the points to be extruded are already located in 3D. Otherwise, the points will just be extruded in the image parallel to the extrusion line that you draw and you will have to select them individually and move them to their "real" locations.



Click on either the extrusion toolbar icon from the mini-toolbar or click on “Draw Menu/Draw Extrusion” from the menu. The cursor changes to the extrusion tool.

Select the base lines and/or faces to be extruded. These will be highlighted. Hold down the shift key to “multiple select” lines.

Once you have selected at least one line, the “Draw Path” button on the extrusion mini-



toolbar will be enabled. Click on the “Draw Path” button on the extrusion mini-toolbar. If you know that you are going to be extruding along the X, Y, or Z coordinate direction, indicate this by clicking on the appropriate button on the extrusion mini-toolbar.



Next, pick a point on the base, then click, drag and release the left mouse button to define the direction of the extrusion. Release the left mouse button at the desired location. The extrusion has now been created.

When you release the left mouse button, the base will be extruded parallel to the line you have just drawn, and the cursor changes to display “moving points”.

Use the mouse to move each of the generated points of the extrusion to match up with their actual location in the photo. Do this one at a time, clicking down on the newly generated point with your left mouse button and move it to their proper location in the image. The extrusion follows the mouse movements.

Note: If the image camera and/or the base points were not already located in 3D (by a “File/Calc 3D” command), then these newly created points will have a question mark on them when they are first displayed. You may need to move several points if there is a significant amount of perspective in the picture. After you have moved a point, the question mark will disappear.

If you have indicated that you were extruding along the X, Y, or Z axis, use the “Flip Axis Sense” button icon on the mini-toolbar to set the direction of the axis.

Note: Remember to keep everything in a right-handed coordinate system!



If you want to continue making more extrusions, click on the “New” tool. This resets the tool to draw another extrusion. Or go back to

the toolbar and select a different tool or another operation. This helpful hint will also be displayed in the Status Bar.

Editing the Results of an Extrusion



You may edit the results of an extrusion at any time. The extrusion is simply a tool which generates some parallel lines, some faces, some equal length lines and some parallel constraints on those lines. You may edit any of those entities just as you had created them using the “Draw Line”, “Draw Face”, “Make Parallel”, or the “Make Equal Length” tool.

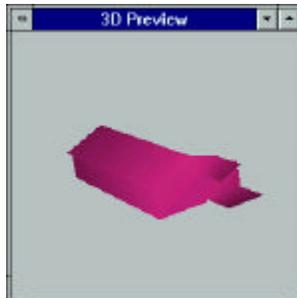
Select the “Selector Tool” (Arrow tool) and select a point on the extrusion. Then click, drag, and release the left mouse button to fine tune points on the extrusion.

Viewing the Results of an Extrusion



If the base points and the image camera were already located by a “**File/Calc3D**” command before starting the extrusion, then a full 3D model will be created by the extrusion tool and may be viewed immediately in the 3D Preview window.

If the image camera and/or some of the base points were not known, then you will need to select the “**File/Calc3D**” command first.



Useful Notes on the Extrusion Tool

1. You can also select a face to extrude by drawing a “bounding box” around the face. It is best, however, to simply click on the “face”; then the points and line associated with the face will be automatically be selected.
2. Be sure to select one of the “axis” (x,y,or z) if the line extrudes in any of those axis planes *before* drawing the extruded path.

-
3. After selecting the “path” for the extrusion, make sure that the line direction is correct. If not, use the “line flip” tool to change the direction of the line path.

PHOTO TIPS FOR IMPROVED ACCURACY

Take Good Pictures...Build Great Models!

The taking of good pictures is very important for making good 3D models with **3D Builder**. Taking a little extra time in planning your photo session before you take pictures is well worth the effort. 3D Construction Company offers these tested tips for getting better quality of photographs to use in your 3D modeling project and for improved accuracy.

Avoid the frustration of coming back from a photo shoot, discovering that one critical area of the model could not be processed because there were not enough visual, natural cues in the photo to locate the camera. This is particularly a problem with objects that do not have a lot of natural X, Y, or Z axes features. So, when in doubt, place a few targets and take measurements.

3D Builder offers you a lot of flexibility and a lot of choices in the data that its powerful, comprehensive math solver can process. Of course, the more accurate the input, the more accurate the 3D model will be. Film is not very expensive, but time is. Take lots of pictures.

Plan Ahead

Planning is one of the essential keys to successful photo sessions. If possible, plan your photo “shoot” on paper before arriving at the site. This action saves a lot of time and frustration when you are on the site, especially if site time is limited. It takes time to complete a photo shoot of an object to be modeled. It is expensive, especially in terms of time, to have to go back and repeat the photo shoot. In some cases, the location may be remote, dangerous or have been completely removed.

Planning how and where you want to set up your camera stations is also time well spent. Determine ahead of time which key points of interest you want to be included. Plan to take more pictures than you think you will need. Film is cheaper than time in

most cases. You do not have to use all the photos that you have taken in your 3D modeling project. **3D Builder** gives you the option and flexibility of adding additional photos to a project at any time. But taking many photos insures that you will have several good quality ones to include in your project.

3D BUILDER has provided a “Planning and Field Notes” forms pack for you to use. A small sketch of the project and camera station locations proves helpful.

Equipment Needs

Make a list of all the equipment (lenses, props, targets, measuring devices) that you think you may need and assemble these together in a central location. If you plan to use targets as reference points, choose targets that are big enough to be seen when viewed through the camera viewfinder. A camera tripod avoids a lot of blurs.

Location Is Important

Choose the location before the day of photography. Plan camera stations to get various angles of the object. Widely spaced camera stations get the best results.

Check for obstacles and obstructions of sighting. If possible, go to the site ahead of time and check through the viewfinder. Be sure the camera stations are neither a safety hazard to you or to others.

Obtain any necessary “permissions” from owners to avoid any problems later.

Several Pictures From Widely Spaced Angles

Try to take several pictures of the object to be modeled. These pictures should be taken from widely separated angles, close to 90 degrees, if possible. **3D Builder** recommends using the Field Guide Forms included with your **3D Builder** program to record and sketch out the positions (camera stations) from which you took the photos. Film is cheap, so take lots of photos.

Overlapping Coverage Of An Object

The ideal scenario is to have overlapping coverage so that the same key points of interest appear in more than one photograph. The more points that are common to multiple photos, the more accurate your model will likely be. In fact, key points that show up in three photos from three different widely spaced camera stations is better.

The following examples show a good camera station layout: Notice that the camera angles overlap to provide a good coverage of the entire object.

If taking photos all around the object, take from the corners, and overlap



Figure 126 Good coverage is obtained by overlapping angles

If taking front of an object, such as a building, take from these angles



Figure 127 Take angled shots for better coverage

Notice that the key points appear in all three photographs.

Photographing A Small Object

If you are photographing a small object for modeling, place a light object on a dark background to improve the contrast. Place a dark colored object on a light background. Glare is of special importance when photographing a small object. Be sure that the

lighting has been checked to reduce the glare bouncing off any shiny parts, especially the background.

Different Camera Heights

Having camera stations of different heights is another way of obtaining key points of interest in multiple photos from differing camera stations. Camera stations may be placed low to the ground. Check carefully through the camera viewfinder, however, to be sure bushes or other obstructions are not blocking the key points of interest you want on the photo.

Camera stations may be taken from heights. Examples have included pictures taken from on top of a ladder, from a rigid pole, the rooftop of another building, and a bucket truck. Care will need to be taken to keep the camera steady. **3D Builder** can also use photos taken from a helicopter or airplane, although it is very difficult to pinpoint the actual camera station location.

One Photo

If you can take only one photo, take from an angle.

You will not be able to model the back side of the object, however, as we show in the post office tutorial, a lot of information can be used from only one photo. In many cases, you can go into a CAD program and mirror the other side still have a complete model.



Figure 128 A "One-Photo" shot should be from an angle

A camera station taken from directly in front of the object is not good.

Mixed Lenses

3D Builder can accept photos taken with different lenses. These can be used together within a single project. This enables you to take close-ups of key interest areas. Again, it

is helpful when taking the photos to mark the changing of the lenses and camera stations on the Field Guide Forms.

Problems:

Bad camera angles too close together



Figure 129 Camera Stations need to be spaced widely apart

Bad coverage

One of the most common mistakes made by beginning photographers is to take pictures from too far back away from the object. Try to place the camera stations so that the viewfinder of the camera is filled with the object. Choose a mid-range lens. The closer to 50mm lens, the less lens distortion.

Obstructions In The Way

In some cases, the key point cannot really be seen in the photo because of a bush or similar obstruction. In many cases, **3D Builder** can still convert the 2D information into a 3D model. **3D Builder** uses an “Approximation” tool feature to help you place the point in an approximate position. **3D Builder** then combines other information to overcome the lack of precise point placement. You could also use background construction lines as hints to build the model. You would need to select the line, and label it as background. Be sure not to mark these construction background lines as part of the exported model.

Lighting Changes

Check your lighting at the beginning of the Photo Shoot and then re-check again near the middle as lighting can change during a short space of time. Shooting into the

sun can be a problem as you walk around an object. Be wary of automatic cameras. Instead use a camera with a light meter that can focus on the object. Be sure to include film for both bright sunlight and overcast or cloudy conditions. Generally, early morning is the best time for taking photos. However, taking the photos near noon will reduce the length of the shadows.

Set-Up Takes Time

Expect that it will take several times as long to setup/mark/measure as it will to actually take the pictures. Check the setup from a distance. Often you can see what needs to be adjusted for a better setup before you begin. Start and end the photo shoot by taking an overview shot from a distance. This gives a good reference later for the project. Make sure the object does not move (unless you are trying to capture motion).

If This Is A Critical Project

Have a second person independently repeat measurements and verify all field notes. Recheck all field notes before breaking down the shoot. A second person is very helpful in many ways--from helping with the setup and moving of equipment to keeping other people from moving targets or equipment.

Know Your Camera

Learn as much about your camera as you can. A basic book on photography is a good investment. So is spending some time with the people at your local camera and photographic supply shop.

Basics Count

Check to see that your film is loaded properly; check that your batteries are fresh, and be sure the lens cap is off. Fill the frame with the object and targets. Keep a constant focus setting if possible.

Targets Improve Accuracy

Targets are work, but they do improve accuracy. Use contrasting color targets. Put stick-on targets on curved parts of the object. A wide angle lens needs BIG targets. Mark target locations with chalk, and you may need more than one color of chalk. Where to place targets is always an issue. Try planning a grid for the object and put targets along the grid. Try to make sure you can see the same target in photos taken from two different camera stations. Spacing your reference targets widely apart improves accuracy.

Measurements Help

One of the quickest and easiest ways to improve the accuracy of a model is to take a few measurements. Measure the distance between at least two points of interest. For example, if you are taking photos of a building, measuring the base wall of one side of the building is a good choice. Rounded edges make it more difficult to get accurate measurements. Taking a few measurements also help in setting the scale of the model more accurately.

It's a good idea to measure each target -to- target distance. This triangulation of targets is a valuable reference later on. If your measuring device reads both inches and decimal feet, choose one and be sure you record the same method each time you measure. Measuring the camera height before you change it helps.

3D Builder deals predominantly with points. You will need to locate points to build your model. Many objects, such as buildings have natural features so that points are readily visible in the images without any special markings before taking photographs. Other objects, such as curved smooth surfaces, lack natural features. You will need to prepare these before the photo shoot by putting some form of "reference target" on them. If you are trying to build a accurate model, then you should carefully place a small number of reference targets in the scene, and carefully measure the distance between these reference points. You will input these measure distances into the program by constructing lines between the points and setting the measured lengths of the lines.

Cropping of the Photos

3D Builder can deal with minor cropping (typically from a photo lab). Major cropping lessens your accuracy. You should not use cropped images or crop the images during the scanning of your prints. If you use cropped images, expect that your accuracy will suffer.

After The Shoot

Going over your field notes as soon as possible after breaking down the shoot avoids errors. Consider using a 1-hour photo finishing service for making quick "proofs" to check your work. But be sure to tell them **NOT** to cut the negatives if you plan to use Photo CD. Use these proofs as you work with **3D Builder** as a "hands-on" reference story-board later on. Number the photos as the ones you add to the project.

Summary

The taking of quality photographs is one of the most important requirements for building a good 3D model. Many photographic mistakes can be compensated for in the **3D Builder** program. Many of the program's tools are designed to deliver a 3D model, without the need for a professional photograph. However, investing some time and

practice beforehand will reap big dividends when a major project comes around. Investing in a good basic book on photography (or finding a knowledgeable resource expert on the subject) is also time well spent.

ACCURACY

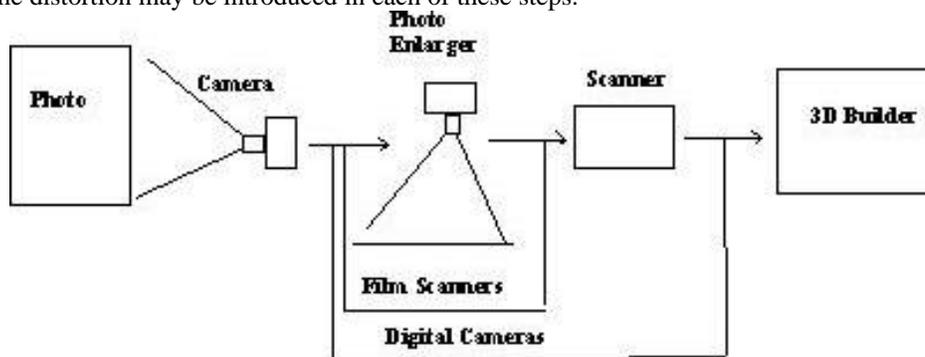
Introduction

Accuracy will vary widely, depending on the type of camera and lens used, the way in which the images are scanned, and the number and type of ground measurements taken. **3D Builder** offers a calibration program which will calibrate the camera/ lens.



The highest absolute accuracy requires calibrated camera lenses. The **3D Builder** calibration “Wizard” is used for calculating focal length and will substantially improve accuracy. The calibration process is simple. The Calibration “Wizard” is described in a separate “*3D Builder Calibration Guide*” booklet.

The process or steps in going from the 2D real world to the 3D model are shown below. Some distortion may be introduced in each of these steps.



Digital cameras are easier to calibrate because they have fewer sources of error. The tradeoff, except for the high end digital cameras, however, is reduced pixel resolution.

Note: when scanning prints from photographic enlargement from negatives, distortion is

introduced both from the original camera lens, in the enlarger, projector lens, and in the image scanning.

3D Builder will automatically compensate for the cropping that occurs during photographic enlargement and with many film scanners (including Photo CD). More specifically, using the available information from the picture, **3D Builder** will calculate the amount of cropping.

3D Builder uses “**sub-pixel positioning**”, so the accuracy of the placement of points is determined by image resolution, the size and type of target features in the scene, and the time the operator is willing to take for the process of “zooming in” when locating points.

To achieve better accuracy, tighten up the accuracy along each part of the chain, or eliminate parts of the chain (example, use a digital camera instead of a print scanner.)

Sources of Error

- Camera lens focal length *
- Camera lens optical decentering*
- Camera lens distortion**
- Film flatness in camera
- Film flatness in photo enlarger
- Photo enlarger optical decentering*
- Photo enlarger lens distortion**
- Print paper flatness in enlarger
- Cropping in enlarger*
- Cropping in scanner*
- Scanner sampling resolution
- Scanner position accuracy
- Location of target points in image by operator



***3D Builder Pro** automatically compensates for these sources of error.

****3D Builder Pro** automatically compensates for these sources of error if the lens has been calibrated with **3D Builder Pro**.

If you are working on a project where accuracy is a major concern, you will want to calibrate your camera lens with the **3D Builder** calibration “Wizard”.

Other Accuracy Features in 3D Builder

3D Builder includes tools for control points and perspective matching. This includes tools for entering known control points or 3D point locations. **3D Builder** will produce the camera position accurately. You can input a variety of known measurements types into **3D Builder**, including known “x”, “y” and/or “z” coordinates of control points and known lengths of lines between points. You can use known camera points if you have them. The known camera height is often very easy to measure and can be used. The program has a full triangulation solver and can accept linear measurements (measurements between points for example).

3D Builder also uses a number of tools to improve the usability of models by forcing vertical surfaces to be vertical and horizontal surfaces to be horizontal. The program also use a series of constraints, for example, that force parallel lines to be parallel and imposing similar sets of constraints. In addition, **3D Builder** has tools for forcing geometry to align with the major coordinate planes.

How to Improve Accuracy

- Place targets on the object being modeled.
- Calibrate your camera/ lens.
- Use a higher resolution digital camera.
- Use a high resolution film scanner rather than scanning from prints.
- Use a better scanner.
- Place targets on the object being modeled.
- Use good lighting (makes features easier to pick in photos).
- Place known measured objects in the scene for reference or independently measure parts of objects. **3D Builder** will adjust the model to agree with known measurements
- Frame objects so they fill the image area (picture area as seen through the view finder of the camera).
- Take more pictures, take close-up pictures of objects of interest.

How to Determine Accuracy

Taken together, the camera, the scanner, and **3D Builder** are a sophisticated measuring instrument. Any instrument used where accuracy is important should be calibrated, and the camera/scanner/**3D Builder** combination is no different.

Take one or more objects which are of the same size and type as what you will be working with, measure them by an independent means, and then take three independent

sets of pictures of the objects. Process each set of pictures as a **3D Builder** project. Comparing these results to the independent measures of the object will give you a reliable measure the accuracy of your camera, scanner, **3D Builder** combination in the particular domain that you are using.

The best results that may be obtained with **3D Builder** are in the range of 1 part in 3,000 (0.3 mm on a 1 meter object). This level of accuracy requires a carefully calibrated high resolution digital camera. At the other end of the accuracy scale, people using **3D Builder** for rapid conceptual modeling where accuracy is not as important will typically be getting between 1 part in 50 to 1 part in 200 accuracy.

Camera Lens Calibration

All camera lenses have some distortion. Objects that are straight lines in the real world may project onto the film as slightly curved. This is most apparent with extreme wide angle lenses, such as shown in the figure below.



The effect is present in all camera lenses, to a greater or lesser extent. This is why, when accuracy is important, camera calibration *should* be used. The calibration feature of **3D Builder** can calculate the camera focal length (Pro and PowerLite versions) and optical decentering and optical distortion (Pro version only). Once a lens has been calibrated, 3D Builder will and then automatically compensate for distortion when calculating 3D models.

The “Calibration Wizard”, accessed by clicking under the “**Tools/Calibrate Camera Lens**” menu will step you through the calibration process.

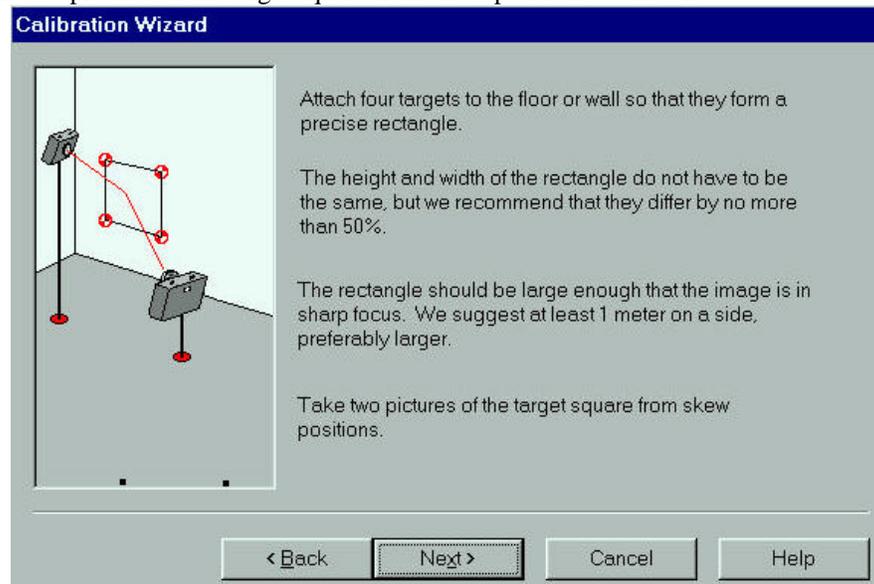


There are two types of calibration: (1) focal length only, and (2) full calibration for distortion and optical centering. Focal length calibration requires two pictures of four targets placed on a wall, forming a rectangle. This procedure is described in this chapter and can be accomplished in about 10 minutes. Full calibration for distortion and optical centering requires 6 to 9 pictures of a number of targets placed in rectangular grid patterns on two perpendicular walls. This procedure typically takes three hours to perform, is only available in the **3D Builder Pro** version, and is described in a separate booklet.

Preparation

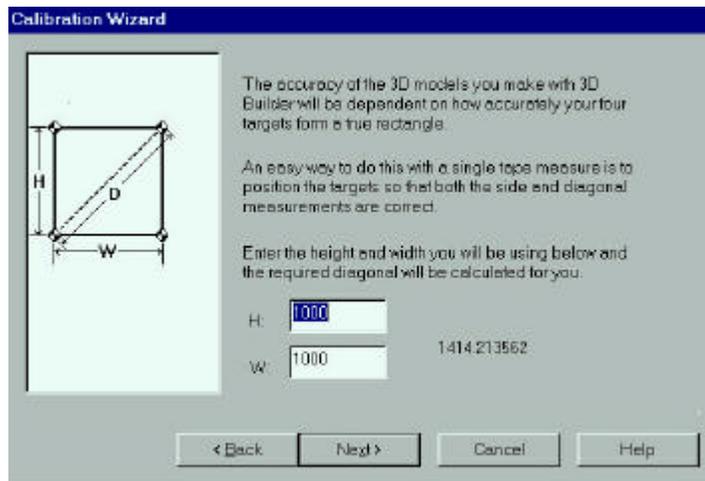
Attach the four targets in your **3D Builder** package to the floor or wall so that they form a precise rectangle. The height and width of the rectangle do not have to be the same, but we recommend that they differ by no more than 50%. The rectangle should be large enough that the image is in sharp focus. We suggest at least 1 meter on a side, preferably larger.

Take two pictures of the target square from skew positions as shown.



The accuracy of your calibration will be dependent on how accurately the four targets form a true rectangle. An easy way to make a precise rectangle is to use calculator in the Calibration Wizard which will give you the exact diagonal dimension for the rectangle if

you tell it the height and width. Simply use a tape measure to position the targets at the correct height, width, and diagonal.

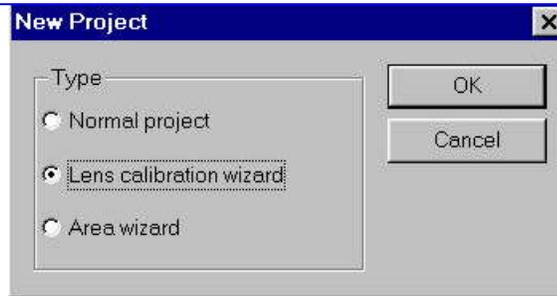


Using the Calibration Wizard

The Calibration Wizard is launched from the **Tools/Calibrate Camera Lens** menu. For focal length only, calculations the Calibration Wizard steps through most of the same steps as the Insert/Camera Lens command. See the section titled **Insert Camera Lens** in the chapter on **Menus**.

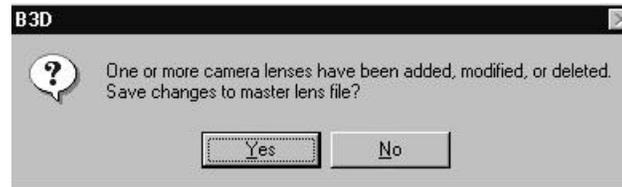


The “Focal Lens Calibration Wizard” can also be launched from the “**File/New Project**” menu selection. Choose “Lens calibration wizard” from the “New Project window, as shown.



Select "Finish" to exit the Calibration Wizard. You will also need to select "OK" to close the calculation progress reporter if you have not already done so.

Note: IMPORTANT: When you exit the program or open another project you will be prompted "Camera lens have been added, deleted, or modified. Save changes to lens.dat?". Be sure to select "Yes" or the lens calibration values will not be saved to disk.



You may use the same calibration project for more than one camera lens. Just start the "Calibration Wizard" again from the "Tools/Calibrate Camera Lens" menu and select the next camera lens and the appropriate image.

The results will be more accurate and well worth the time taken in calibrating the camera lens.

Remember: Each camera/lens must be calibrated separately. However, once the camera/lens has been calibrated, it will be accurate for all 3D Builder projects using that camera/lens.

WHAT DO I DO IF?

Chapter

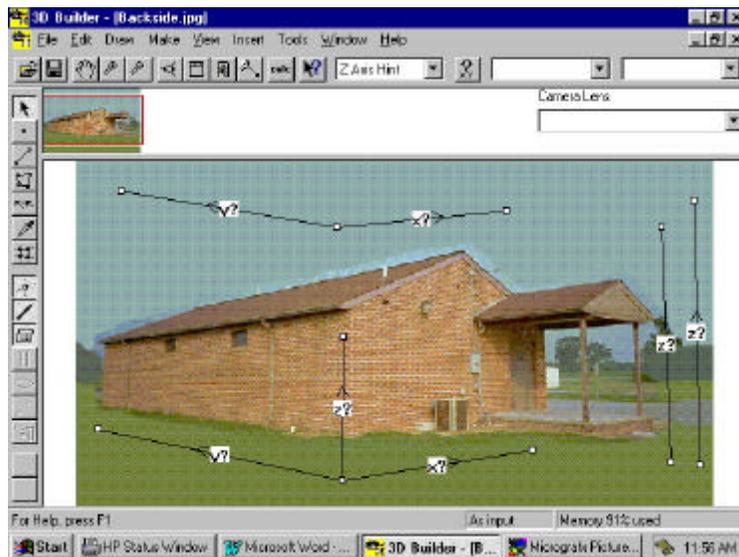
19

This chapter includes information about possible problem or unusual scenarios that may occur in your working environment. It discusses how to solve the problem in **3D Builder**.

Unknown focal length of the camera

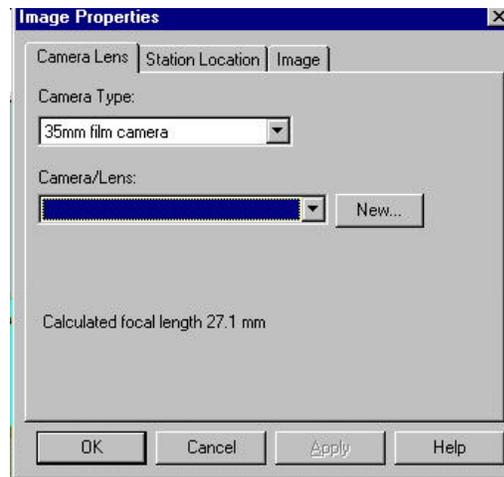
If the focal length of the camera is unknown, **3D Builder** can estimate it for you. Give **3D Builder** a start by putting in a “best guess” estimate for the focal length of the camera.

Put in several “X,Y, and Z” axis hint lines. Make sure these are fairly long lines.



Note: This will give you a “rough estimate” and should be good enough under the circumstances for a “starting point”.

Double click the left mouse button in a blank area of the image screen to bring up the “Image Properties” box. The “calculated” focal length appears in the “Image Properties” box.



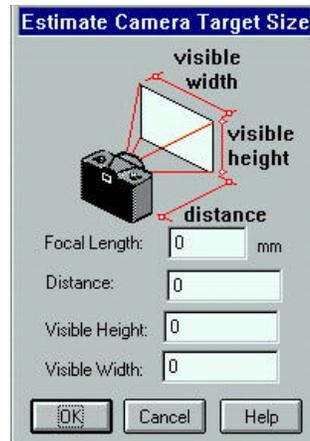
Unknown camera type

If the camera type is unknown, bring up the “Camera Lens Tab Pages” by right mouse button clicking in an empty area of the screen. This dialog box will bring up the “pop-up” menu. Then, click on “properties” with the left mouse button. On your screen will appear the “Camera Lens”.



1. Click on the “New” button.
2. Give Camera/Lens a name.
3. If focal length is known, put that information in the focal length box.
4. If you do not know the type of camera or none of the listed cameras seem to be correct, choose the “Blank” item, the last item in the drop down list box.
5. If the Target Height and Width is known, put that information in the “Target (Film Height) and “Target” (Film Width)
6. If the Target Height and Width is NOT known, click on the “Estimate” button to the right of the dialog box. This information brings up the “Estimate Camera Target Height and Width” Dialog Box.

The “Estimate Camera Target Height and Width” Dialog Box will guide you through the estimation of the camera target size.



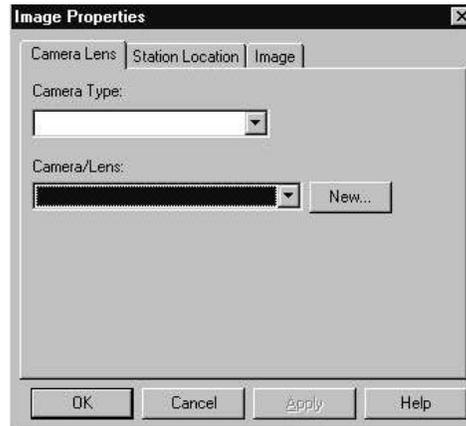
If neither the focal length or target height and width information is **NOT** known, go to “Estimate” and take your best guess to give the **3D Builder** program an initial starting point. In most cases, **3D Builder** can estimate the focal length for you after the calculation process has been completed.

6. If the camera is a **digital** camera, fill in the image height and width and internal magnification. This information can be obtained from the camera manufacturer.

Camera not on 3D Builder “camera list”

Camera companies are coming out with new types of cameras almost weekly. Our camera list will be updated as camera information becomes available. If the camera used

to take the photos is not on the **3D Builder** camera list, it can be added easily. The instructions are similar to the “Unknown camera type” above. This dialog box may also be accessed by “right mouse clicking” in an open area of the main image screen to bring up the “pop-up” menu. Then, click on “properties” with the left mouse button. On your screen will appear the “Camera Lens Properties box”, as shown in the above section of text. This time, select the “New” button to the right of the “Camera Type” drop down list box by clicking on it. This action brings up the “Camera Lens Property” box. Add the name of your camera type and lens by typing in the text box “Name, Camera/Lens” as shown below:



No measurements known

Set some artificial values and everything will scale from these. Look closely at the photos for objects to help you with this estimation. For example, entrance doors are usually a standard 6'8" in height and usually 3'0" in width in the United States. From just these kinds of initial estimates, **3D Builder** will scale the rest of the 3D model proportionally.

No reference marks visible in the photo

Look carefully at the photos to determine if there are any visible features in more than one photo. If there are, use them to help you get the modeling project started. Zooming in on the photos may help you see natural features that can be used as target areas.

If the photos have not yet been taken, plan to place a few targets or reference marks on the object. Colored dots, tape, stickers, chalk, paint, pencil...all of these have been used as targets on objects. A few targets in some key places on the objects, visible in more than one photo, will make your job of modeling so much easier and faster.

Pictures taken by someone else and “Handed to You”

If Accuracy important: First, get as much information from the person who took the photos as you can. For example, the type of camera and the focal length of lens used.

If this information is not known, you will need to give **3D Builder** an initial start by filling in the “Camera Type” from the “Camera Lens/Image Properties” box. Refer to the “Unknown camera type” section of text described above.

3D Builder cannot work with photographs that have been **greatly** cropped.

If you find yourself in this situation and you have access to the negatives, give one of our technical staff a call and we will discuss some techniques that have been moderately successful for us. **3D Builder** can work with photos that have been slightly cropped as in Photo CD.

If possible, return to the scene and make a few measurements. This would greatly help in making your model more accurate. If this is not possible, then go ahead and begin your **3D Builder** project by adding the images.

When working with the images in your **3D Builder** project, use extra care in placing the points on the photos. Zooming in helps in accurate placement of points. Remember, the more points you can tie or “merge” together in more than one photo, the more accurate your 3D model will be.

If you have access to the camera and lens used to take the photos, use the **3D Builder** calibration chart and calibrate the camera lens. Refer to the chapter in the User’s Manual for details on the Calibration process.

If accuracy **not** important, as in a conceptual modeling project: Estimate the focal length of the camera lens. Try to place the points as best you can to create an initial starting model.

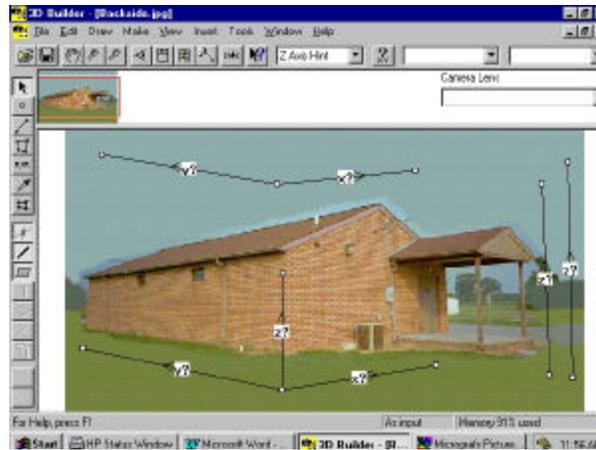
No natural right angles and parallel lines in the photos

3D Builder needs a **rough** estimate of the direction the camera that took each picture was pointed in. You give this information to **3D Builder** by drawing in pairs of x, y, and/or z coordinate axis lines in each image.

If there are no natural “x”, “y” or “z” axis lines in the picture then just imagine a cube somewhere in the scene and rough in two pairs of edges for the “cube”. Be sure to use the same convention for all images. That is, if you decide that the “x” axis is pointed in a particular direction in one picture then be sure that the “x” axis is pointed in roughly the same direction in world space in all pictures. Most people put the “z” axis up. Select the “? Axis” (axis hint) toggle on the toolbar when creating these lines so that **3D Builder** will **not** assume that the lines are **exactly** along the world “x”, “y”, and/or “z” coordinate axes. If you forget to do this, the “**File/Calculate 3D**” command will give

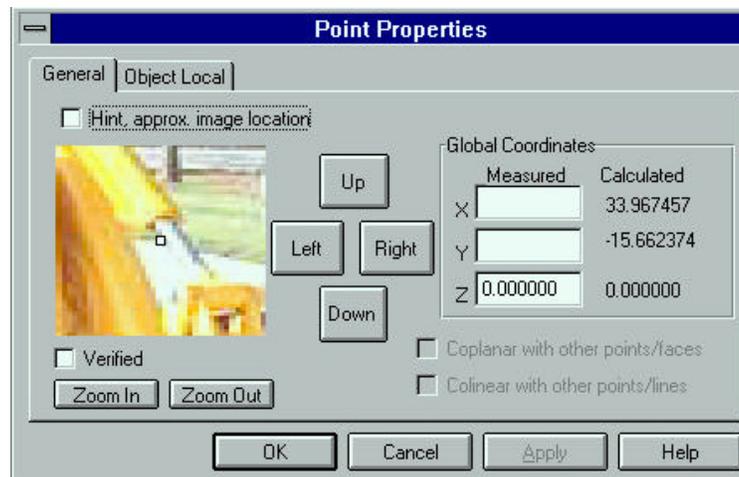
bad results because it is trying to match the axes exactly. In this case, go back and select the lines. Then from the toolbar, change the axis from “X Axis” to “X Axis Hint”, “Y Axis” to “Y Axis Hint”, and so forth. Alternatively, you may double click on each line and check the “Approximate” checkbox next to the axis/plane field.

Keep in mind that parallel lines, when not viewed from the perpendicular line of sight seem to come together in the distance, like looking down a set of railroad tracks.



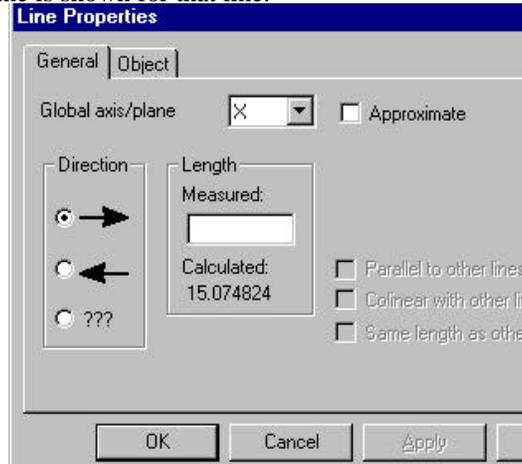
Need to know the location of a point or “point location”

After doing a 3D Builder “Calculate 3D” from the toolbar button or from the “File menu/Calculate 3D”, the calculated “X,Y, and Z” location for each point can be viewed. Double click (or right mouse button click) on the point to bring up the “point properties” box. The calculated “X,Y, and Z” location is shown for the point.



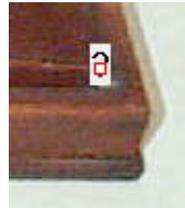
Need to know the length of a line

After doing a **3D Builder** “Calculate 3D” from the toolbar button or from the “**File** men/**Calculate 3D**”, the calculated length of each line can be viewed. Double click (or right mouse button click) on the line to bring up the “Line Properties” box. The calculated length of the line is shown for that line.



Point location is unseen/blocked by something

Use the “Approximate” Point Tool on the toolbar. First, click on the “Point” tool either on the toolbar icon or by the “Draw/ Draw” menu. Then click on the “?XY” toolbar icon which is the “Approximate tool”. Locate where the point location is “thought” to be and click with the cursor there. The newly created point appears on the photo image with a “?” on it to indicate that the point location is not absolute.



Here are three examples from a building, where the point cannot be seen in any photo:

- Measure from roof down to the ground
- If you are working with a building and you can see clearly the end points of one corner wall, but not the other, you can tell **3D Builder** that line “Z1” and “Z2”

are parallel and equal. (this corner and that corner are parallel and equal and you can clearly see corner “1”, but not corner “2”)

- Use a control rod of known length (a piece of electrical conduit 4’ placed against corner, with end resting on the ground. Now the top of the rod can be seen in two photos and the point in question is 4’ below.

Suggestions for complex, organic objects or objects with unusual shapes...

If possible, shoot on or against a known grid. A tile floor, a tiled corner, a wall with vertical and horizontal stripes. Show the grid table and lay out several “X,Y, and Z” axis lines before photos are taken. Put reference marks or targets on the object, such as tape, magnets, stickers, chalk, paint, etc. Shine a grid onto the object.

Model due YESTERDAY! Need model ASAP

Take a few moments to read the chapter on “Taking Better Photos” in the User’s Manual. Use a digital camera. They can often be rented if you do not own one. You can use a Video camera, but be sure you have access to a digitizer or frame grabber. Place targets on the object. Take a few measurements before you take photos. Make sure you take overlapping photos, so that key features appear in more than one photo. Begin the **3D Builder** project as described in the “Getting Started” section of the “User’s Manual”.

Have Pictures, but no negatives

Best suggestion is to have the pictures scanned, using the best scanner you can find. Be aware of cropping errors. Try to line the photos up in the same corner of the scanner each time. Be sure to try to keep the photo flat.

Have pictures AND negatives, BUT need to model ASAP

IF accuracy IS important: Depending on the time factor, scan the photos from a high quality scanner, such as a “Negative scanner”. Photo CD will give you better results. In many areas, you can get a several hour turnaround for Photo CD.

IF accuracy is NOT important: Have pictures scanned and work from those to begin the model.

I am Having Trouble with Texture Maps in Wavefront and/or Inventor files: Go to Tools/Settings/Defaults...

The second tab page is the “Defaults” page, which allows you to set defaults. There is a checkbox for using an “odd size .JPEG texture map” size. This is necessary to work

around a Netscape 3D bug. When the check box is in the checked position, an odd sized texture map is created. If you experience difficulty in your texture map using Inventor or Wavefront, be sure to “uncheck” this box as both of these files expect an even number of pixels in the texture maps. Also see the “Menu” chapter of this User’s Manual, Tools menu.

How Do I Delete a Photo from a Project ?

You may delete a photo from the project from the “Project Window”.

- From the “**Window**” menu, choose “Project”.
- Expand the project control tree to show the “Stations/Photos” branch.
- **Stations/Photos** Gives a list of the camera stations and individual photos identified in the project. Click on the + sign to expand the tree control level.
- Click on camera stations, select the photo and click on the “Delete” key.

I Keep Getting An Error Message when I Calculate...What Am I doing Wrong?

Modeling errors are the usual cause of the calculate error messages. Here are a list of the most frequently found modeling errors (from looking at customer projects):

- Check lines to see if they are the correct axis and direction.
- Check faces to see if they are the correct plane and type of polygon (example, 4 point rectangular polygon when you meant to have just a 4 point polygon)
- Check points to see if they are placed correctly. A pixel up, down, left, or right can sometimes make a difference in the accuracy level. Zooming in on the area where the points are being placed is a tremendous help in accurately placing points. Also, check to see if you have placed the correct type of point (example, placing a grid point instead of a ‘single’ point)
- Check curves and circles to see if they are set correctly as to plane, open/or closed.
- Make sure “same” or “merged” points are really merged. (Highlighting one point with the select tool will make the merged point highlight in the other image).
- Make sure you do not have points “stacked” on top of other points (or lines on top of other lines, or faces on top of other faces). To correct this:
 - Point: select it, move it over and see if there is one (or more) under it. If so, select the duplicate point and delete it with the “Del” key.
 - Line: select the endpoint, move it over, see if there is another under it. If so, select the endpoint of the undesired line, and delete it with the “Del” key. look in “status Bar” at bottom of screen, noting the number assigned to the line.

- Face: select the face (it highlights), look in “status Bar” at bottom of screen, noting the number assigned to the face. Use the “Make Behind” tool from the Make/Make Behind menu, put the 1st face behind. Select the currently showing face, check its number in the “Status Bar”. If it is a different number, there is a duplicate face. Decide which to delete and use the “Del key”.

I Get A Message after Calculating: Lens Focal Length Conflicts with Actual...

Refer to Appendix A for the correction to this error message.

Other Error Messages Upon Calculating...

Refer to Appendix A for the list of the most common error messages and what to do to correct them.

The Password For the License that I Typed In Does Not Work...

The most common mistakes made in working with the License Wizard are either not giving the correct “machine ID” number (see the chapter on License Authorization earlier in the User’s Manual) or incorrectly typing in the password key returned to you.

- Check to see that the “machine ID” number that you sent to 3D Construction Company is the correct machine ID for your machine. This is an 8 character (alpha-numeric) number located on the same screen in the License Wizard as the field in which to type in the password. (May be listed as Xhost ID on some machines)
- Check to see that you have correctly typed in the password.
 - Use *all* lower case letters.
 - Use “-“ (dash symbol) *not* “_” (underscore symbol).
 - Use “0” (number zero symbol) *not* “o” (letter o symbol).
 - Use “1” (number one symbol) *not* “l” (lower case letter “l” symbol)
- Check the clock (date and time) on your computer to be sure it is showing the current date.
- If the above items are correct, contact 3D Construction Company at the number and address listed below and we will guide you through getting set up.

Other Problems not Listed Here

If you have another type of problem that is not listed here, give 3D Construction Company a call at 1-543-543-8917, a fax message at 1-423-543-4011, or contact us by Email at “threedc@usit.net”. Talk with one of our staff members and we will be glad to help you find a solution to your unique situation.

3D BUILDER

CUSTOMER SERVICE PLAN

Registration:

To register your **3D Builder** product, complete the registration card included and drop it in the mail or fax it to us at 1-423-543-4011.

Customer Service:

Call our Customer Service to:

- Register your 3D Builder product
- Order an upgrade
- Request product information
- Change your registration address (You may mail, fax, or phone)
- Request the replacement of missing or defective package parts (disks, CD, manuals, charts, etc.)

Call Our Technical Support For Specific Questions About Using The Software.

We are very focused on making this software work for you. We believe in helping our customers, providing support to solved problems with large or small projects. We provide **free** technical support. This support is available to all registered **3D Builder** customers. If you need help immediately, you can contact 3D Construction Company at the number listed below. You will receive more thorough technical support if you Email us or fax in the Technical Support form, as this gives us more time to study your problem. Before you call Technical Support, please have the following information ready to give the Technical Support staff:

- Which 3D Builder program you are using (Pro or PowerLite)
- Type of Operating System and Version (example: Windows 98)
- How much memory (RAM) your machine has
- Video Card type (if known)
- A brief description of what you were doing when the problem occurred

- What steps you have taken to try to solve the problem before you called us.

Having this information readily available will save time and allow us to better help you resolve the problem. A Technical Support form is provided for you in **Appendix E**.

We may ask you to send us the file that demonstrates the problem. We consider all data sent to us confidential, of course. Without the file, it may be difficult to determine exactly what is going on, find the bug or explain the problem.

If the problem is not urgent, or if you prefer to write, contact 3D Construction Company at the address listed below. Include a disk with the problem .B3d file. We will also need all the images and all the texture maps used in the project. We will need the type of camera and focal length of the camera lens (if known). Be sure to write your name and address on the disk label. Support is also available from our Web site. Contact us at threedc@usit.net.

- . A member of our staff regularly checks for messages.

Customer Service And Technical Support

3D Builder

3D Construction Company

122 Creative Station

Elizabethton, Tennessee USA 37643-5304

Phone 1-423-543-8917, Fax 1-423-543-4011

Email threedc@usit.net

Appendix
A

APPENDIX A

CALCULATE 3D MESSAGES

Need At Least One Known Point

When you have given a camera height but have not located any points in the scene, this message is a reminder that you need to locate at least one point.

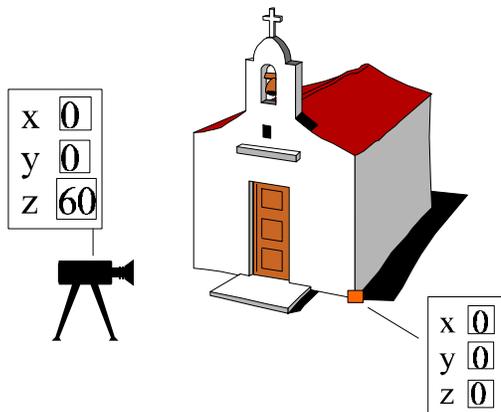


Figure 130 Calculate 3D error message 'Need at least one known point'

Need Three Known Points Or Two Pairs Of Axes.

In order to locate and orient the camera, **3D Builder** needs either three known widely spaced non-colinear points, or two widely spaced known points and some lines along the world x, y, and/or z axes. If natural cues are available, the latter case is the easiest to use. One point can always arbitrarily be chosen as the origin. If scale is not important then an axial line from the origin point can arbitrarily assigned a length. This is the “no measurements at all” case when using **3D Builder**.

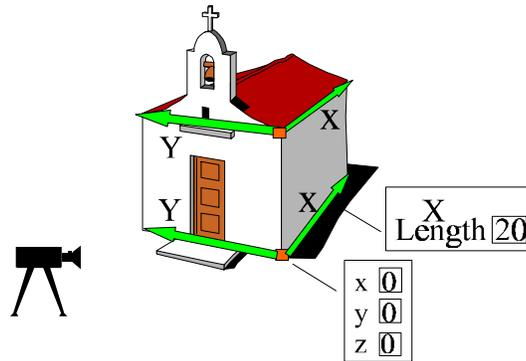


Figure 131 Calculate 3D error message "Need at least three known points or two known axes"

Instead of typing in x,y,z coordinates for three measured coordinates, you may use one known point and set the length of two axial lines connected to it.

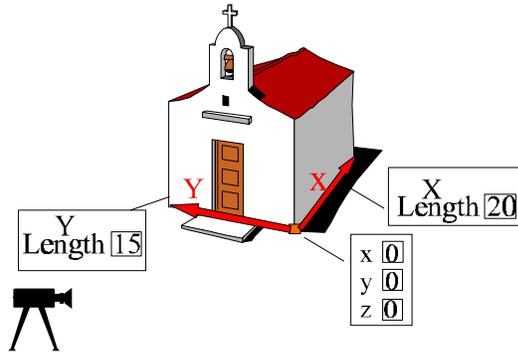


Figure 132 Two measured axial lines and one known point

You can always just type in the three known points, of course:

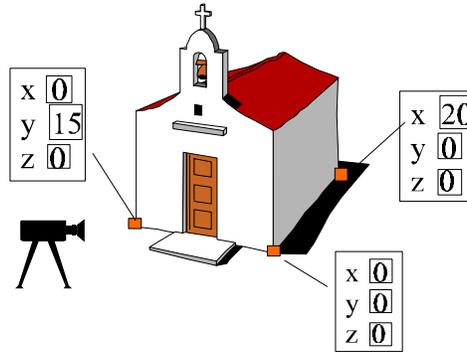


Figure 133 Three known points

Another way of getting three known points is to have measured distances between three points. Again, you would arbitrarily pick one point as 0,0,0. Also arbitrarily assign one of the lines to a coordinate axis and put the other lines in that plane (xy, yz, zx).

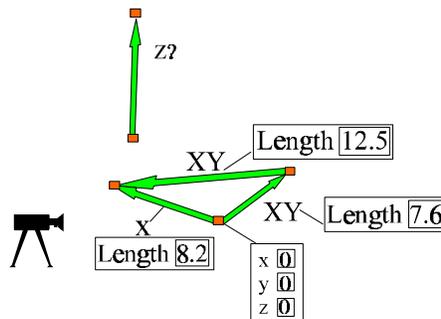


Figure 134 Measured distance between three points

X Axis Line Direction Conflict

Y Axis Line Direction Conflict

Z Axis Line Direction Conflict



In addition to saying that a line is along the “X”, “Y”, or “Z” axis, you must also specify the axis direction. **3D Builder** has detected two or more lines that appear to be in opposite directions. Use the “view filter” command under the “**View**” menu (or access via the Toolbar ribbon icon which looks like an eye).



Examine the image to find the lines in question; check to be sure you are using a right handed coordinate system. Use the arrow tool to select the line(s) and bring up its property box. Change the direction arrow toggle and “OK” the data.

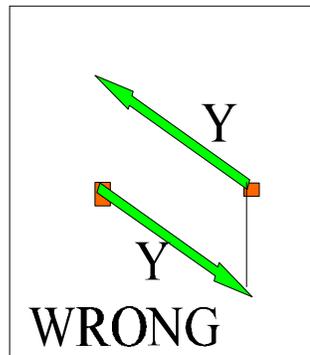
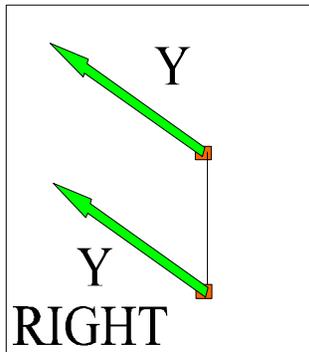


Figure 135 Axes lines going conflicting directions

X Axes Do Not Intersect

Y Axes Do Not Intersect

Z Axes Do Not Intersect



In perspective pictures, including photographs, lines which were parallel in the real world will converge to a point. **3D Builder** checks for this and reports cases where parallel lines intersect poorly. This is only a warning. Use the arrow tool to bring up the property box for the end points of these lines and move the points if their positions are off.



Figure 136 Examples of Good and Poor Axes Lines Intersections

How to Correct This Problem:



- Bring the image up in the window.
- Use the “**view filter**” command under the “**View**” menu (or access via the Toolbar ribbon icon which looks like an eye).
- Select the appropriate axes so that only those lines are shown. (for example, only “X’ lines)
- Look first for obvious errors like X lines that are really Y lines.
- If the axes lines are only estimates, (such as using a tree for a vertical) make sure they are tagged as approximate.
- Double click on each end point of each axes line and use the fine tuning controls to carefully position the points. This is the most common mistake made.



Note: This message is only a warning. There are some cases, such as when you have fairly short axes lines that is just not possible to position them accurate enough that they really do intersect at a single point. In that case, ignore the message.

Known Points Are Colinear

If three points are being used to locate the camera, they must not lie on a straight line. In fact, they should be widely spaced from each other and in different directions.

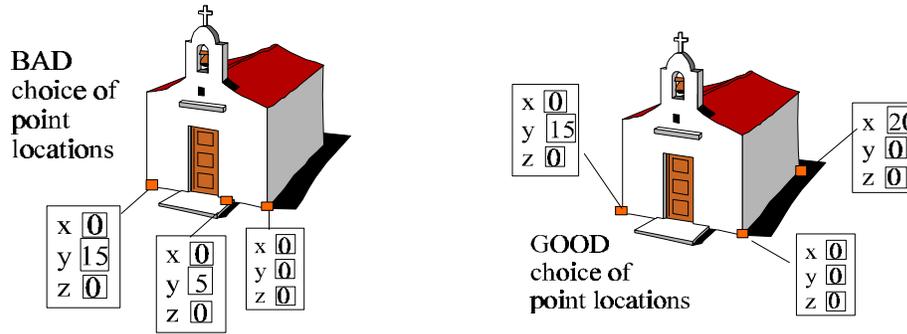


Figure 137 Point Location recommendations

Note that this problem goes away if you use natural x, y, and/or z axis lines in the image since only two known points are required in this case.

Points Not Located Because They Are Visible In This Image Only

In order for **3D Builder** to locate a point, the point must either be visible from two or more different camera stations, or one coordinate must be given or the point must lie along an axis or plane that **3D Builder** can locate.

If the program tells you that it can't locate a point because it is only located in one photo, you hopefully will have another picture with that point located in it. Use the "merge" tool to tie these points together.

If you are working with only one image and you get this message, then the points need to be tied together, whose directions **3D Builder** can determine. So if you are working with a single photo, make sure you have all the points tied together with lines. State the axes or apply other constraints to the lines.



Figure 138 Points not calculated correctly

Points Not Located Because The Other Image(s) That They Are Visible In Have Not Been Calculated Successfully

This is just a reminder that some additional information is required to locate and orient one of the other camera stations before some points in this image can be calculated.



Figure 139 Need additional information to calculate correctly

Nominally, **3D Builder** has to be able to locate each camera station from which that you took the picture. This message comes up telling you that something is wrong and it could not locate the camera. Messages appear describing what is wrong with the picture in which the camera could not be located, so begin correcting this problem by working on each individual message.

Lens Focal Length Calculated From Axes Conflicts With Actual

3D Builder can estimate the lens focal length by examining the angles that world coordinate axis lines make with each other. This is not a very accurate procedure and you should tell the program the actual lens focal length if possible, using the “**View**”/Photo Data menu command or by right mouse clicking in an empty area of the image. As a check, **3D Builder** will warn if its estimated value is substantially different from the stated lens focal length. This may be a symptom of incorrectly placed lines or lines that are not really coordinate axes, or the stated lens focal length may be wrong.

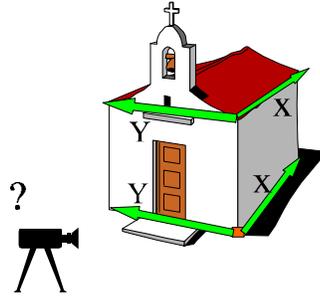


Figure 140 Lens focal length conflict

- First, double click on each of the **end points** of each lines and use the fine tuning tools to make sure that they are lined up correctly.
- Secondly, go to the image and look carefully at each of the “X”, “Y” and “Z” axis lines and verify that they **really are** “X”, or “Y” or “Z” axis lines.
- Also, go back and re-check your Field notes to be sure you have entered the camera information correctly.

In some camera orientations, the estimation of the focal length is very sensitive to the positioning of the axis lines, so a move of an axis end point of even one pixel can make a substantial difference in the camera focal length. Again, sometimes, especially when you have really short axial lines, you will need to do the best you can and realize that this message is just a warning.

Need To Specify Camera Lens Focal Length

In general you should always state the camera lens used if it is known. If there are enough coordinate axis queues in the scene **3D Builder** can estimate the lens focal length (see above), but this is not a very accurate procedure. Use the Image/Photo Data menu or right mouse click in an open area of the image to bring up the image properties box.

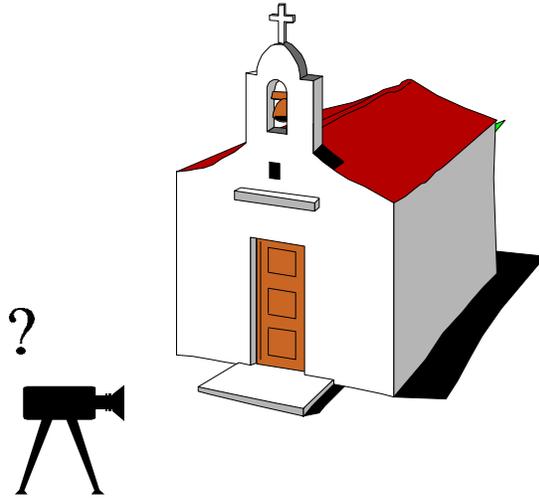
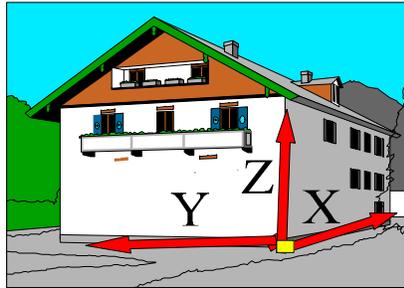


Figure 141 Need to give camera focal length

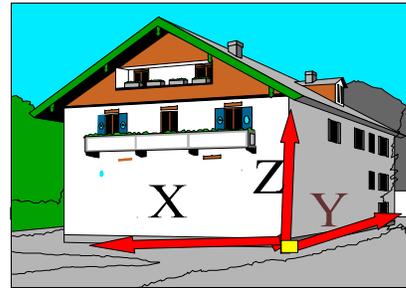
Axis Coordinate System Is Not Right handed



3D Builder requires the “X”, “Y”, and “Z” coordinate axes to be right-handed. That is, the “X” axis should point along your thumb, the “Y” axis along your first finger, and the “Z” axis along your bend second finger. Use the arrow tool to choose the line(s) to be changed and then change either the axis name or the axis direction of one the appropriate lines.



RIGHT
Right-Handed
Coordinate System



WRONG
Left-Handed
Coordinate System

Figure 142 Coordinate Systems/See illustration later in manual

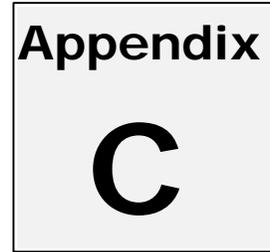


- Bring the image up in the window.
- Use the “**view filter**” command under the “**View**” menu (or access via the Toolbar ribbon icon which looks like an eye).
 - Select the appropriate axes so that only those lines are shown. (for example, only “X’ lines)
 - Look first for obvious errors like X lines that are really Y lines.
 - Make sure that they really are in a right handed orientation.



Note: In particular, be on the lookout for very short lines which may have their direction wrong.

APPENDIX C KEYBOARD ACCELERATORS



Under File Menu:

New Project Ctrl + N
Open Project Ctrl + O
Close
Save Ctrl + S
Calculate_3D F3
Exit

Under Edit Menu

Delete Del

Under Draw Menu

Point P
Line L
Circles/Arcs C
Polygon F
Freeform Bezier curve B
Extrude E
Merge M

Under View Menu

As Intput I
As Calculated U
Select Image F2
Next Image >
Prior Image <
Pan N
Zoom Z
Zoom In +
Zoom Out -

Under View Menu

All A
Properties D

Under Insert Menu

Photo/Ins Ins

Under Window Menu

New Window
Cascade
Tile
Arrange Icons
Split
3D Preview F4

Help Menu

Index
Help F1
Using Help
About 3D Builder

APPENDIX D

Appendix

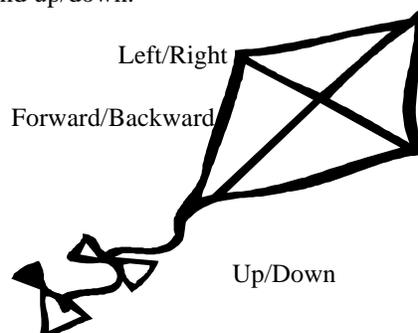
D

FUNDAMENTAL 3D CONCEPTS

Coordinate Systems

The term “coordinates” comes from calling numbers “ordinal”. To ordinate something is to name it. In this case, coordinates refers to locations in space and it means to number them. So “coordinates” means to co-number locations in space so you can find them.

Picture yourself flying a kite. We can describe the kite’s motion in three dimensions, left/right, forward/backward and up/down.



But describing the motion of the kite does not describe the kite completely. How could we tell someone else how to locate the kite in the sky? We would need to locate its position relative to a reference point. This reference point should be independent of other objects being measured. This non-moving reference point is called the “Origin”. Space is measured using a coordinate system that is built upon a reference point at the origin, and the axes radiating from it.

For example, you might describe the kite as being 10 feet south, 8 feet west and 32 feet above the first tall pine tree. So the kite is located by stating its distance from the

origin. The directions we just gave (south, west, up) all have a distance associated with them. When we measure along that distance line, that line is called the “axis” line. The way these axes are aligned is called a “coordinate system”. The north/south, east/west, up/down directions are replaced by the letters “X”, “Y”, and “Z”.

The coordinate system that **3D Builder** uses is the “Cartesian coordinate system”, developed by French mathematician Rene Decartes. In this system, the axes are at right angles to each other. This system is also the most commonly used in computer graphics.

There are two possible orientations of the axes in three dimensions. They are called the left hand coordinate system and the right hand coordinate system. **3D Builder** also used a “right-handed” coordinate system. This means that if you line up your right hand, your thumb would equal the X axes, your first finger would equal the “Y” axis and your second finger, pointing up would equal the “Z” axis. This system is also the most commonly used in computer graphics.



Example of a Right -Handed Coordinate System

2-D Space

Photographs are 2-D, flat objects on the paper. Most of us are used to identifying things in 2-D space. Each point has an address. Think of a piece of graph paper from geometry class. The “X” axis runs along the horizontal grid lines of the graph paper and the “Y” runs along the vertical grid lines of the paper. The first number is always the “X” address, the second number is the “Y” address location. So a point address of (3,4) would be three coordinate points along the “X” horizontal grid lines of the paper and

four coordinate points along the “Y” vertical grid lines of the graph paper and would look like this:

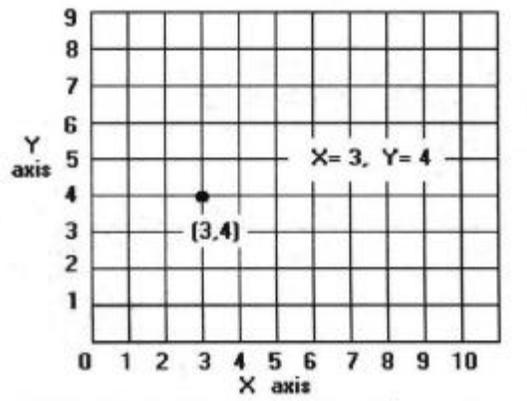
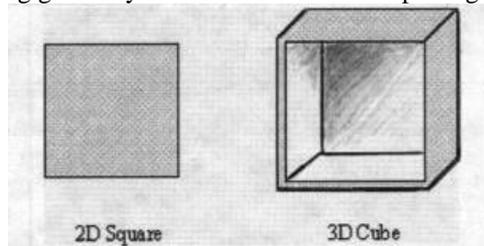


Figure 143 2D Grid showing X and Y Axis Lines

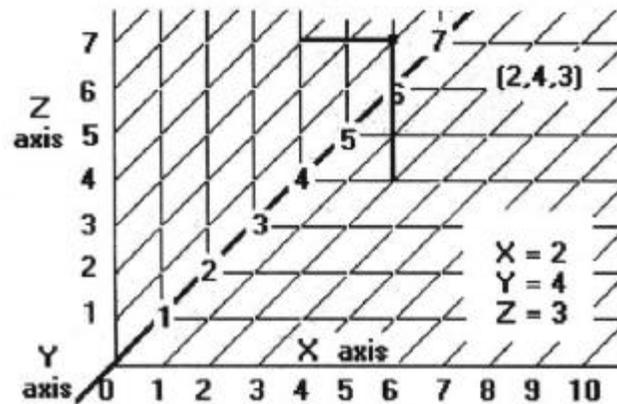
3-D Space

The fundamental difference between 2-D and 3-D is that two dimensions pictures are flat, while three-dimensional pictures appear to have volume. Three-dimensional space is created using geometry. At the basis of all computer-generated pictures is geometry.



The 3-D objects are created from 2-D geometric elements (sometimes called primitives). Although the above example is very simple, it helps to show how 3-D objects are constructed. The user describes a surface shape, the program breaks it down into 2-D geometric shapes. **3D Builder** calculates the shape, the placement and the orientation of an object based on its geometry, such as triangles and rectangles. A three-dimensional coordinate system, similar to the “x-y” coordinated system in 2-D, is defined in mathematics as a “world space” with height, width, and depth. The 3-D volume is represented by the “Z”-axis. This space makes it possible to have objects that not only appear three-dimensional, but can be rotated in three dimensions and viewed from any angle.

To select a point in 3-D space, the three coordinates must be listed in the order “X, Y, Z”. For example, if we use coordinate point (2,4,3), we are addressing a point that is two coordinate points along the “X” axis, 4 coordinate points along the “Y” axis and three coordinate points along the “Z” axis.



3D Builder uses a right-handed coordinate system. This being the convention of the “X” direction being to the left and the right, “Y” in and out of the screen, and “Z” being up and down.

Points

The basic entity of 3D models is the point. The terms “point”, “coordinate” and “vertex” are often used interchangeably. “Point” refers to a single location in space that can be located precisely. A point is not really a “thing”; it is a place where a thing can be. The location of a point is specified as three numbers, the distance along the “X, Y, Z” coordinate axes. These three values define the point in space.

Lines

A line is the simplest way to connect two points. A line describes the shortest distance between two points. **3D Builder** uses the terms “line” and “edge” interchangeably.

Faces

A plane is defined as the flat surface that passes through both the line and the third point.

Edges are the sides of polygons. **3D Builder** uses the term “face” and “polygon” interchangeably to describe the area between those edges. When you create a face, its points and edges are added to the **3D Builder** database.

Axes Planes

There are three natural coordinate planes.

- The “XY” plane contains the “X” and “Y” axis lines. Points in an “XY” axis plane have **the same** “Z” value.
- Similarly, the “YZ” plane contains the “Y” and “Z” axis lines. Points in an “YZ” plane have **the same** “X” value.
- Also, the “ZX” plane contain the “Z” and “X” axis lines and points in an “ZX” plane will have **the same** “Y” value.

3-D Modeling

You can learn a lot about 3-D modeling by thinking about the way things are made in the world around you. If you can mentally take apart some of the objects around you, you will get a good idea of how to approach the process of modeling them in 3D. If, for example, you have a photograph of a table, in mentally breaking down the table into legs and top, you come up with a list of faces to be created.

Artists trained in perspective drawing can create convincing simulations of 3D objects. This is labor intensive and if you change the orientation of the object, you have to start all over again. 3D programs allow you to create three-dimensional objects that are displayed on the screen. Once these are created, they can be viewed from any angle, scaled or rotated. You use point, line and face tools to create 3D objects.

A photograph can capture a lot of information quickly and inexpensively. With **3D Builder**, you can use the information on a photograph and convert it into a 3D model. Use the calculate tool to begin the **3D Builder** calculation process for converting the information given about the photo image to a 3D model. The “**Calculate**” commands begins the **3D Builder** calculate process. **3D Builder** does the complicated math for you and figures the x, y, and z coordinates.

3D Builder fosters some very sophisticated tools to locate the points, lines, and faces in 3D world space. It also calculates the distances between points, lines and faces. **3D Builder** creates the 3D model for you. With the special 3D Preview window, you can take a look at the model before you export the files. Then, you export the file to a rendering, CAD or animation package. **3D Builder** has the technology targeted at saving you time and money, and a lot of frustrations.

3D Builder Technical Support Form

Appendix

F

APPENDIX F

LIST OF FIGURES

3D Construction Company	
122 Creative Station	1
Elizabethton, Tennessee USA 37643-5358	1
1-423-543-8917	1
Fax 1-423-543-4011	1
Email: threedc@usit.net	1
Figure 1 An image displayed in the main work area	26
Figure 2 You need to identify 2 pairs of coordinate axis lines in your photo	27
Figure 3 Using construction lines for "Z" and "X" coordinate axes lines	28
Figure 4 Construction "Hint" lines using measured reference targets	28
Figure 5 "Camera Station" dialog box, from the "Station" tab page, "Image Properties"	30
Figure 6 "Calculate 3D" dialog box, showing error messages	31
Figure 7 Known Camera Height	33
Figure 8 Two Pairs of Coordinate Axes	34
Figure 9 One Known Point, Two Known Lengths	35
Figure 10 Three Known Points	35
Figure 11 Known Lengths	36
Figure 12 License Wizard showing Time Periods	38
Figure 13 License Wizard Screen showing the "finish" button	39
Figure 14 License Wizard Screen showing the "MachineID" location	40
Figure 15 3D BUILDER Opening Screen	42
Figure 16 "New Project" Window	43
Figure 17 Splitter Bar in Image Window	44
Figure 18 Project Tree, accessed by selecting "Window" menu, then choosing "Project"	45
Figure 19 3D Preview Window	46
Figure 20 Activate an Image Window by the "Window" menu, select the desired image by clicking on it	46
Figure 21 Visible Toolbar & Status Bar	47
Figure 22 Confirmation Message Box	48
Figure 23 Message Confirmation Box for "lens.dat" file	48
Figure 24 "File" Menu Commands	51

Figure 25	File Open Project Requester Box.....	52
Figure 26	Close Project Command Dialog Box	53
Figure 27	"Save Project As" File Requester Box.....	53
Figure 28	"Calculate 3D" Dialog Box	54
Figure 29	"Calculate 3D" Dialog Box expanded to show problem image.....	55
Figure 30	Export Menu Commands	55
Figure 31	Export Options Dialog Box.....	56
Figure 32	Export Problems Reporter.....	57
Figure 33	File export "Options" for perspective correction.	58
Figure 34	Export Camera Viewpoints Options Box.....	59
Figure 35	Exit Command Confirmation Requester Box.....	59
Figure 36	Message Confirmation Box for "lens.dat" file.....	59
Figure 37	Edit Menu Commands	60
Figure 38	Edit menu "Properties" command, shown editing a selected "X" line	61
Figure 39	Edit "Material Properties" dialog box, showing selected face materials being edited.....	62
Figure 40	Edit "Object Properties" shown here editing selected object.....	62
Figure 41	Draw Menu Commands	63
Figure 42	Grid Point dialog box.....	65
Figure 43	"Point on a Curve or Circle "point" shown as a special "circle" point. Note regular points above and to the right of the curve. The dark box has been added for emphasis in this manual and does not appear on your screen.....	68
Figure 44	Semi-Automatic Point Matching Wizard.....	71
Figure 45	Draw menu "Pick Color" dialog box	72
Figure 46	Draw "Texture Map", creating the bounding box around the area to be textured... ..	73
Figure 47	Draw "Texture Map" dialog box, shown after drawing area to be textured.....	74
Figure 48	"Make" menu commands	74
Figure 49	Make "Colinear" command showing 2 "X" lines constrained to be colinear.....	76
Figure 50	Points and Faces Constrained to be CoPlanar	77
Figure 51	View Menu Commands.....	80
Figure 52	Viewing Points Outside the Image.	83
Figure 53	View Properties, Image Properties Camera Lens Tab Page.....	84
Figure 54	Insert Camera, "Camera Lens Properties" dialog box	85
Figure 55	Estimate Camera Target Size dialog box.....	85
Figure 56	View Properties, Image Properties "Station Location" tab page	86
Figure 57	View Properties, Camera Station , "New Camera Station" dialog box	86
Figure 58	Camera Target Point.....	87
Figure 59	Camera Station Location Tab Page.	87
Figure 60	View Properties, Image Properties, "Image" tab page	88
Figure 61	Edge Detection Filter Shown.....	89
Figure 62	View Filter Dialog Box	90
Figure 63	"Insert" Menu Commands.....	92
Figure 64	Insert Photo File Requestor Box	92
Figure 65	Insert "Object" Dialog Box.....	94

Figure 66	Grid dialog box.....	95
Figure 67	Insert "Material" dialog box.....	96
Figure 68	Message Confirmation Box for "master materials" file.....	97
Figure 69	Insert "Camera Station" dialog box.....	97
Figure 70	Project Settings Camera Station default settings.....	98
Figure 71	Camera Station Properties Window showing images assigned to camera station	199
Figure 72	Insert Camera, "Camera Lens Wizard".....	100
Figure 73	Camera Name Screen.....	100
Figure 74	"Zoom" Lens Screen.....	101
Figure 75	Screen for the optics of digital and video cameras.....	101
Figure 76	Screen for selecting option for focal length source.....	102
Figure 77	Screens showing positioning of targets.....	103
Figure 78	Targets should form a rectangle for better accuracy.....	103
Figure 79	Pictures should be taken from skew angles.....	104
Figure 80	Select the images for the calibration process.....	104
Figure 81	Locating the reference points in the image.....	105
Figure 82	Target Points Identified.....	105
Figure 83	3D Builder does the calculations for you.....	106
Figure 84	Internal Sensor size for the camera.....	Error! Bookmark not defined.
Figure 85	Insert Camera, "Camera Lens Properties" dialog box.....	103
Figure 86	Camera Lens Property Box, General Page.....	104
Figure 87	"Tools" menu commands.....	106
Figure 88	Verify Points Wizard.....	107
Figure 89	Verify Points Wizard, fine-tuning of point locations.....	108
Figure 90	Verify Points, Point Matching Screen.....	108
Figure 91	Point Properties Tab Page.....	109
Figure 92	Project Preferences for Setting Colors.....	110
Figure 93	Setting Custom Colors for Project Preferences.....	110
Figure 94	Project Preferences Setting Defaults.....	111
Figure 95	License Wizard Screen.....	112
Figure 96	License Wizard showing the machine ID location.....	113
Figure 97	Progress Reporter Box.....	113
Figure 98	Window Menu Commands.....	114
Figure 99	Windows "Split" command changes the cursor to control the splitter bar in the active window.....	115
Figure 100	Project Tree with some tree branches expanded.....	116
Figure 101	3D Preview Window.....	117
Figure 102	Help Menu.....	118
Figure 103	Help Tutorials.....	119
Figure 104	Toolbar Icons, shown here "docked" to the top of the screen.....	121
Figure 105	Grid Point dialog box.....	123
Figure 106	Edit Point "General" Tab Page.....	124
Figure 107	Edit Point Properties, "Object Local" dialog box.....	125

Figure 108	Edit Point, "Local Object" tab page, shown with two grids intersecting	126
Figure 109	Semi-Automatic Point Matching	127
Figure 110	Edit "Line" Dialog Box	128
Figure 111	Insert Photo Dialog Box	130
Figure 112	Select Image List Dialog Box	132
Figure 113	Calculate 3D Progress Reporter Dialog Box	133
Figure 114	Close Command Dialog Box	141
Figure 115	Select Image List Dialog Box	142
Figure 116	Save As Dialog Box	144
Figure 117	The "Export" menu command is accessed via the File menu	146
Figure 118	The "Export" Options tab page.....	146
Figure 119	"Export" Problems Tab Page	147
Figure 120	Texture Map Dialog Box.....	150
Figure 121	Edit Material Properties Dialog Box.....	152
Figure 122	Information Box.....	152
Figure 123	Editing through the Paint Program.....	153
Figure 124	3D Preview window with textures touched up in Paint program	153
Figure 125	Polyline shown as a special "circle" point. Note regular points above and to the right of the polyline. The dark box has been added for emphasis in this manual and does not appear on your screen.....	164
Figure 126	Special "circular" point. Note regular points above and to the right of the polyline. The dark box has been added for emphasis in this manual and does not appear on your screen.....	169
Figure 127	Good coverage is obtained by overlapping angles	178
Figure 128	Take angled shots for better coverage.....	178
Figure 129	A "One-Photo" shot should be from an angle	179
Figure 130	Camera Stations need to be spaced widely apart	180
Figure 131	Calculate 3D error message "Need at least one known point"	203
Figure 132	Calculate 3D error message "Need at least three known points or two known axes"	204
Figure 133	Two measured axial lines and one known point	205
Figure 134	Three known points	206
Figure 135	Measured distance between three points	206
Figure 136	Axes lines going conflicting directions.....	207
Figure 137	Examples of Good and Poor Axes Lines Intersections	208
Figure 138	Point Location recommendations	209
Figure 139	Points not calculated correctly.....	210
Figure 140	Need additional information to calculate correctly.....	211
Figure 141	Lens focal length conflict.....	212
Figure 142	Need to give camera focal length.....	213
Figure 143	Coordinate Systems/See illustration later in manual	214
Figure 144	2D Grid showing X and Y Axis Lines.....	221

INDEX

- ?—
?Axis Line Tool Icon, 64, 65
- 0—
0,0,0. *See* 0,0,0 point
0,0,0 point, 29
- 1—
1-hour photo finishing service, 182
- 2—
256 color, 16
2-D, 221
2D information, 180
2-D Space, 220
- 3—
30 day trial evaluation, 19
30 day trial period, 38, 112
35mm camera, 25
35mm cameras, 137
3-D, 221
3D Builder Calibration Guide, 183
3D button, 32. *See* Calculate button
3D CONCEPTS, 219, 224
3D Construction Company, 1, 3, 4, 119, 176, 202
3D Geometry, 32
3D model, 182
3-D Modeling, 223
3D models, 222
3-D objects, 221
3D Preview, 22, 52, 76, 116, 153, 154, 2-217, 223
3D Preview Window, 41, 45, 55, 116. *See* Preview
3D space, 76
3-D Space, 221
3D Studio, 15, 22, 56, 84, 145, 147, 149, 154
3D View, 116
3-D volume, 221
3-point polygon, 67, 129. *See* Polygon tool command. *See* Polygon tool command
- 4—
4 Point Polygon RECTANGLE, 67
4 Point Polygon RECTANGLE Tool Icon, 129
4 Point Polygon Tool Icon, 67, 129
- 5—
50mm lens, 180
- 6—
640 by 480, 121
640 by 480 VGA screens, 23
- 8—
8 character filenames, 149
800 by 600, 121
800 by 600 SVGA screens, 23
- A—
About 3D Builder, 2-217
About 3D Builder command, 119
accuracy, 176, 183, 187
Accuracy Features, 185
Accuracy suggestions, 30
accurate model, 28
accurate perspective correction, 55
Active files, 51, 117

Active image, 58, 61
Active photo image, 131. *See* Image List Tool
active window, 140
add a new image, 130
Add a new photo image, 130, 138. *See* Insert Photo Tool. *See* Insert Photo Tool
Add Image, 100
Add image to Project, 51, 138
Add Image to the Project, 89, 130
Add Images, 43, 138
Add New Window, 138
Add The Images, 25
Add window tool, 131
Adding Photos, 137
Additional Circle Points, 164
Additional Points on Curve, 170
address, 220
airplane, 179
Ambient, 70, 92
angle, 25, 179, 223
angles, 177
animation, 223
any geometric constraints. *See* constraint
approximate, 80, 124, 128, 195, 208
Approximate check box, 128
Approximate Point Tool, 197
Approximate Point Tool Icon, 63
Approximation tool, 180
arc, 162, 164
arc mini-toolbar, 134
arcs, 66, 160, 2-217
Area Calculations, 91
Arrange, 2-217
Arrange Icons command, 114
Arrow Tool, 122, 207, 208, 214. *See* Selector Tool
As Calculated, 31, 78, 2-217
As Input, 31, 78, 2-217
aspect ratio, 45
assign colors, 70
assigning the material, 135
authorization code, 18, 39, 40, 111, 112
AutoCAD, 15
AutoCAD 3D, 145
Automatic cameras, 180
average difference, 52
axes, 214
Axes Coordinates. *See* Coordinate axes

Axes Planes, 223
Axial line, 34, 204
axial lines, 212
axis, 199, 210
Axis direction, 33, 207, 214
axis hint, 195
axis hint lines, 191
axis line, 220
axis lines, 27, 135, 212
Axis Plane, 61
Axes Planes, 87
axis system, 125

B

background, 180
Background Color, 88
backspace key, 68
backup, 19
base to extrude, 173
Batteries, 181
behind, 76
better accuracy, 184
Bezier spline curve, 21
Bezier spline curves, 66, 167
BMP, 22
BMP file, 71, 93, 149
BMP texture map file, 71
bounding box, 70, 140
Brightness, 85, 140
Browse, 147
bucket truck, 179
bullet, 78
Buttons, 42. *See* Toolbar

C

C:\Program Files\3DCo\3DBuilder, 17
CAD, 15, 145, 179, 223
CAD packages, 15
Calc, 30, 132, 145, 157
Calc3D, 22
Calculate, 32, 52, 72, 132, 203, 223
Calculate 3D, 32, 53, 72, 92, 145, 157, 2-217.
See Calculate button
Calculate Dialog Box, 30, 132
calculate tool, 223
Calculated Camera location, 83

- Calculated focal lens length, 81
- Calculated view, 31
- calculating focal length, 183
- calculation process, 30
- calibrate, 21, 185
- Calibrate Camera Lens, 112
- calibrate the camera lens, 195
- calibrated camera lenses, 183
- calibration, 187
- calibration chart, 195
- calibration for distortion and optical centering, 188
- calibration grid program, 184
- calibration process, 187
- calibration program, 183
- calibration project, 98, 190
- Calibration Wizard, 183, 187, 190
- camera, 21, 81, 95, 115, 180, 181, 211, 212
- camera angles, 177, 180
- camera calibration wizard, 21, 112
- camera focal length, 187
- camera focal lens, 83
- Camera height, 33, 83, 203. *See* camera
- Camera Heights, 179
- Camera Information, 26
- camera lens, 80, 190, 213
- Camera Lens box, 104
- Camera Lens Data File, 47, 48, 57
- Camera lens decentering, 184
- Camera Lens dialog box, 81, 192
- Camera Lens distortion, 184
- Camera Lens drop down box, 81
- Camera lens focal length, 184
- Camera lens focal length., 33. *See* focal length
- Camera lens optical decentering, 184
- Camera Lens Properties, 81
- Camera Lens Properties dialog box, 81, 95
- Camera Lens Property, 103, 194
- Camera lens Wizard, 95
- camera lenses, 47, 57, 115
- camera list, 193
- camera location, 84. *See* camera
- camera magnification, 23, 104
- camera name, 96
- Camera Orientation, 85, 140
- camera orientations, 212
- camera position, 22
- camera sensors, 98
- camera settings. *See* camera
- Camera size, 33
- Camera Station, 29, 69, 80, 83, 84, 95, 177.
See insert
- camera station layout, 177
- camera station number, 83
- Camera Station Properties, 95
- Camera Stations, 30, 33, 44, 109, 116, 143, 176, 177, 179, 180, 181, 199, 210, 211
- camera stations coordinates, 94
- Camera Target Point, 84
- camera target size, 193
- camera tripod, 177
- camera type, 96, 111, 194
- Camera Viewpoints, 22, 56
- Camera Wizard, 21
- camera/lens combination, 112
- Cameras, 15, 30, 33, 44, 52, 111, 115, 132, 180
- Cameras positions, 52
- Cameras unreachable, 30, 52, 132
- Cancel, 50
- Cartesian coordinate system, 220
- Cascade, 2-217
- Cascade command, 114, 141
- CD, 17
- CD Installation, 17
- check box, 73, 74, 75, 87, 124, 158, 159
- Check Boxes, 91
- check mark, 46, 77
- child. *See* object
- Choosing Images, 25
- Circle center, 162
- circle point, 65, 164
- circle tool, 160
- Circle Tool mini-toolbar, 160
- Circle, Curve, and Extrusion mini-toolbars., 23
- circles, 52, 66, 160, 199, 2-217
- Circles and Arcs, 21
- Circles mini-toolbar, 134
- Circles Tips, 118
- circular arc, 162, 164
- circular arcs, 66, 160
- clock (date and time), 200
- Clockwise, 85, 140
- Close, 140, 141, 2-217
- Close caption bar, 79
- Close command. *See* Exit command

- Close Project, 50
- Close The Image, 140
- close the loop, 68, 129
- closed circle, 162
- Closed Curve, 21, 167, 168, 171
- close-ups, 179
- cloudy, 180
- Colinear, 72, 125, 128, 157, 158, 209
- Colinear constraint check box, 125
- Colinear Constraint" dialog box, 73
- color, 25, 91, 92, 106, 149, 181
- Color dialog box, 110
- Color Page, 92
- Color Settings, 109
- Colors tab, 23
- columns. *See* grid
- Command button, 16
- commands, 20, 42, 52, 58, 61, 78, 113, 117, 132, 223
- Commands for creating geometry, 42
- complex, organic objects, 198
- conceptual modeling
 - modeling, 186
- conceptual modeling project, 195
- confidential, 202
- confirmation message, 47, 57
- confirmation message box, 50, 140
- constraint, 115, 125, 128, 157
- constraint branch, 73, 74, 75, 157
- Constraint check boxes, 128
- Constraint Project Tree, 76, 159
- constraint properties window, 159
- constraints, 72, 76, 157, 159, 185
- Construction Hint Lines, 27
- construction lines, 180
- Contents command, 118
- Contents of windows. *See* Save
- Context sensitive help, 117. *See* help
- Contrast, 85, 140
- Contrast of the image, 85, 140. *See* Properties
 - command. *See* Properties command
- control center, 115
- control points, 185
- control rod, 197
- coordinate, 222
- Coordinate Axes, 27, 33, 34, 64, 65, 127, 212, 214
- coordinate axes plane., 64
- Coordinate axis, 36, 206, 212, 213. *See*
 - Coordinate axes
- Coordinate axis direction lines, 33
- coordinate axis line, 64, 128
- coordinate axis lines, 27
- Coordinate Axis Pairs, 33
- coordinate axis plane, 64
- coordinate planes, 127, 223
- coordinate point, 221
- coordinate points, 220
- coordinate system, 220
- Coordinate Systems, 219
- coordinates, 219
- coordinates of the camera location, 84
- CoPlanar, 73, 125, 157
- Coplanar constraint check box, 125
- Coplanar constraint" dialog box, 74
- copy the texture map, 148
- Copyright, 119
- coverage, 180
- Critical project, 181
- cropped, 195
- cropped texture file, 150
- cropping, 184
- Cropping in enlarger, 184
- Cropping in scanner, 184
- Cropping of the Photos, 182
- CRTL +S, 51. *See* "Save command"
- CTRL + O, 50. *See* "Open command"
- CTRL +N, 49. *See* "New command"
- cube, 195
- cursor, 20, 42, 43, 61, 62, 63, 65, 68, 122, 127, 129
- cursor arrow, 65
- Curve, 87
- curve merging, 135
- curve plane, 168
- Curve Sense Tool, 135
- curve tool, 21, 66, 168
- Curve Tool mini-toolbar, 167
- curve weights, 23
- curves, 52, 133, 167, 199
- Curves mini-toolbar, 134
- Curves Tips, 118
- Custom Install, 17
- Customer Service, 201, 202

—D—

Data Exchange Format, 145
Decartes, 220
Decimal feet, 182
Default, 86, 92, 94, 109, 122, 129, 147, 149
Default cursor, 61. *See* Select command
Default directory, 17, 18
default material, 91
default object, 54
Defaults, 111
Defective package parts, 201
Delete, 44, 143, 199, 2-217
Delete command, 58
delete duplicates, 199
Delete key, 51, 58. *See* Delete command. *See*
 Delete command
demo mode, 19, 38, 112
depth, 221
dialog box, 76
Diffuse, 70, 92
digital camera, 21, 25, 193, 198
Digital Camera Information Sheet, 105
digital camera sensors, 98
digital cameras, 23, 104, 137, 183
digitizer
 frame grabber, 198
Direction arrow, 207
Direction indicator arrows, 128
direction of line, 135
Directory, 47, 51, 54, 130, 138
Display mini-toolbar, 23, 133
Display mini-toolbars, 88
Display of the status bar, 46, 78. *See* Status
 bar
Display of the toolbar, 41, 46, 77. *See* Toolbar
distortion, 187
docked, 77
Docking toolbar, 121
Down, 124
Drag and Drop, 23
drag and drop to move point, 122
Draw, 56, 69, 70, 148, 150, 151, 154
Draw Menu, 32, 61, 2-217
Draw Path, 174
Draw/ Pick Color, 69
Draw/Circle, 160
Draw/Curve, 167

Draw/Extrusion, 172
Draw/Merge, 29
drive, 54
drives, 130, 138
drop down list, 26, 111
drop down list box, 70, 89, 91, 150
drop down list box., 70
duplicate face, 199
duplicate line, 199
duplicate point, 199
DXF, 54, 145
DXF layer. *See* export

—E—

edge, 222
Edit, 123, 140, 151
Edit A Line, 128
Edit command, 16, 58, 61
Edit Menu, 2-217
Edit Point, 124
Edit/ Delete, 58
Editing a Circle, 164
Editing a Circular Arc, 164
Editing a Curve, 171
Editing an Arc, 164
Editing an Extrusion, 175
Editing an Individual Item, 58
ellipse, 160
end point, 63
end points, 212
ending point, 127
enlarger, 184
Equal Length, 158
Equal Length Constraint dialog box, 75
equivalent focal length, 98
erase, 153
error message, 199
Error Messages, 200
errors in modeling, 199
Errors in Password, 200
Estimate box, 82
Estimate Camera Lens Dialog Box, 82
Estimate Camera Target Height and Width”
 Dialog Box, 193
Estimate Camera Target Size Dialog Box, 82
existing point, 63
Exit, 41, 47, 57, 93, 153, 2-217

- Exiting 3D Builder, 47
 - Export, 15, 25, 32, 49, 53, 54, 91, 92, 145, 147, 154
 - Export command, 53
 - Export check box, 91
 - export circle, 165
 - Export Dialog Box, 32
 - Export Dialog Tab Page, 32
 - export file, 22
 - export file formats, 145
 - Export File Tab Page., 55
 - export files, 154
 - Export Options, 54, 146
 - exported, 180
 - exporting camera viewpoints, 56
 - Extrude, 2-217
 - Extrusion mini-toolbar, 134
 - Extrusion Tips, 172
 - extrusion tool, 21
 - Extrusion Tool mini-toolbar, 172
 - extrusions, 52, 68, 172
 - Extrusions Tips, 118
 - eye, 208, 214
 - eye dropper, 69, 151
- F—
- F3, 22, 52
 - F4, 22, 45
 - face, 59, 76, 87, 92, 151, 173, 199, 222, 223
 - face material, 59
 - Faces, 32, 52, 58, 72, 73, 86, 91, 115, 116, 125, 128, 133, 149, 159, 199
 - features, new, 21
 - Field Guide Forms, 177, 179
 - Field notes, 181, 182, 212
 - Field Notes Forms, 33, 215. *See* Appendix B
 - File, 30, 32, 47, 49, 51, 54, 72, 117, 145, 157
 - File format, 32
 - file format to be exported, 54
 - file formats, 137. *See* import
 - File Menu, 2-217
 - File name, 47, 54, 79, 89, 130, 138
 - File requester box, 50, 51
 - file type, 51, 143
 - File/Calc3D, 173, 175
 - File/Calculate 3D, 127
 - File/Calculated 3D Preview, 45
 - File/Export, 55
 - Film, 176, 180, 181
 - Film flatness, 184
 - Film Height, 193
 - film scanners, 184
 - film size, 96
 - Film Width, 193
 - filmstrip, 142
 - Filter Edges, 86
 - Filter Tool, 140
 - fine tune point location, 107
 - fine tuning, 208, 212
 - fine-tune, 124
 - Finish button, 39
 - Flip Axis Sense, 174
 - Flip Line/Curve Sense Tool, 135
 - flipping the direction of the curve, 135
 - Floppy Disk Installation, 18
 - focal length, 21, 33, 82, 188, 212, 213. *See* camera
 - focal length box, 193
 - Focal Length Conflicts, 200
 - focal length of the lens, 98
 - focal length source, 98
 - focal lens, 95
 - Focus setting, 181
 - Fonts, 106, 109
 - format, 54, 147
 - Frame, 181
 - frame grabber, 198
 - free form curves, 66
 - free-form (Bezier spline) curves, 21, 167
 - Freeform Bezier curve, 2-217
 - free-form curves, 167
 - Full Install, 17
 - Functions, 37, 41, 191
- G—
- General tab page, 124
 - Generic digital camera, 23
 - geometric elements, 221
 - geometric shapes, 221
 - geometry, 221
 - Getting Help, 20
 - Getting Started, 25
 - Glare, 178
 - Global axis/plane drop down list box, 128

global coordinate planes, 92
 Global Coordinates input boxes, 124
 global list box, 128
 global plane list, 92
 grayed out, 76, 125, 128
 grid, 92, 123, 181, 198
 grid lines, 220
 grid location, 125
 grid object, 92
 grid plane, 92
 Grid Point, 123
 Grid Point tool, 62, 123
 Grid Point Tool Icon, 62, 123
 grid spacing, 92
 grid table, 198
 Grid Tool window, 62
 grids, 125

—H—

Height, 82, 221
 helicopter, 179
 help, 20, 64, 2-217
 Help menu, 118, 2-217
 Help tool, 133. *See* On-line help
 Help tool icon. *See* help
 Help/Tutorial, 22
 Helpful Tips on Circle, 161
 Helpful Tips on Curves, 168
 Helpful Tips on Extrusion, 172
 Hidden Point, 124
 hierarchy structure, 91
 high resolution film scanner, 185
 highlight, 58, 62, 68, 72, 73, 74, 75, 76, 92, 123, 157, 158, 159
 highlighted, 125
 Hint, 124, 157
 Hint line, 78. *See* Status Bar
 hint lines, 27
 hints, 180
 horizontal, 64, 127, 220
 horizontal grid, 125
 horizontally, 129, 139

—I—

icon, 121, 141, 207, 208, 214
 IGES, 54, 145

Image, 43, 79, 92, 111, 124, 128, 140, 208, 212, 223
 Image Area, 124
 Image files, 25
 image list tool, 79, 131
 Image List tool icon, 79
 Image Properties, 26, 81, 192. *See* View
 image properties box, 213
 Image properties tab page, 84
 image properties window, 84
 image resolution, 184
 image scanning, 184
 Image type, 51
 image view, 76
 image views, 115
 image window, 25, 26, 41, 70, 79, 113, 151
 Image/Photo Data, 213
 images, 137
 Import, 32
 Import file, 145
 Importing File Formats, 137
 Improve Accuracy, 185
 Improved accuracy, 176. *See* Photo Tips
 Inches, 182
 independent measures, 186
 Independent mini-toolbars, 133
 individual machine, 19
 Information Box, 152
 information is not known., 195
 initial estimate, 52
 initial estimates, 194
 Initial Graphics Exchange Specification, 145
 Insert, 25, 70, 89, 92, 93, 123, 150
 insert a photo, 94
 Insert Camera Lens, 95, 189
 Insert Camera Station dialog box. *See* insert
 Insert camera wizard, 95
 Insert Grid. *See* grid
 Insert Grid dialog box. *See* grid
 Insert Material, 93. *See* material
 Insert menu, Insert Material, 93
 Insert Object. *See* insert
 Insert Photo, 26, 89. *See* Insert
 Insert Photo dialog box, 130
 Insert photo tool, 130, 137
 Insert Station. *See* camera
 Insert Station” command, 95
 Insert/Camera Lens, 26

Install button, 40
 installation, 17
 Installation Instructions, CD, 17
 Installation Instructions, Floppy Disks, 18
 Installation Procedures, 17
 internal magnification, 193
 internal sensor size, 102
 Internet, 54, 145
 Internet browser, 22, 118
 Internet Browsers, 145
 Inventor, 22, 54, 56, 111, 198, 145, 147, 154
 Inventor Studio, 56
 Invert the image, 85, 140. *See* Properties
 command. *See* Properties command

—J—

JPEG file, 71
 JPEG texture map file, 71
 JPEG Texture Maps, 22
 JPG, 22, 149
 JPG file, 93
 just-in-time helpful tips, 118
 Just-In-Time On-Screen Helps/Circle Tool,
 161
 Just-In-Time On-Screen Helps/Curve Tool,
 168
 Just-In-Time On-Screen Helps/Extrusion Tool,
 172

—K—

Key features, 27
 key points of interest, 176
 keyboard accelerator keys, 46
 Keyboard Accelerators, 41, 2-217
 Known Camera Height, 33, 185. *See* camera.
 See camera height
 known camera points, 185
 known control points, 185
 known data, 124
 Known Lengths, 35, 36
 known measured objects, 185
 known measurements, 185
 Known points, 34, 35, 36, 204, 206, 209
 Known points are colinear, 209

—L—

ladder, 179
 Left, 124
 left hand coordinate system, 220
 Length, 33, 34, 35, 204, 205, 212, 213
 length of a line, 197
 lens, 95
 lens cap, 181
 lens distortion, 180, 184
 lens focal length, 81, 97, 212. *See* camera
 lens.dat, 47, 190
 lens.dat file, 103
 Lenses, 44, 115, 177, 179. *See* Camera data
 Liability, 4
 LICENSE, 3, 37, 111, 200
 License Authorization Instructions, 18
 license authorization procedures, 37
 License Wizard, 18, 37, 111
 Light meter, 180
 lighting, 178, 180
 line, 59, 72, 74, 86, 87, 109, 121, 128, 158,
 173, 180, 2-217, 222, 223
 Line command, 63. *See* Toolbar
 line configurations, 63
 Line Dialog Box, 75, 128, 158, 159
 line directions, 135
 Line Flip, 24
 Line Properties, 135, 197
 Line tool, 63, 68, 127
 Line tool command, 63. *See* Toolbar
 Line Tool Dialog Box, 31, 65
 line tool icons, 63
 Line tool mini-toolbar, 170
 Line Weight, 110
 line weights, 23
 Lines, 27, 32, 33, 34, 35, 36, 52, 58, 72, 115,
 125, 133, 159, 199, 204, 205, 206, 207,
 208, 209, 212, 214
 List files of type drop down list box, 130
 LIST OF FIGURES, 225
 local coordinates, 125
 local objects, 125
 locate the camera, 176
 location, 177
 Location of targets, 184
 Locked. *See* point

—M—

machine ID, 200
 Machine ID number, 39, 112
 Magnify, 79, 139. *See* Zoom In command. *See* Zoom In command.
 magnifying glass, 130
 Main menu, 42
 Main menu bar, 45
 Main project window., 46, 77. *See* project window
 Make, 72, 74, 75, 157, 158, 159
 Make Behind, 72, 76, 199
 Make Colinear, 72, 157, 158
 Make CoPlanar, 73, 157
 Make Equal Length, 74, 158
 Make Parallel, 75, 157, 158
 Make Perpendicular, 75, 159
 Make Perpendicular constraints, 23
 manufacturer's data on the sensor size, 103
 Many Point Polygon tool icon, 67, 129
 master "lens.dat" file, 103
 master lens.dat, 47
 material, 59, 70, 92, 93, 149, 150
 material box, 93, 151
 material colors, 149
 Material Data File, 57
 Material dialog box, 92
 Material List, 70
 Material Properties, 59, 92, 151
 material type, 59
 Material.dat, 93
 material.dat file, 22
 Materials, 3, 4, 44, 58, 70, 91, 115, 116, 117, 119, 150, 151
 Materials box, 150
 Materials dialog box, 92, 153
 Materials drop down list box, 151
 Materials list, 150
 Materials Property Box, 93, 150
 Materials tree branch, 59
 Maximize, 140
 maximum setting. *See* grid
 measure the distance, 182
 Measured. *See* measurements
 Measured Length input box, 128
 measurement, 25
 Measurements, 25, 33, 34, 176, 181, 204

Measuring device, 182
 Measuring devices, 177
 memory, 42
 Menu, 16, 17, 20, 21, 25, 30, 31, 32, 42, 45, 46, 47, 49, 51, 58, 61, 77, 78, 113, 117, 160, 212, 213
 Menu command, 16, 212
 Merge, 15, 62, 68, 122, 126, 163, 170, 195, 2-217
 Merge command, 126
 Merge point tool, 126
 merge the circles, 160
 Merge Tool, 29, 32, 210
 merged points, 199
 merges the two points, 68
 Merging Curves, 170
 Merging process, 32. *See* Merge
 merging the curve, 135
 message box, 93
 Microsoft Windows, 15
 mid-range lens, 180
 Minimize, 140, 141
 minimum. *See* grid
 mini-toolbars, 23
 mirror, 179
 Mixed Lenses, 179
 Model, 32, 180, 182
 Model due YESTERDAY, 198
 modeling errors, 199
 Movable toolbar, 121. *See* Docking toolbar
 Multiple Images, 29, 32, 141
 Multiple Line, 65
 multiple photos, 179
 multiple select, 61, 122, 138
 multi-select images, 138

—N—

name, 92
 Name of Material Box, 91
 Name of the Object. *See* object
 natural cues, 27
 natural features, 28, 194
 Natural Queues, 33, 34, 204. *See* Queues
 Need model ASAP, 198
 Negative, 85, 140
 Negative scanner, 198
 negatives, 182, 195

- Network, 90, 130, 138
 - New, 81, 93, 150
 - New tool, 174
 - New button, 83
 - new camera station, 83, 94
 - New command, 49
 - new features, 21
 - New File, 2-217
 - new image, 138
 - new image window, 139
 - new point, 122
 - New Project, 43, 49
 - New Window, 26, 43, 113, 138, 141, 2-217
 - New Window command, 113, 138
 - New Window tool, 114
 - Next image, 78, 79, 80, 2-217
 - No measurements, 204
 - No measurements known measurements, 194
 - No natural right angles, 195
 - No reference marks visible reference marks, 194
 - Non-collinear, 34, 204
 - Non-Planar curves, 167
 - Non-textured materials, 22
 - Normal Project, 43
- O—
- object, 17, 32, 60, 91, 109, 121, 149, 151, 178, 180
 - Object and Material Assignment, 135
 - Object and Material Drop Down List Box Icon, 63
 - Object dialog box. *See* object
 - Object Local tab, 125
 - object points. *See* object
 - Object Properties, 60
 - object properties box, 151
 - Objects, 15, 25, 28, 44, 54, 58, 61, 76, 115, 116, 125, 147, 151, 154, 176, 182
 - objects tree, 92
 - Objects tree branch, 60
 - objects with unusual shapes, 198
 - obstacles, 177
 - obstruction, 65, 180
 - obstructions, 177
 - odd size texture map, 111, 198
 - On A Curve, 125
 - on screen, just-in-time helpful tips, 118
 - one beep signal, 52
 - one photo, 179, 210
 - on-line form, 22
 - On-Line Help, 20, 117, 118. *See* Help command
 - online tutorials, 22
 - Only Show, 87
 - open circle, 162
 - Open command, 50
 - Open Curve, 21, 167, 168
 - Open Project, 50, 2-217
 - Open windows, 45. *See* Windows menu
 - Operating defaults, 106
 - Optical decentering, 184, 187
 - optical distortion, 187
 - optics, 98
 - Options, 106
 - Options Export, 55
 - ordinal, 219
 - orient, 211
 - Orient the camera, 34, 204. *See* camera orientation
 - orientation, 27, 84, 140
 - orientation export, 22
 - orientations, 220
 - Origin, 33, 34, 204, 219. *See* 0,0,0 point
 - Origin point, 34, 204
 - overcast, 180
 - overlap, 177
 - Overlapping Coverage, 177
 - overview, 115
 - overview shot, 181
- P—
- Paint program, 151
 - palette, 110
 - Pan, 29, 79, 129, 2-217
 - Pan tool, 79, 129, 139
 - Parallel, 75, 92, 128, 158, 208
 - Parallel Constraint dialog box., 75
 - Parent Object, 92. *See* object. *See* object
 - password, 37, 200
 - Password Problems, 200
 - percentage of calculations, 113
 - Perpendicular, 23, 75, 157, 159

- perspective, 147, 148
- perspective correction, 55, 154
- Perspective Correction for Texture Maps, 55
- perspective distortions, 56
- perspective drawing, 223
- perspective matching, 185
- Perspective pictures, 208
- Photo, 25, 89, 93, 139, 143, 150, 176, 2-217, 223
- Photo CD, 25, 90, 137, 182, 184, 198
- Photo CD Select Resolution Size Box, 85
- Photo CD Size, 140
- Photo Data, 212
- photo enlarger, 184
- photo session, 176
- photo shoot, 28, 176, 180, 181
- Photo Tips, 25, 176
- photograph, 223
- photographic enlargement, 184
- photographic supply shop, 181
- photographs, 137, 182, 220
- Photos, 15, 16, 21, 25, 26, 27, 44, 52, 115, 132, 143, 180, 181, 182, 199
- Photos Cropping, 182
- Pick, 36, 61, 206
- Pick Color, 69, 70, 151
- Pick Color Dialog Box. *See* Draw
- picking a color, 149
- Pictures taken by someone else, 195
- pixel, 212
- pixel resolution, 183
- pixel size, 71, 150
- Placing Points Outside an Image, 80
- planar curves, 167
- Plane, 36, 73, 92, 157, 160, 199, 206, 210, 222, 223
- plane of the curve, 168
- Planning, 176, 177
- plus sign (+), 17
- point, 29, 59, 68, 72, 73, 86, 109, 121, 123, 125, 210, 2-217, 222, 223
- point address, 220
- Point Dialog Box, 73, 158
- point location, 196
- Point location is unseen, 197
- Point Merge tool, 69
- Point on a Circle, 65
- Point on a Curve, 65
- Point Pair Tool Icon, 62, 123
- Point Properties, 125, 196
- Point tab page, 123
- Point Tool, 17, 27, 31, 32, 62, 122, 126
- Point tool command, 62. *See* Toolbar
- point tool icons, 62
- Pointer tool, 121. *See* Selector tool
- Points, 27, 28, 29, 30, 32, 33, 34, 35, 36, 52, 58, 62, 63, 67, 68, 72, 87, 92, 115, 122, 125, 126, 129, 132, 133, 157, 158, 159, 177, 182, 199, 203, 204, 206, 208, 209, 211
- points on the circle, 122
- polygon, 70, 2-217, 222
- polygon configurations, 66, 129
- Polygon Object and Material Tool Icon, 67
- Polygon Plane Tool, 67
- Polygon tool, 66, 128. *See* Toolbar
- polygon tool icons, 66, 129
- polygons, 128
- Polyline Tool, 65, 164, 170
- pop-up, 192, 193
- pop-up menu, 151
- power shortcut keys, 22
- preferences, 106
- primitives, 221
- Print paper flatness, 184
- print scanner, 184
- Prior Image, 79, 2-217
- problem, 52, 191
- Problem Area, 147
- Problem Reporter, 147
- Problems, 55, 88, 180, 200
- Problems not Listed, 200
- Product information, 201
- Progress reporter, 30, 52, 113, 132
- projec, 115
- Project, 43, 58, 59, 73, 74, 92, 103, 116, 130, 131, 138, 142, 143, 151, 179, 199
- Project file, 50, 89, 94, 154
- Project files, 32, 44, 91
- Project settings, 94. *See* options
- project tree, 58, 60, 116, 142, 159
- Project Window, 22, 41, 44, 58, 72, 76, 91, 115, 142, 143, 151, 157, 199
- projector lens, 184
- proofs, 182
- Properties, 58, 59, 75, 80, 140, 151, 192, 194, 2-217. *See* View

Properties Box, 151
 Properties window, 59, 74, 92
 property box, 208
 property window, 115
 Props, 177

—Q—

QUICK GUIDE, 25

—R—

radial lens distortion, 183
 rapid conceptual modeling, 186
 rapid prototyping machines, 54
 Read Me file, 18
 Recent File, 117
 Recent File” command, 117
 rectangle, 67, 70, 93, 129, 150
 rectangles, 221
 Reference, 29
 reference marks, 194, 198
 reference point, 219
 reference points, 28, 29, 177. *See* targets
 Reference targets, 25, 27, 28, 32, 160, 167, 181, 182
 Refresh, 149
 Registration, 201
 Registration address, 201
 Registration card, 4, 20, 201
 Remove. *See* Delete command
 rendering, 223
 Rendering package, 32, 49
 rendering program, 84
 Rene Descartes, 220
 reposition, 124
 resize, 142
 resized, 45, 79
 Resizing the window, 116
 Resolution Size, 85
 Right, 124
 right hand coordinate system, 220
 Right handed coordinate system, 207
 right-handed coordinate system, 174, 222
 rigid pole, 179
 rooftop, 179
 Rotate, 140

rotated, 116, 223
 rows. *See* grid
 rubber-banded, 65

—S—

Safety hazard, 177
 same length, 74, 128, 157, 158
 same point, 109
 Same Point tool, 124
 Same Point Tool Icon, 62, 123
 Save, 32, 41, 47, 51, 132, 143, 2-217
 Save As, 47
 Save As Dialog Box, 47
 Save Project, 51
 Save Project As, 51
 Saving A Project, 47
 Scale, 34, 181, 194, 204
 scaled, 223
 scanner, 198
 Scanner position accuracy, 184
 Scanner sampling resolution, 184
 scanners, 137
 scanning from prints, 185
 scanning prints, 183
 screen, 82
 Screen Layout, 23
 Scroll, 79, 129, 139. *See* Pan Tool command
 second beep signal, 52
 select, 121
 Select All command, 61
 Select command, 61
 Select First Point, 126. *See* Merge point command
 Select image, 90, 139, 2-217
 Select Image command, 79
 Select Image Dialog Box, 79, 131, 142
 Select Image list, 79, 131, 142. *See* Image List tool. *See* Image List tool
 Select Photo dialog box, 130, 138. *See* Insert Photo Tool. *See* Insert Photo Tool
 Select This Point, 126. *See* Merge Point command
 Selector, 128
 Selector tool, 121, 122, 171, 175
 Selector tool icon, 123
 semi-automatic mode, 69
 Semi-Automatic Point Matching, 69, 126

sensors, 98
Set button, 109
set of materials, 149
Setting the colors, 70
Setting the object, 135
settings. *See* grid
Settings/Line Weight, 110
Setup, 181
Shift, 73, 158, 159
shift key, 122
Shortcut, 42, 46, 51, 58. *See* Toolbar
 commands
shortcut keys, 22
shrink, 124
Single Point Tool Icon, 62, 122
Skew, 65, 127
Skew Line Tool Icon, 64
Small Object, 178
snap, 72, 158
Snap-to, 63
Software License Agreement, 3
Solid, 88
Sources of Error, 184
spacing, 92
Specular, 70, 92
spin control, 150
spin control arrows, 71
spline curves, 66
Split, 114, 2-217
Splitter, 140
Splitter bar, 43, 114, 139
Splitter window, 25, 43
STARTING A PROJECT, 41
starting point, 127
Station. *See* camera
Station Location, 81
Station Location tab page, 83
station number. *See* camera
stations, 115
Stations/Photos, 143
Status bar, 41, 42, 46, 65, 68, 78, 126, 129,
 199. *See* Status bar
Status Bar command, 78
Step back. *See* Zoom Out command
STL, 54, 145
story-board, 182
sub-pixel positioning, 184
sub-pixel precision, 22

sun, 180
surface properties, 92
surface shape, 221
System Requirements, 16

—T—

tab, 109
tab page, 26, 80
tagged, 91, 92
tape measure, 99, 188
target, 182
target features, 184
Target Film Height and Width., 82
Target Height, 193
Target locations, 181
Target points, 33
Targets, 25, 27, 32, 99, 176, 177, 181, 182,
 185, 188, 194, 198. *See* reference targets
technical support, 20, 201, 202
telephoto, 97
Texture, 91, 149, 150
texture a circle, 165
texture a circular arc, 165
texture an arc, 165
texture an object, 66
texture coordinates, 56, 148
texture file name, 154
texture file name embedded, 56
Texture Map, 70, 93, 111, 198, 149, 151
Texture Map dialog box, 71, 150
texture map from the photo, 150
texture map image file, 148
Texture Map Tool, 150
Texture maps, 56, 115, 116, 147
Texture Pattern, 70, 92
Texture Pattern icon, 70
textures, 25, 117
Texturing a Curve, 171
The Project Settings, 106
the texture map section, 93
three dimensions, 220
threedc@usit.net, 200
three-dimensional coordinate system, 221
Thumbnail, 25, 43, 79, 131, 140, 151
Tile, 2-217
Tile command, 114, 141
tip, 176

tips, 118
 Tips on Curves, 168
 toggle switch, 78
 tool, 157
 tool bar, 42
 Tool Bar command, 77
 tool icon, 131, 138
 Tool icons, 77. *See* Toolbar
 Toolbar, 20, 29, 30, 31, 32, 41, 46, 62, 63, 70, 74, 75, 76, 77, 79, 90, 109, 114, 118, 121, 122, 123, 126, 127, 130, 131, 132, 133, 137, 142, 143, 145, 151, 207, 208, 214
 Toolbar ribbon, 77
 Tools/Calibrate Camera Lens, 187
 Tools/License menu, 38
 Tools/Verify Points, 22, 102, 106
 Touch Up, 152
 Touching Up Textures, 151
 tree control level, 116
 Tree control system, 44, 115. *See* Project Window
 tree listings, 115
 triangulation solver, 185
 Turn the image by 90 degree, 85, 140. *See* Rotate. *See* Properties command. *See* Rotate. *See* Properties command
 tutorial image files, 19
 tutorials, 118
 two dimensions, 221
 type of camera, 96
 Type of Project, 43
 types of colors, 70

—U—

Unknown camera type, 192, 193, 195
 Unknown focal length, 191
 Unlocated. *See* point
 unlocated points, 87. *See* Calculate 3D
 unnamed-1, 54, 147
 Unreachable, 30, 52, 132
 unrestricted use, 19, 38, 112
 Unsaved information, 47
 Up, 124
 Upgrade, 201
 upgrades, 20
 Using Help, 2-217

—V—

Verified check box, 124
 Verify occurrences/ same point, 108
 Verify Point wizard, 107
 Verify Points, 106
 Verify Points Wizard, 106
 Verify Wizard, 102
 Version number, 119
 vertex, 222
 vertical, 64, 127, 220
 vertical grid, 125
 vertically, 129, 139
 video camera, 25, 198
 video cameras, 98, 137
 View, 26, 29, 52, 80, 86, 90, 113, 139, 140, 142, 207, 208, 212, 214
 View Filter, 86, 207, 208
 View Filter dialog box, 87
 view finder, 185
 View Image Properties, 83
 View menu, 31, 46, 77, 78
 View Menu Commands, 76
 View/ Select Image, 79
 View/“Prior” Image, 79
 View/All, 80
 View/Background Color, 45
 View/Background Colors, 116
 View/Next Image, 79
 View/Solid, 45, 116
 View/Wireframe, 45, 116
 View/Zoom Out, 80
 ViewFilter mini-toolbar, 88
 viewfinder, 179, 180
 Viewing an Extrusion, 175
 Virtual Reality Modeling Language, 145
 Visible, 29, 46, 77, 78, 210, 211
 visible features, 194
 Visible Height, 82
 Visible Width, 82
 VRML, 22, 54, 56, 145, 147, 154
 VRML 2.0, 22

—W—

Warranty and Disclaimer, 3
 Wavefront, 54, 56, 111, 198, 145, 147, 154
 Web, 145

wide angle, 97
wide angle lenses, 187
Widely Spaced Angles, 177
Width, 82, 221
Window, 52, 58, 59, 90, 92, 116, 131, 141,
143, 151, 159, 199
Window/3D Preview, 22
Windows 98, 16
Windows commands, 113
Windows menu, 45, 113
WindowsNT, 16
Wireframe, 88
wizard, 106
world space, 221

—X—

X, 33, 34, 35, 52, 132, 204, 205, 207, 209,
214, 220, 223
X axes do not intersect, 208
X axis line direction conflict, 207
X Line Tool Icon, 64
Xhost ID, 200
XNETINST.TMP, 18
XY, 223
XY Line Tool Icon, 64

—Y—

Y, 33, 34, 52, 132, 204, 205, 207, 209, 214,
220, 223

Y axes do not intersect, 208
Y axis line direction conflict, 207
Y Line Tool Icon, 64
YZ, 223
YZ Line Tool Icon, 64

—Z—

Z, 33, 34, 52, 132, 204, 205, 207, 209, 214,
220, 221, 223
Z axes do not intersect, 208
Z axis line direction conflict, 207
Z Line Tool Icon, 64
Zoom, 2-217
Zoom Feature, 24
Zoom In, 79, 124, 130, 139, 2-217. *See* Zoom
In command. *See* Zoom In command. *See*
Zoom In command
Zoom In command, 79, 139
Zoom in tool, 130, 139
Zoom lens, 97
Zoom Out, 80, 124, 2-217. *See* Zoom Out
command
Zoom Out command, 80
Zoom out tool, 130, 139
Zoom Tool, 129
zooming in, 184
ZX, 223
ZX Line Tool Icon, 64