3D Models Specifications for TerraExplorer®

www.SkylineGlobe.com

All specifications are subject to change without notice

Table of Contents

Last update: June 2009

The purpose of this document is to describe the 3D model formats that are available for use in TerraExplorer ® suite. It discusses the available functionality, conversion methods from different formats, and recommendations for efficient model creation for real-time rendering.

CHAPTER 1. SUPPORTED FORMATS

TerraExplorer supports the import of the following 3D model file formats:

- DirectX (*.X)
- OpenFlight (*.FLT)
- Google SketchUp 6 (*.KML, *.KMZ, *.DAE)

Skyline internal formats:

- Compressed DirectX (*.XPC)
- Compressed DirectX with Level Of Details (*.XPL)
- Compressed OpenFlight (*.FPC)

Compressed versions of DirectX and OpenFlight models are automatically created during the Viewer Kit creation process (See: TerraExplorer User Manual). The compressed format includes the model file and all of the texture files it uses. The compressed file with all of its resources can be efficiently downloaded over the Internet and displayed on the client computer. Once a compressed format is generated, you can use it as a model source file in TerraExplorer.

The following section provides detailed information about supported features for DirectX and OpenFlight models.

1.1 DirectX Specific

The visualization of DirectX models depends on your version of Microsoft DirectX. To determine what version is installed on your computer, from the **Start** menu select **Run**, and type "dxdiag". This launches a dialog that displays DirectX version information.

TerraExplorer uses two versions of DirectX:

- **DirectX 9** – For computers with DirectX 9 and above installed.
- **DirectX 6** – For computers with DirectX 6 and above (not including 9).

Each version of DirectX adds functionality not available in previous versions. Therefore, models that were created using one version of DirectX may display incorrectly in another version:

- **Flipped Textures** – Models created for version 6 may appear with flipped textures when viewed with version 9. You can use the "Flip Texture" field in TerraExplorer 3D model properties page to flip the textures back.
- **Transparent Textures** – Version 9 supports transparency in TGA texture files. In version 6, these models display without transparency.
- **Multi/Single Mesh** – Models created for version 9 may include multiple meshes. These models do not display correctly in version 6.

Some converters listed below (e.g. Conv3ds) create X models for DirectX 6. These models display properly on computers running DirectX 6 and above. Converters, which create models for DirectX 9, however, may create models that do not display properly on computers running versions prior to 9.

DirectX Specific Multi-Resolution Models (XPL):

Use of 3D X-file models with high-resolution textures carries a performance penalty. Skyline's XPL models are a preferred format when streaming models over the Internet or locally importing many models simultaneously (more than 20 Mb).

A set of XPL files is created from a single X or KMZ/KML file where each file contains data for one Level of Detail (LOD). The XPL format is automatically generated as a set of models in diminishing texture resolution from the original textures. For further optimization, textures are automatically converted to DDS image format, so that the input's texture formats are irrelevant. When streaming XPL models over the Internet, the XPL best texture level file should not exceed 100kb for a single model or 400kb for grouped models. See the "Model Building Guidelines" chapter for further information.

When LOD models are used in a project, the best texture scale is dynamically selected based on the visibility and proximity of the viewer. See: "Best LOD Size" section in this chapter for further information.

When posted to a web server, each of the models in a set is downloaded independently to improve performance.

Creating XPL Files Using the TerraExplorer Viewer Kit

To create a set of XPL files:

1. Load the models you want to a FLY file.
2. From the **File** menu, select **Build TerraExplorer Viewer Kit**. The Build TerraExplorer Viewer Kit dialog box is displayed.
3. Select the **Generate objects level of details (LOD)** check box.

The resulting models are used in the created kit or in local or remote projects. See: the "Streaming 3D Models Using Point Feature Layers" chapter for more information about importing many models simultaneously.

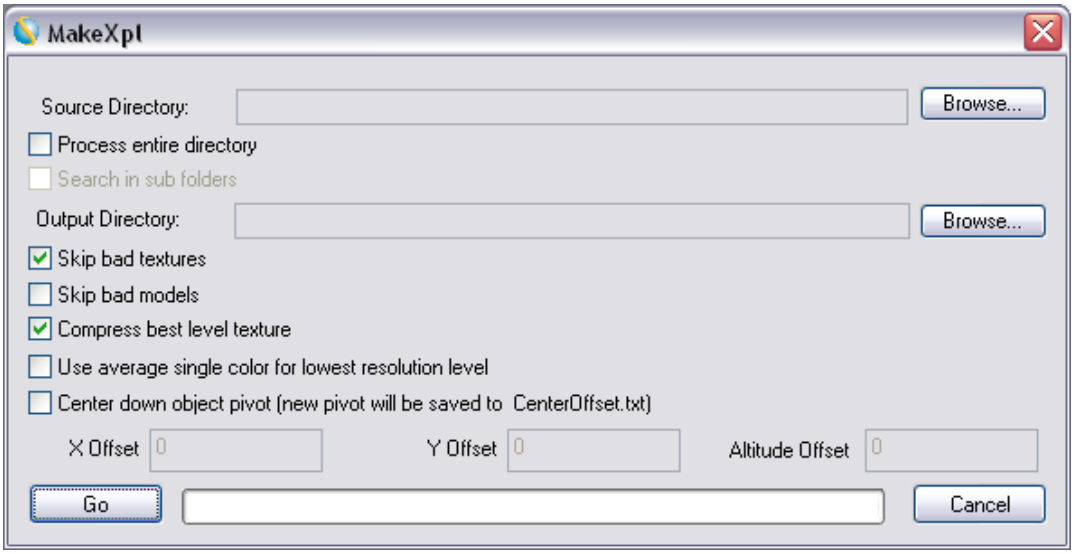
Creating XPL Files Using the MakeXPL Tool

Alternatively, X and DAE files can be converted using the MakeXPL tool that is provided as part of the TerraExplorer Pro installation.

To convert to an XPL file:

1. From the **TerraExplorer Pro Installation** folder, browse for and run the **MakeXPL** tool. The MakeXpl dialog box is displayed.
2. Browse for the required Source Directory and select the X, XPC, or DAE models to convert to XPL.
3. Do one of the following:
   - Select the **Process Entire Directory** check box to convert all the models in the source directory.
   - Select the **Search in sub folders** check box to convert all the models in the sub folders.
4. Browse for the Output Directory.

5. Click **Go** to start converting.



Note: For best results, it is recommended to select the **Compress Best Level Texture** check box and to clear the **Use average single color for lowest resolution level** check box.

Best LOD Size:

An object's Best LOD Size determines what texture resolution level TerraExplorer should use in relation to the viewer's distance from the model.

To set an object's Best LOD Size:

- In the model's properties sheet in TerraExplorer, position the camera the distance from the model, in which you want the highest resolution, and click **Capture.** Clicking the Capture button sets the current object size as the size where the best level of detail is used.

When zooming out from the best LOD size the object is displayed using data retrieved from a lower Level Of Detail file (XPL file).

1.2 OpenFlight Specific

OpenFlight is an extensive format for scene description. TerraExplorer supports a subset of its capabilities. Stand-alone models that are created or converted to OpenFlight (*.FLT) can be imported to and viewed in TerraExplorer.

TerraExplorer supports most of the texture files used by OpenFlight models, e.g. GIF, JPEG, BMP, RGB, RGBA, BW. There is no support for intensity maps and attribute files.

See: the "Feature Layers" chapter in the TerraExplorer User Manual for information on importing OpenFlight models that reference other models.

1.3 KML/KMZ Specific

OGC KML (formerly Keyhole Markup Language) is an XML grammar and file format. Internally, models are stored in COLLADA (DAE) format. Models that are created with Google SketchUp 6 and up (*.KML, *.KMZ) can be imported to and viewed in TerraExplorer.

See: "How to Load Kml/Kmz Files" in the TerraExplorer User Manual for information on importing SketchUp models.

Note: When importing many models simultaneously, it is recommended to convert KML/KMZ files to XPL format. See "DirectX Specific Multi-Resolution models (XPL)" in this chapter for further information.

CHAPTER 2. DIRECTX CONVERTERS

There are several converters available for converting different formats to the DX model format.

- **Conv3ds** - A simple command line converter Microsoft utility.
  - **Input formats**: 3D Studio (*.3DS)
  - **DirectX version**: 6 and above
  - **Available at**: 3DModelConverters.zip - .\Conv3ds
  - **Additional information**: http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=26fca7ce-6c37-4d9b-9b20-5f71b7bd369c
- **Deep Exploration** - Standalone application, developed by Right Hemisphere, to manage 3D models. Can read, translate and optimize various formats.
  - **Input formats**: Extensive. See: http://www.righthemisphere.com/products/dexp/de_std.html
  - **DirectX version**: 9
  - **Available at**: http://www.righthemisphere.com/index.html
- **Polytrans/NuGraf** – Translation, viewing, and data optimizing system, developed by Okino Computer Graphics.
  - **Input formats**: Extensive. See: http://www.okino.com/conv/filefrmt_3dimport.htm
  - **DirectX version**: 6 and above
  - **Available at**: http://www.okino.com/default.htm
  - **Additional information**: http://www.okino.com/conv/exp_flt.htm. Also available as Plug-in for 3D Studio Max (PolyTrans-for-MAX")
- **MS SDK 3D Studio MAX Export Plug-in** – Microsoft plug-in for *3D Studio Max R 4.x/5.x,* that is provided with DirectX SDK.
  - **Input formats**: 3D Studio MAX files
  - **DirectX version**: 9
  - **Available at**: 3DModelConverters.zip - .\3D Studio Plug-ins
  - **Additional information**: http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=26fca7ce-6c37-4d9b-9b20-5f71b7bd369c
- **Panda DX Exporter** - Plug-in for *3D Studio Max R 4.x/5.x/6.x,* developed by Pandasoft, which allows export to .X files with a few more options than the MS SDK version.
  - **Input formats**: 3D Studio MAX files
  - **DirectX version**: 9
  - **Available at**: http://www.andytather.co.uk/Panda/directxmax_downloads.aspx

CHAPTER 3. OPENFLIGHT CONVERTERS

There are several converters available for converting different formats to the OpenFlight (FLT) model.

- **Polytrans/NuGraf** – Translation, viewing, and data optimizing system, developed by Okino Computer Graphics.
  - **Input Formats**: Extensive. See: http://www.okino.com/conv/filefrmt_3dimport.htm
  - **DirectX version**: 6 and above
  - **Available at**: http://www.okino.com/default.htm. **Note**: Requires 'DCC/Pack' Add-On License
  - **Additional information**: http://www.okino.com/conv/exp_flt.htm. Also available as Plug-in for 3D Studio Max (PolyTrans-for-MAX")
- **Deep Exploration** - Standalone application, developed by Right Hemisphere, to manage 3D models. Can read, translate and optimize various formats.
  - **Input Formats**: Extensive. See: http://www.righthemisphere.com/products/dexp/de_std.html
  - **DirectX version**: 9
  - **Available at**: http://www.righthemisphere.com/index.html

CHAPTER 4. MODEL BUILDING GUIDELINES

Displaying models in a real-time environment can require extensive computer resources. This section discusses methods of converting and creating resource-efficient and optimized models for real-time rendering in TerraExplorer.

Visualization performance of a FLY file, containing 3D models, depends primarily on:

- CPU Speed
- Physical and virtual memory
- Graphics card

There is an obvious tradeoff between the level of detail in the models, and their number in a project and the resulting display performance. Therefore, when creating your models and populating your projects, you need to take into account the target hardware. It is advised to run tests on the target hardware and optimize the models accordingly. Any reference to absolute numbers in this document is based on an average computer, and should be considered only a rough estimate.

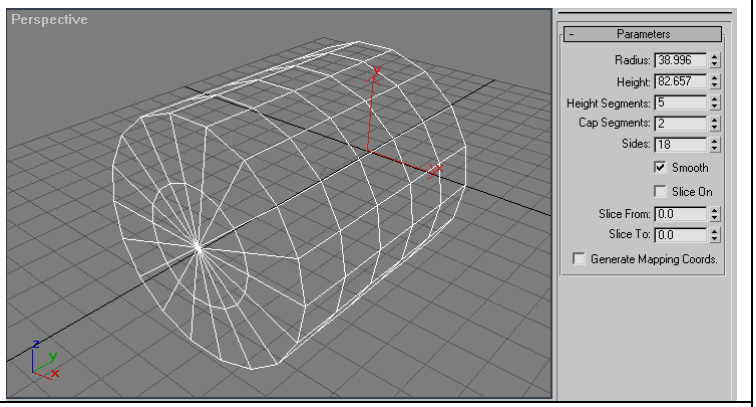
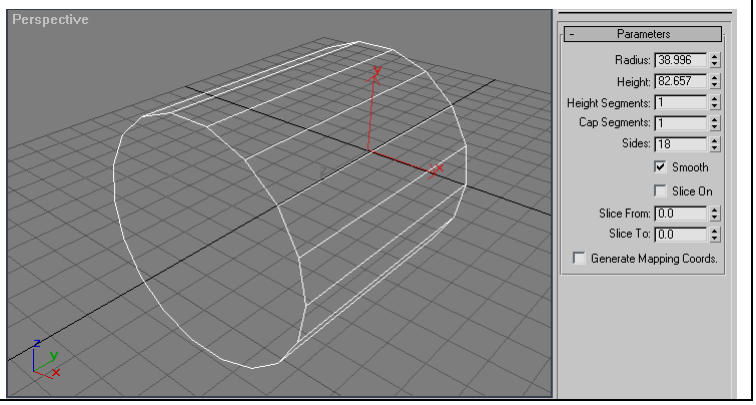
Another aspect of creating models is the total model size, in relation to Internet download. When you post your FLY file on a web server, the models are downloaded in the background while streaming the terrain data. If your models are large, they may take a while to download, and will slowly start to appear on the terrain as the user is exploring the environment. Therefore, it is advised to group several small models into one model. The available bandwidth is another factor when deciding on model size.

The two main factors in the optimization of a model for real-time visualization are: polygon count and texture size.

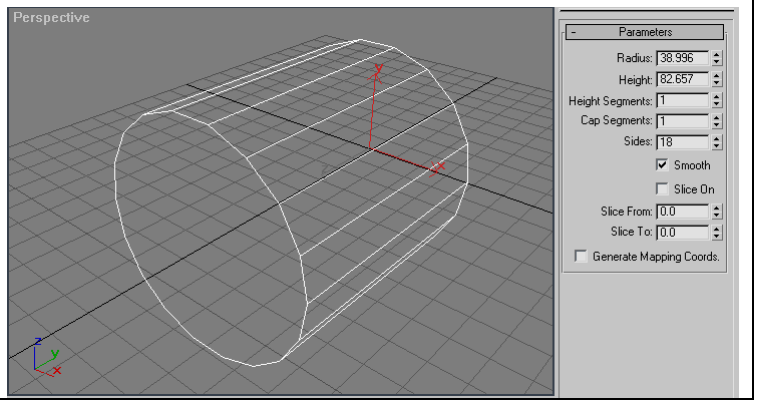
4.1 Polygon Count

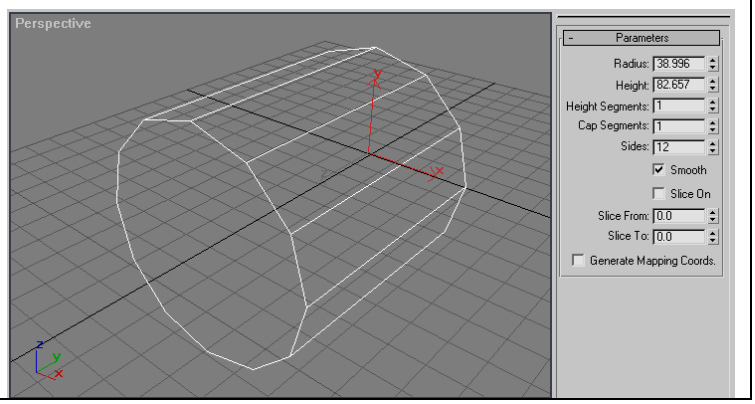
To reduce the number of vertices, faces and polygons in a model, while maintaining an appealing visual appearance, follow the following guidelines:

- **Flat Surfaces** – Create flat surfaces made of one (or a minimum number of) polygon.
  Example: When creating a cylinder, use *Height Segment* and *Cap Segment* of 1:

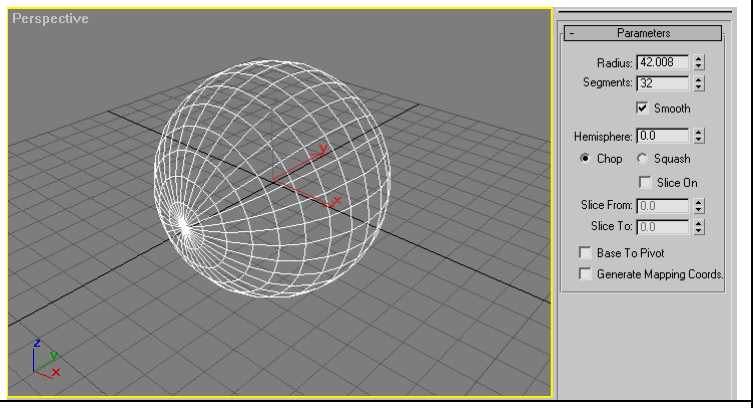
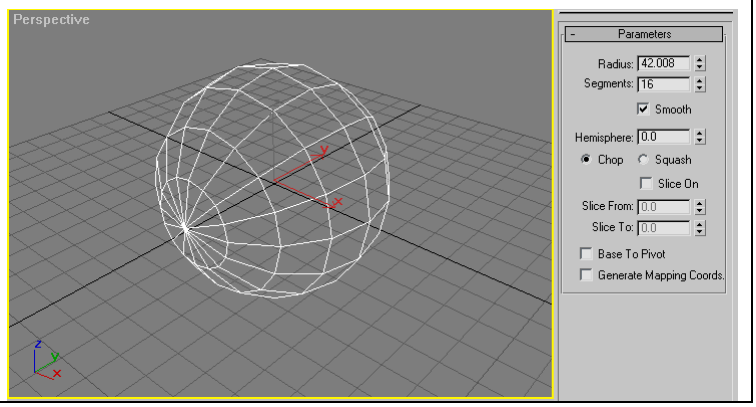
Regular Height Segment: 5 Cap Segment: 2	
Optimized Height Segment: 1 Cap Segment: 1	

- **Curved Surfaces** – Use the minimum number of polygons that maintains the curved shape. For small shapes like poles, use a minimal *Sides* value. For larger objects like a round tower, use bigger values.
  Example: When creating a cylinder, use appropriate *Sides* values:

Regular Sides: 18	

Optimized Sides: 12	

Example: When creating a sphere, use appropriate *Segment* value

Regular Segments: 32	
Optimized Segments: 16	

- **Repetition** – If your model includes repeated instances of certain large elements (e.g. a building block with multiple instances of the same type of building), create the repeating element as a single model and place it multiple times in TerraExplorer.

4.2 Texture Size

To create resource-efficient texture files, follow the following guidelines:

- **Pixel Size** – Use a texture pixel size that is a power of 2 (i.e. 2, 4, 8, 16 etc.).

- **Texture Format** – Use the image format that produces the smallest file size, while maintaining the required image quality. While the common formats are JPG, BMP, PNG and TGA, it is recommended to use JPG and PNG. When converting models to XPL, the textures are automatically converted to DDS format. Therefore, inputs texture formats have no significance.
- **Unified Texture** – If using more then 4 textures for a single model, unify them in one texture image, and map each area to the relevant surface. Textures that are tiled on the model should not be unified with other textures.
- **Texture Size** - Do not exceed a texture size of 1024 x 1024, since most graphics-cards do not support larger sizes.
- **Tiling** – When the texture is repetitive (e.g. a building façade), use a tiled texture. This reduces the total texture size.
- **Black Color** – With FLT models, avoid the use of pure black (R=0, B=0, G=0) color. Black is considered transparent when viewed in TerraExplorer.
- **Blurring** – Use textures with a "dirty look" and avoid the use of flat colors, since a texture with high contrast and sharpness may produce aliasing effect and "noisy" display.

Examples of good "Dirty" Textures.

4.3 Other Considerations

Make sure the model is centered in the world coordinate system (0,0) and the base of all models is on the ground plane (Z=0). The scale should represent true dimensions. For example:

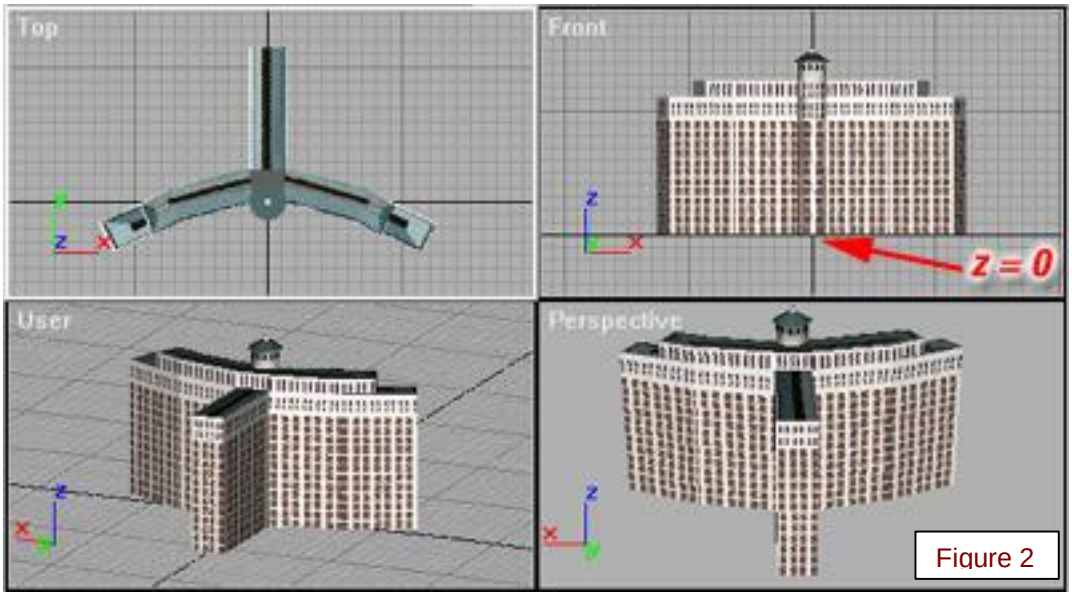


Figure 2

CHAPTER 5. EXPORT SETTINGS

This section describes export settings for some of the converters listed in Chapters 2 and 3.

Some of the settings used define count and texture optimization as part of the export process.

5.1 Conv3ds

To export an **X file** using Conv3ds:

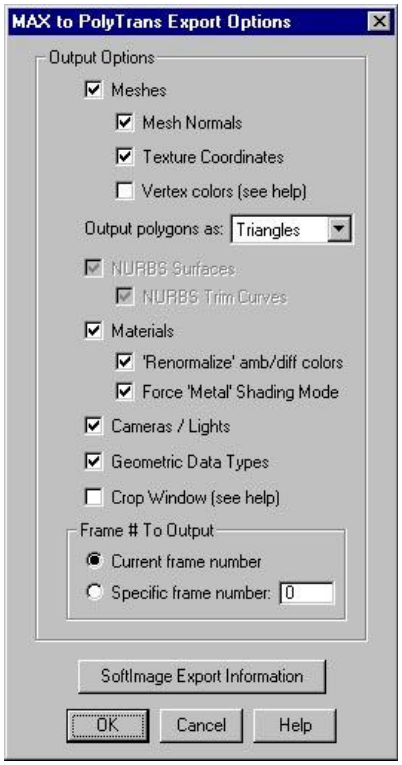
1. From the **Start** menu, select **Run**, and type "cmd". This launches the command window.
2. Type the full path to the "Conv3ds.exe" file, and specify the executable name.
3. Follow the text with " –m " (space, "-m", space).
   This creates the model as a single mesh.
4. Type the full path and name of the 3D Studio file you wish to convert.
5. If you want, you can specify the name of the resulting file. By default, an *.x file by the same name as the *.3ds file is created in the same folder.

Example:

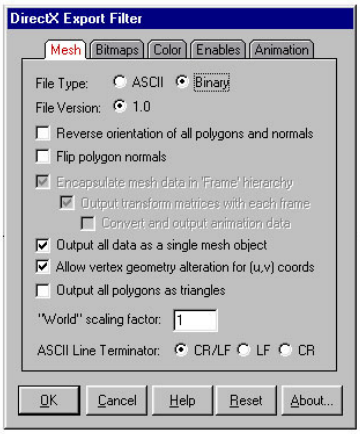
[Full Path]Conv3ds.exe –m [Full Path]FileName.3ds [Full Path] [NewFile.x]

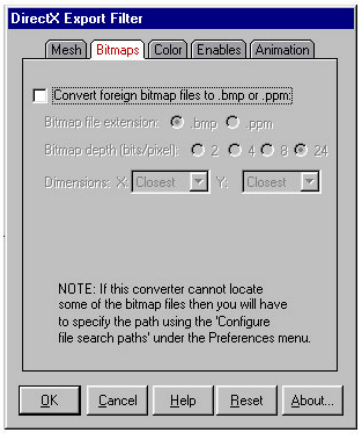
5.2 Polytrans/NuGraph

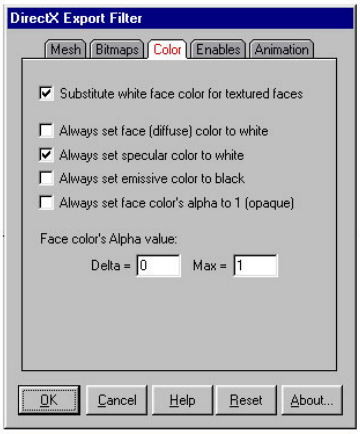
Use the following settings when exporting using Polytrans, Nugraph or the respective MAX Plug-in:

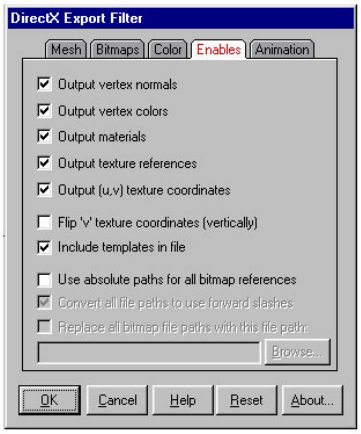


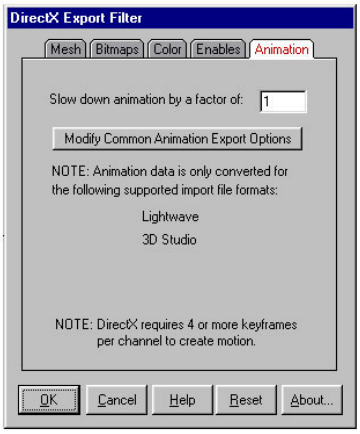
Make sure that your first dialog box matches this one exactly.











These dialog boxes are the settings for the DirectX export from NuGraph. The settings shown in these screen shots are necessary for models to work correctly in TerraExporer.

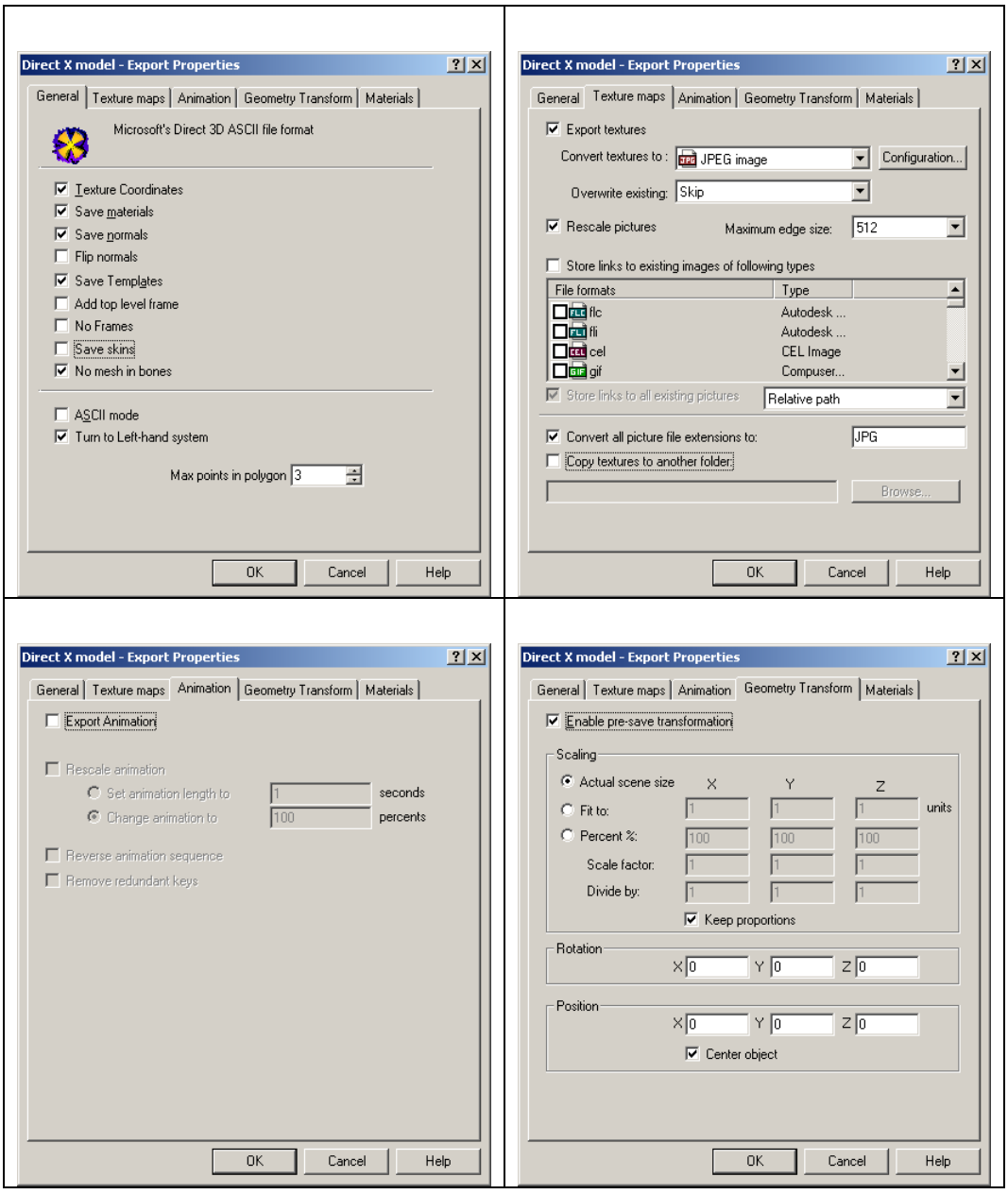
Figure 3

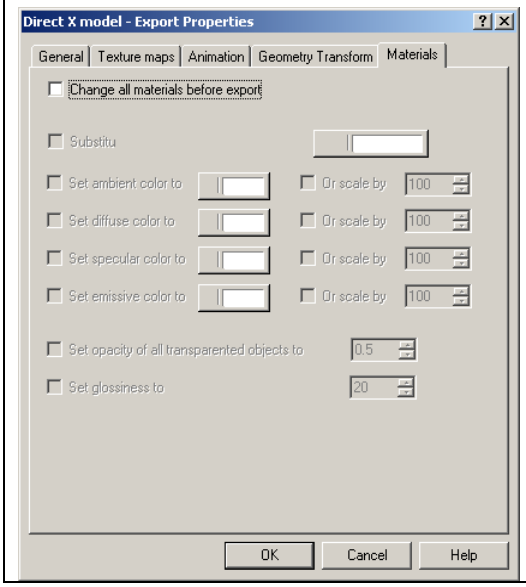
5.3 Deep Exploration

Exporting an X File

Use the following settings when exporting an **X file** using Deep Exploration:

- In the **Save As** dialog box, in the **Objects to save** list, select **All scene objects** and **Show Export Dialog**.

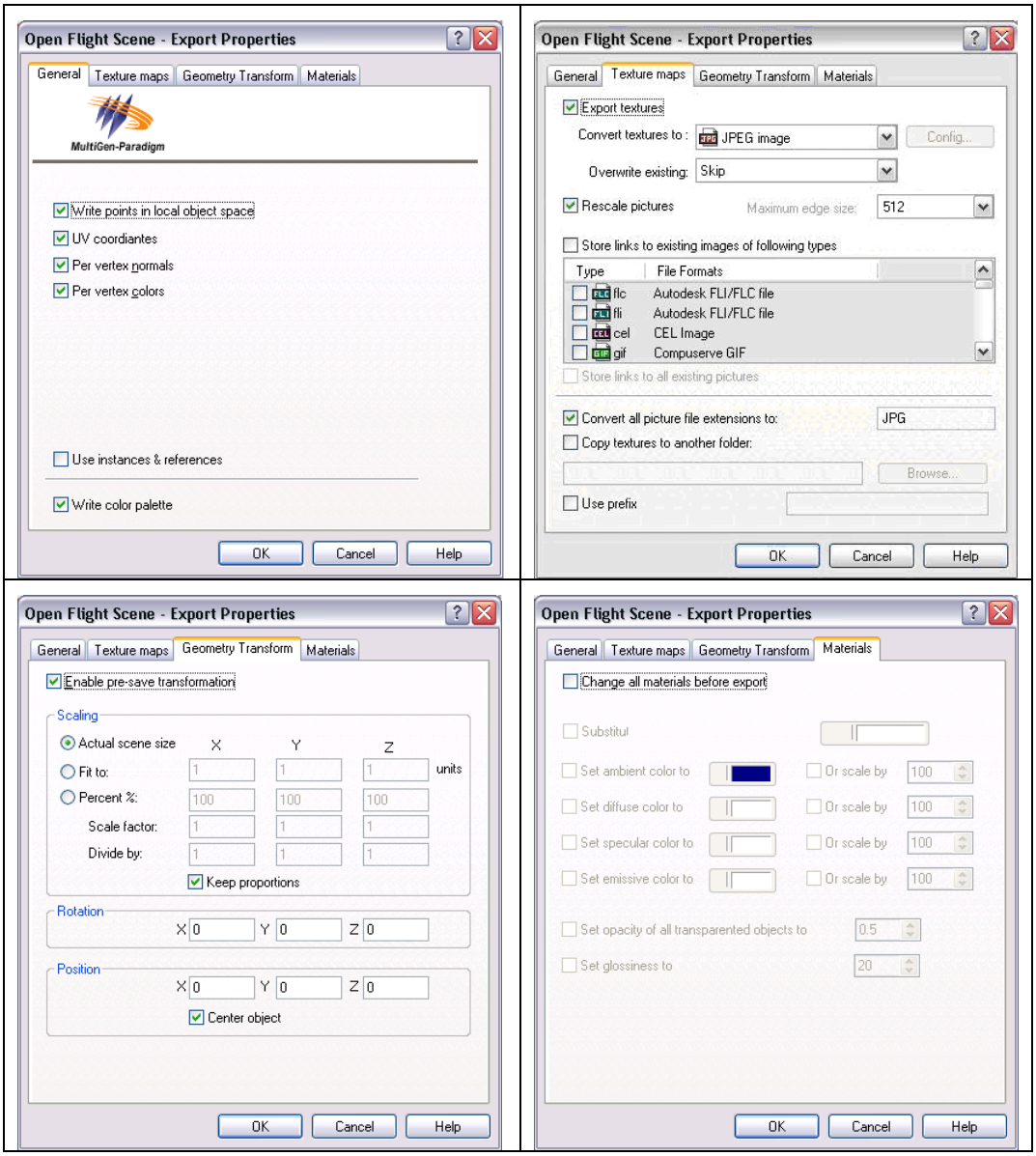

Direct X model - Export Properties
General
Texture maps
Animation
Geometry Transform
Materials
Microsoft's Direct 3D ASCII file format
Texture Coordinates
Save materials
Save normals
Flip normals
Save Templates
Add top level frame
No Frames
Save skins
No mesh in bones
ASCII mode
Turn to Left-hand system
Max points in polygon
3
OK
Cancel
Help
Export textures
Convert textures to :
JPEG image
Configuration...
Overwrite existing:
Skip
Rescale pictures
Maximum edge size:
512
Store links to existing images of following types
File formats
Type
flc
Autodesk ...
fli
Autodesk ...
cel
CEL Image
gif
Compuser...
Store links to all existing pictures
Relative path
Convert all picture file extensions to:
JPG
Copy textures to another folder
Browse...
Export Animation
Rescale animation
Set animation length to
1
seconds
Change animation to
100
percents
Reverse animation sequence
Remove redundant keys
Enable pre-save transformation
Scaling
Actual scene size
X
Y
Z
Fit to:
units
Percent %:
Scale factor:
Divide by:
Keep proportions
Rotation
Position
Center object


Direct X model - Export Properties
General
Texture maps
Animation
Geometry Transform
Materials
Change all materials before export
Substitu
Set ambient color to
Or scale by
100
Set diffuse color to
Or scale by
100
Set specular color to
Or scale by
100
Set emissive color to
Or scale by
100
Set opacity of all transparented objects to
0.5
Set glossiness to
20
OK
Cancel
Help

Exporting an FLT file

Use the following settings when exporting an **FLT file** using Deep Exploration:

- In the **Save As** dialog box, in the **Objects to save** list, select **All scene objects** and **Show Export Dialog**.

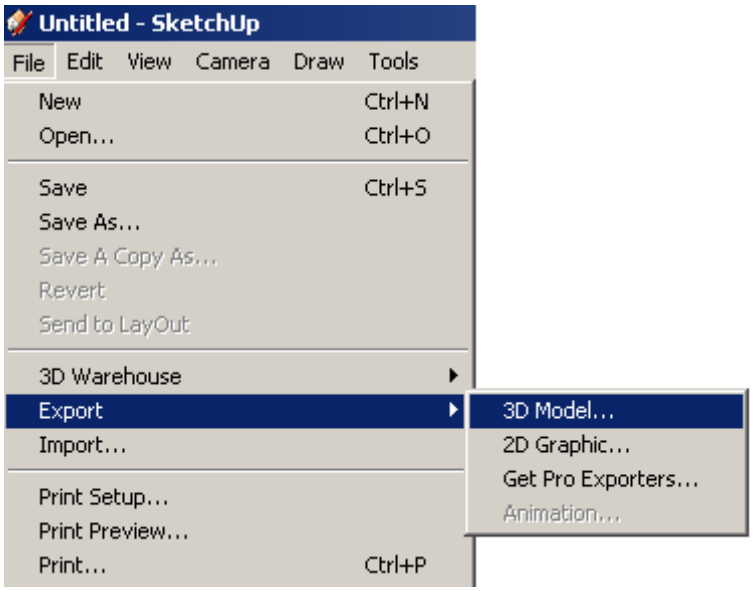


5.4 Google SketchUp

Use the following settings when exporting a KML/KMZ using Google SketchUp:

- In the **3D Model Export**, in the **Export Type**, select **Google Earth (*.KMZ)**.

Note: When using Google SketchUp **6**, in the **3D Model Export**, in the **Export Type**, select **Google Earth 4 (*.KMZ)**.


Untitled - SketchUp
File
Edit
View
Camera
Draw
Tools
New Ctrl+N
Open... Ctrl+O
Save Ctrl+S
Save As...
Save A Copy As...
Revert
Send to LayOut
3D Warehouse
Export
Import...
Print Setup...
Print Preview...
Print... Ctrl+P
3D Model...
2D Graphic...
Get Pro Exporters...
Animation...

CHAPTER 6. STREAMING 3D MODELS USING POINT FEATURE LAYERS

The best way to import many 3D models simultaneously is by streaming. Further optimization is achieved by using the XPL format.

To stream a 3D model using a point feature layer:

1. Create a point Feature Layer where each point represents a model's pivot. The layer should contain the model's name as an attribute.
2. Import the point layer as a streaming layer.
3. Set an appropriate block width of the stream requests that are sent from TerraExplorer to the remote server.

   Note: It is not recommended to have TerraExplorer dynamically calculate the request block width according to performance related criteria in this situation. See: "Determining an Appropriate Block Width" in the TerraGate User Manual, for more information.
4. In the **Layer Settings** dialog box, click the **Annotation** tab. From the **Symbol Type** drop-down list, select **3D Model**.
5. In the **File Name**, use the Field by Attribute dialog to set the model's path followed by the model name from the attribute value, e.g. c:\mymodels\[MODEL_NAME].
6. If using XPL models, set an appropriate LOD size. If possible, you should set the LOD for each model separately, using Field by Attribute.
7. Determine and select a reasonable Streaming Altitude and Max Visibility Distance.
8. For streaming the FLY file via the Internet, save it and build a TerraExplorer Viewer Kit for the Internet. **See**: "Creating TerraExplorer Viewer Kits" in the TerraExplorer Manual, for more information.

CHAPTER 7. SUMMARY

Displaying large-format models in a real-time environment can require extensive computer resources. This manual described the following methods of converting and creating resource-efficient and optimized models for real-time rendering in TerraExplorer:

- **Model Geometry** –Model geometries should have no unnecessary vertices, faces or polygons. The model should be centered in the world coordinate system and the scale should represent true dimensions. **See**: "Polygon Count" and "Other Considerations" in the "Model Building Guidelines" chapter for further information. It is also recommended to group several small models into one model.
- **Model Texture** - Resource-efficient texture files are created by following the guidelines in the "Texture Size" section in the "Model Building Guidelines" chapter. It is also recommended to group several small textures into one texture.
- **Model Format** - Skyline's XPL models are the optimal format when streaming models via the Internet or locally importing large-format models (more than 20 Mb). See "DirectX Specific" in the "Supported Formats" chapter for more information.
- **Streaming** – Streaming 3D models is the best way to import large-format models, locally and via the Internet. Selection of an appropriate block width is essential for efficient streaming. Usually, it is best to use the value 1222 m, and Max Streaming Altitude < 3000.
- **Best LOD** – This value determines what texture resolution level TerraExplorer should use in relation to the viewer's distance from the model.Setting this value in TerraExplorer (available when using XPL only) increases project efficiency. **See**: "DirectX Specific" in the "Supported Formats" chapter for more information.

Remember! It is advised to run tests on the target hardware and optimize the models accordingly. Any reference to absolute numbers in this document is approximated for an average computer, and should be viewed as a rough guideline only.

Skyline Software Systems, Inc.
4506 Daly Drive, Suite 100 Chantilly,

VA 20151 USA

Main Tel: 703.378.3780
Main Fax: 703.378.3760
General Information: info@skylinesoft.com

Technical Support: support@skylinesoft.com
Web: www.SkylineGlobe.com