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Publishing DWG Data to Google Earth

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GD405-1 After completing this session, you will be able to import image and terrain data into AutoCAD-based products, use that data to help with various design and modeling tasks, and publish DWG-based models to Google Earth for presentation to wider audiences. You will also gain an understanding for the context in which Google Earth data should be used, and for the various options available for publishing DWG data to Google Earth, including temporal data.

About the Speaker: Tom is a software architect for the Autodesk AEC Division. With 23 years of experience, he is an expert in the design, development, and implementation of civil-engineering applications. For the past 9 years, Tom has helped architect Civil 3D into the leading AutoCAD-based civil engineering application. He has degrees in mapping, and civil engineering and surveying. His most recent side project at Autodesk has been the implementation of the DWG publishing extension for Google Earth, available on the Autodesk labs site and within Civil 3D.



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Introduction

This class provides information on the two-way exchange of data between AutoCAD (and AutoCAD-based verticals) and Google Earth. This exchange of data can help you in numerous ways in your day-to-day design and engineering responsibilities. Several scenarios where this data exchange might be useful includes:

- Import imagery from Google Earth for use as a design back drop.
- Import elevation relief data into AutoCAD to help depict as-built and proposed building designs relative to the surface terrain.
- Publish map parcel information to Google Earth as a means of disseminating cadastral information.
- Publish from AutoCAD to Google Earth temporal data for a phased construction project that can be used by public agencies to depict how the project will impact residents.

Where to find the Software Described in this Class

The AutoCAD Google Earth publishing extension tool is available for free at Autodesk's labs web site, <http://labs.autodesk.com>.

Furthermore, AutoCAD Civil 3D 2008 includes most of the functionality described here-in.

Understanding Google Earth's User Interface

This class utilizes several features within Google Earth extensively. There are numerous on-line guides to using Google Earth. Four that are highly recommended are:

- Google Earth User Guide: <http://earth.google.com/userguide/v4/>
- Google Earth Blog: <http://www.gearthblog.com/basics.html>
- Juicy Geography's GE Blog: http://www.juicygeography.co.uk/blog/?page_id=5
- Google Earth Timelines: http://earth.google.com/userguide/v4/ug_gps.html#timeline



Import Image from Google Earth

To publish AutoCAD models to Google Earth, you must first be able to define the location of where the models are to be located on the Earth's surface. This correlation of AutoCAD model space coordinates to Google Earth latitude and longitude coordinates is referred to a *geo-referencing*.

A simple method of geo-referencing AutoCAD model space data is to import an image from Google Earth and position the image properly relative to your model data. Additionally, you can use the imported image as a backdrop for design.

Prior to importing the image you should complete the following steps:

- Start Google Earth, and zoom to the location on the Earth's surface where you want to capture the image.
- Zoom in close enough to capture the appropriate level of detail of the Earth's surface in the area of interest.
- Be sure you are looking straight down at the Earth's surface (that is, the view does not have any tilt.) You can remove all tilt from the current Google Earth view by pressing the 'u' key.
- Generally, it is best to keep the Google Earth application window maximized. Do not minimize or collapse the Google Earth application window.

Now you are ready to bring an image of the Google Earth view into AutoCAD.

- The *ImportGEImage* command is used to import an image from Google Earth.
- After selecting the command, there will be a brief pause while the image is obtained from Google Earth. Then, a rectangle representing the border of the image will be attached to the AutoCAD graphics cursor.
- Position the image to the desired location, and then specify a rotation angle to orient the image as desired, or
- If AutoCAD Civil 3D 2008 or AutoCAD Map 3D 2008 is being used, and a map projection has been defined, you can select the option at the command prompt to position the image automatically using the map projection coordinate conversion algorithms.

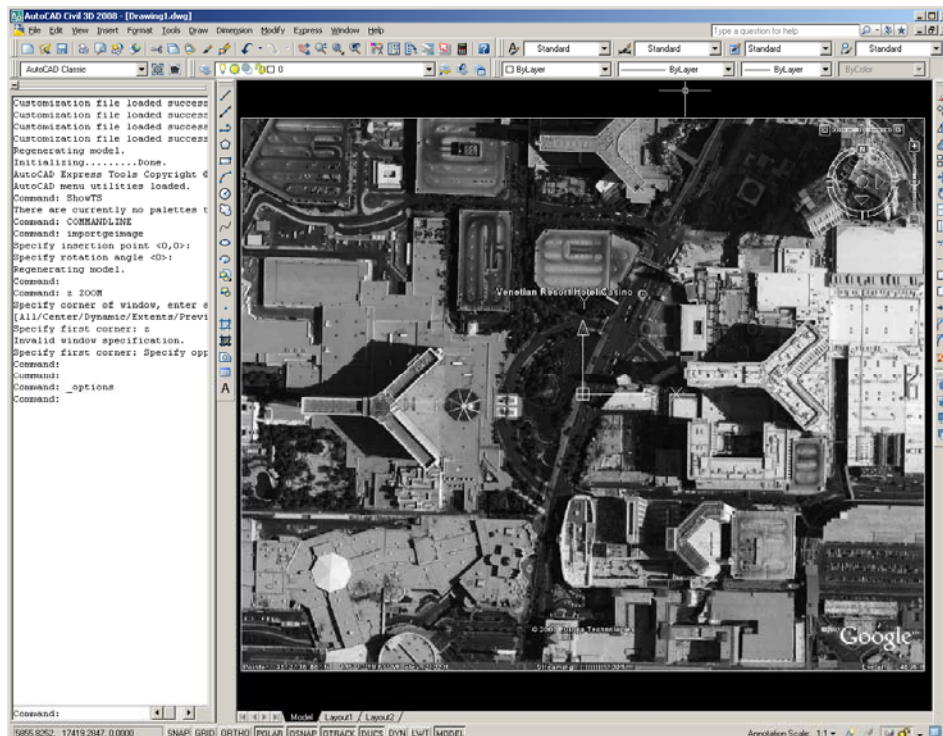
Note the following items about the image import process:

- Once placed, you may use AutoCAD's *move* and *rotate* commands to further refine the position of the image relative to your model. Do not adjust the position of your DWG model. Rather, adjust the position of the image relative to your model.



- The dimensions of the image in the drawing are defined by the extent of longitude and latitude the image covers in Google Earth and a transformation of those extents to the linear units defined by the INSUNITS system variable in AutoCAD.
- If a map projection is active within Civil 3D or Map 3D, only the center point of the image is placed using the map projection transform algorithms. The extents of the image are still defined as in the previous item.
- The image displayed in the drawing is an AcDbRasterImage, and is stored in the same folder as the DWG file. The first three letters of the image file name will be the same as the first three letters of the DWG file, and the file extension will be JPG.
- The image entity has x-data attached that contains information about where on the Earth's surface the image covers. This x-data is used to properly geo-reference the model space coordinates with the Google Earth coordinates.
- The image brought into AutoCAD using this command will only be black and white, even though the image in Google Earth is in color. This is a limitation imposed by Google when using the Google Earth application programming interface (API). There is no way to change this. However, see the next section for a method to manually import a color image.

Here is an example of an image of the Venetian Hotel imported to AutoCAD from Google Earth.



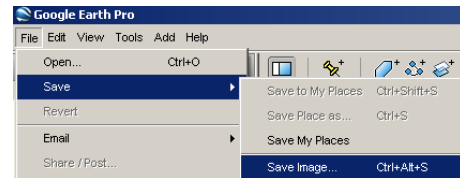
Import Color Image from Google Earth

Although it is not possible to import a color Google Earth image automatically, it is never-the-less possible to display color images in AutoCAD.

Prior to importing the image you should complete the following steps:

- Start Google Earth, and zoom to the location on the Earth's surface where you want to capture the image.
- Zoom in close enough to capture the appropriate level of detail of the Earth's surface in the area of interest.
- Generally, it is also best to keep the Google Earth application window maximized. Do not minimize or collapse the Google Earth application window.

Next, from within Google Earth, use the *File > Save > Save Image...* command to save the current Google Earth view as a JPG image file.

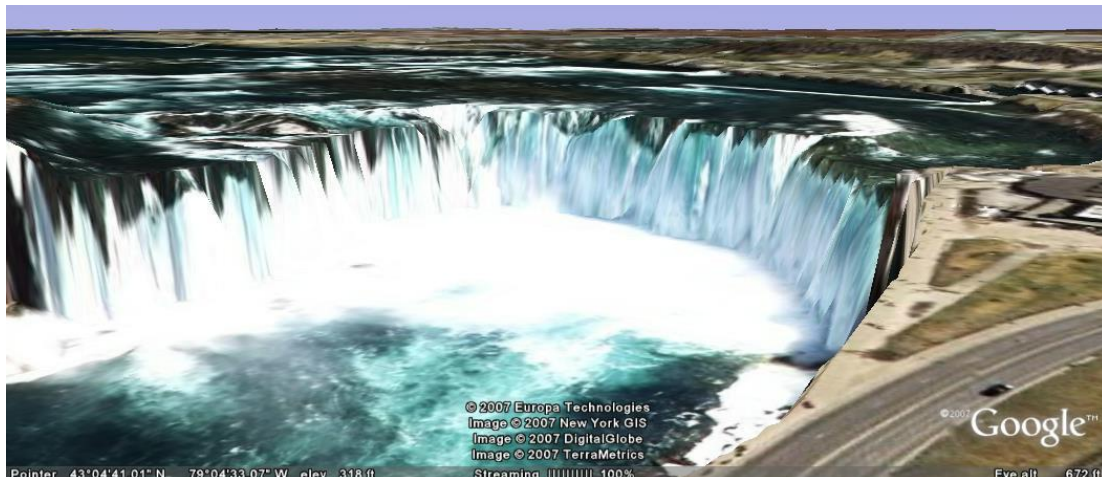


Finally, from within AutoCAD, use the *ImageAttach* command to import the image into the AutoCAD drawing.

Note the following items about the color image import process:

- Once placed, you may use AutoCAD's *move*, *rotate*, and *stretch* commands to further refine the position of the image relative to your model.
- The image is displayed in the drawing is an *AcDbRasterImage*.

Here is a color image of Niagara Falls imported into AutoCAD from Google Earth.





Import Google Earth Terrain as AutoCAD Mesh

You can import the elevation data for the current Google Earth view into AutoCAD as a mesh.

A new material is also created in the current drawing file from an image created using the Google Earth view. The new material is assigned to the newly created mesh. With the realistic shade mode for an AutoCAD view port turned on, the image will appear draped on the newly created mesh.

Prior to importing the terrain data as a mesh, you should complete the following steps:

- Start Google Earth, and zoom to the location on the Earth's surface where you want to import the elevation data.
- Ensure the *Terrain* layer in Google Earth is toggle on.
- Be sure you are looking straight down at the Earth's surface. (That is, the view does not have any tilt.) You can remove all tilt from the current Google Earth view by pressing the 'u' key.
- Also, for best results, zoom in close enough to capture enough detail of the Earth's surface in the area of interest.
- Lastly, keep the Google Earth application window maximized. Do not minimize or collapse the Google Earth window.

Now you are ready to bring a mesh of the Google Earth terrain into AutoCAD.

The *ImportGEMesh* command is used to collect the mesh data.

- After a brief period, a mesh representing the terrain data will be attached to the AutoCAD graphics cursor.
- Position the mesh to the desired location, and then specify a rotation angle to orient the mesh as desired.
- If AutoCAD Civil 3D 2008 or AutoCAD Map 3D 2008 is being used, and a map projection has been defined, you can select the option at the command prompt to position the mesh automatically using the map projection coordinate conversion algorithms.

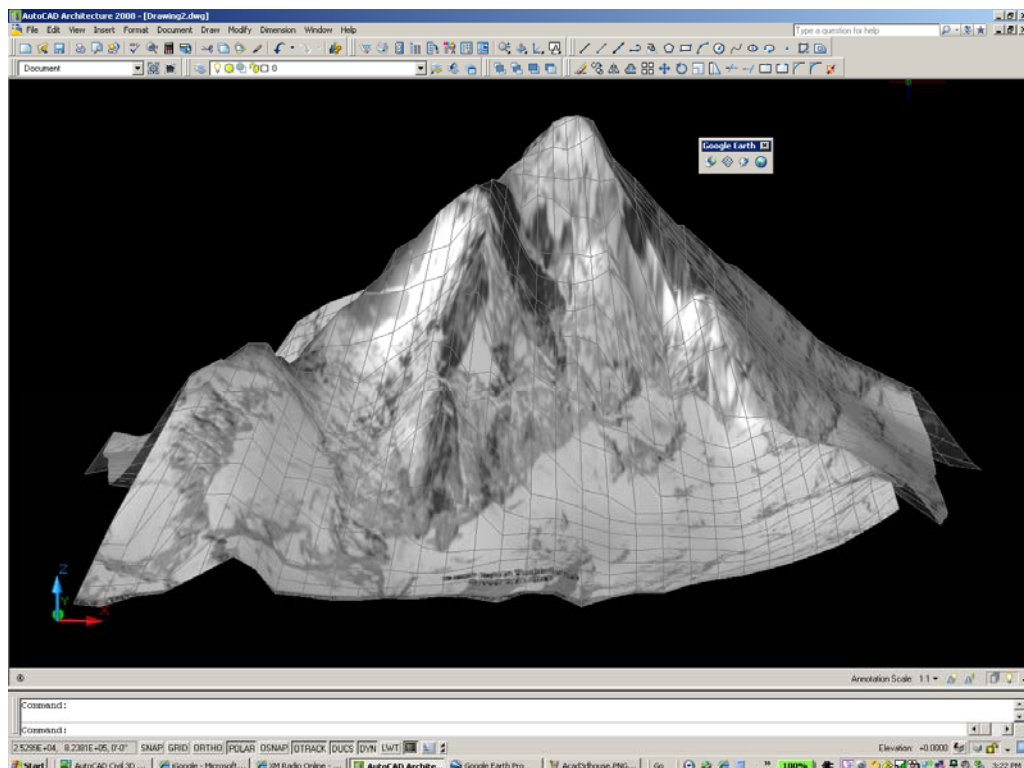
Note the following items about the import mesh process:

- Once placed, you may use AutoCAD's *move* and *rotate* commands to further refine the position of the mesh relative to your model. Do not adjust the position of your DWG model. Rather, adjust the position of the mesh relative to your other model space data.



- The dimensions of the mesh in the drawing are defined by the extent of longitude and latitude the mesh covers in Google Earth, and a transformation of those extents to the linear units defined by the AutoCAD INSUNITS system variable.
- The mesh is displayed in the drawing as an *AcDbPolygonMesh* object, and is of type *simple mesh*.
- The mesh size is fixed at 32 rows by 32 columns.
- The image captured from the Google Earth view is saved in the same folder as the drawing file, has the same three-letter prefix as the first three letters in the drawing file name, and has a JPG extension.
- The material created in the drawing is named using the first three letters of the drawing file, followed by several random numbers.
- The material created from the image brought into AutoCAD using this command will only be black and white, even though the image in Google Earth is in color. This is a limitation imposed by Google when using the Google Earth application programming interface (API). There is no way to change this. However, see the next section for a method to manually drape a color image onto the mesh.

Here is the Matterhorn area in the European Alps imported as a mesh with a material.



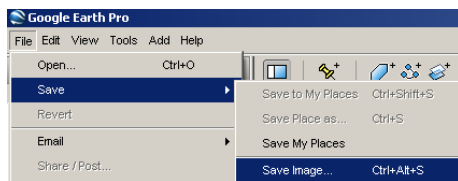
Import Color Google Earth Image as AutoCAD Material

You can create AutoCAD materials from images saved from Google Earth. These materials can then be applied to AutoCAD entities.

Prior to creating the material you should complete the following:

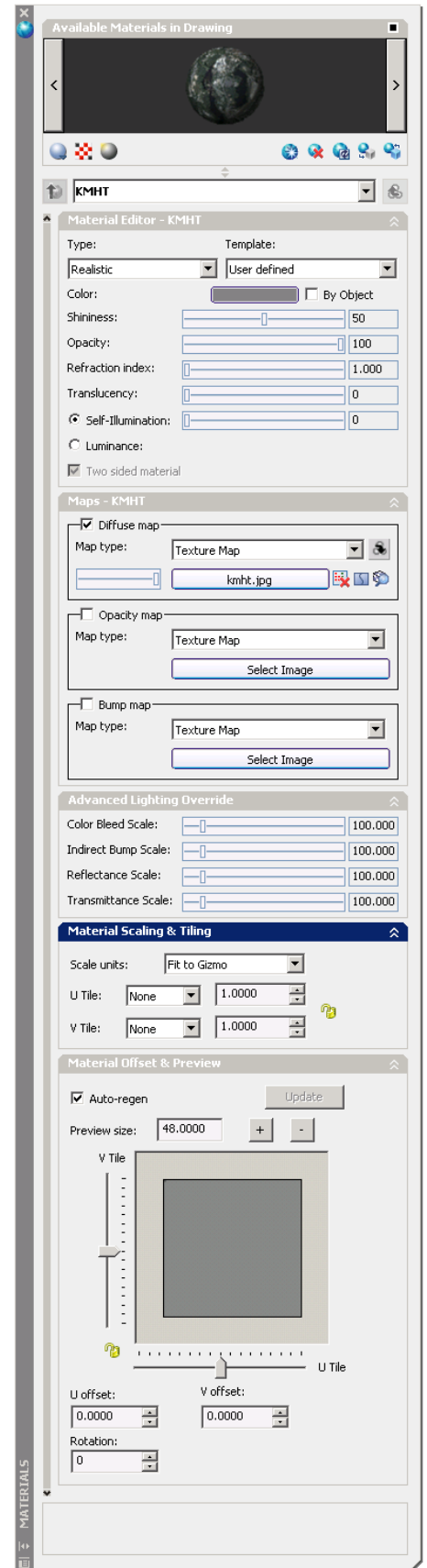
- Start Google Earth, and zoom to the location on the Earth's surface where you want to capture the image.
- Zoom in close enough to capture the appropriate level of detail of the Earth's surface in the area of interest.
- Generally, it is also best to keep the Google Earth application window maximized.

Next, from within Google Earth, use the *Save Image...* command to save the current Google Earth view as a JPG image file.



Now you are ready to create the new AutoCAD material.

- From within AutoCAD, create a new material using the *materials* command. Associate the saved JPG image to the new material's diffuse texture map.
- Use settings similar to those shown in the dialog along the right side of this page, especially set the *Material Scaling and Tiling* and *Material Offset and Preview* values as shown.
- Attach the new material to any appropriate AutoCAD entity, such as a mesh object as imported in the previous topic.
- Using the *materialmap* command, select the *Planar* option and apply it to the AutoCAD entity.
- Finally, change to the realistic visual style using the *shademode* command, and the color image should appear on the entity as a material.



Import Google Earth Terrain as AutoCAD Civil 3D 2008 Terrain Model

Users of AutoCAD Civil 3D 2008 can import terrain model data from Google Earth directly into a Civil 3D surface object. The subsequent surface object can then be visualized with more than ten different styles.

To import terrain data to a Civil 3D 2008 surface object, follow these steps:

- Start Google Earth, and zoom to the location on the Earth's surface where you want to capture the terrain. Ensure that you are looking straight down at the Earth's surface.
- Zoom in close enough to capture the appropriate level of detail of the Earth's surface in the area of interest.
- Ensure the *Terrain* layer within Google Earth is toggled on.
- Generally, it is also best to keep the Google Earth application window maximized. Do not minimize or collapse the Google Earth application window.

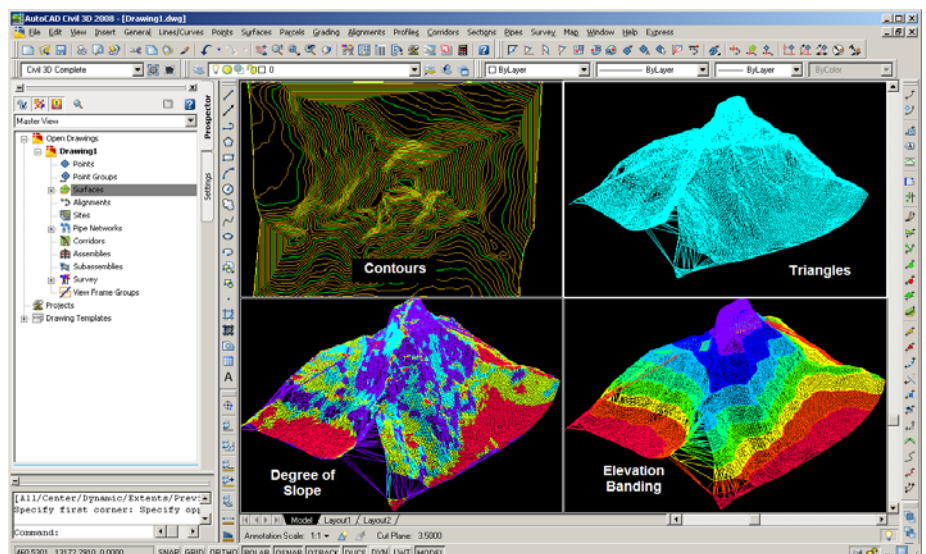
From within Civil 3D, use the *ImportGESurface* command to collect the terrain data from Google Earth.

If no map projection is defined, then specify the origin and rotation of the surface data. With a map projection defined, you can have Civil 3D automatically transform the Google Earth longitude and latitude coordinates to the AutoCAD world coordinates.

Finally, specify the name, description, and display style of the new surface.

Note the surface data is imported as a matrix of points. You can specify the number of points in the matrix using Civil 3D's *Settings > Surface > Commands > ImportGESurface > Google Earth Options > Rows and Columns* settings. The default is 100 rows and 100 columns, for a total of 10,000 points resulting in approximately 20,000 triangles.

Here is an example of terrain data imported into Civil 3D and displayed several different ways.

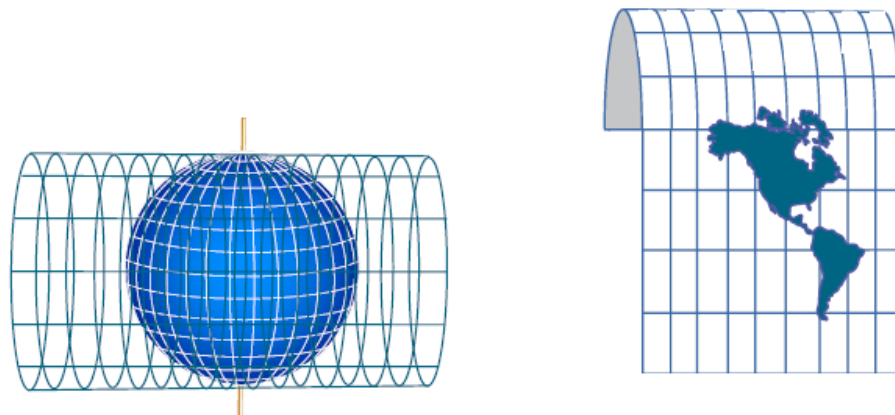




Map Projections

Numerous books have been written on techniques to map items on the Earth's curved surface to planar surfaces. We will not delve into much detail here other than to note the following items:

- The internal coordinate system of Google Earth is geographic coordinates (latitude/longitude) on the World Geodetic System of 1984 (WGS84) datum.
- AutoCAD does not have the inherent notion of distance linear coordinates, so the value of the AutoCAD insertion scale, INSUNITS, system variable is used. Use the *ddunits* command to set that value.
- When no map projection has been defined, an approximate formula is used to convert between the Google Earth and AutoCAD coordinate systems.
- This approximate coordinate transformation method is suitable when working with localized areas such as building sites and the like.
- When using the publishing tool with AutoCAD Civil 3D 2008 or AutoCAD Map 3D 2008, and a formal map projection has been defined using commands available within those products, a much more rigorous set of formulae are used to convert between the two coordinate systems.
- These more precise conversion methods provide suitable transformations over larger distances and areas.



Universal Transverse Mercator Projection (UTM)

Publishing AutoCAD Model Space Entities to Google Earth

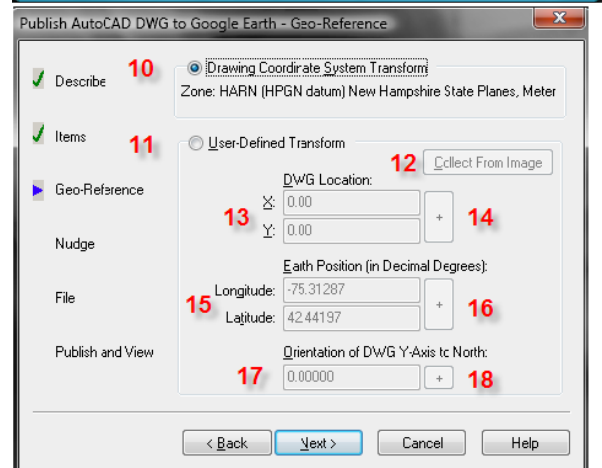
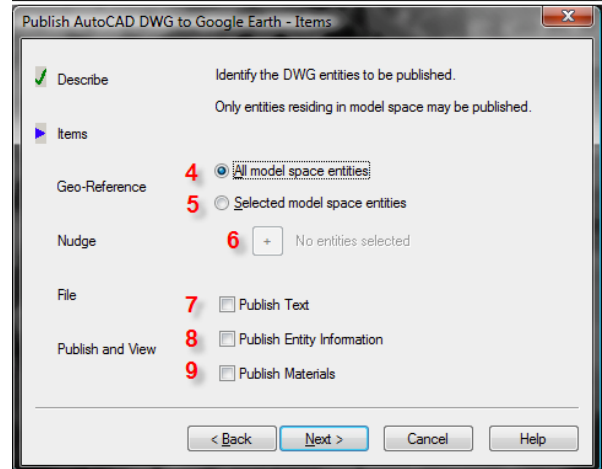
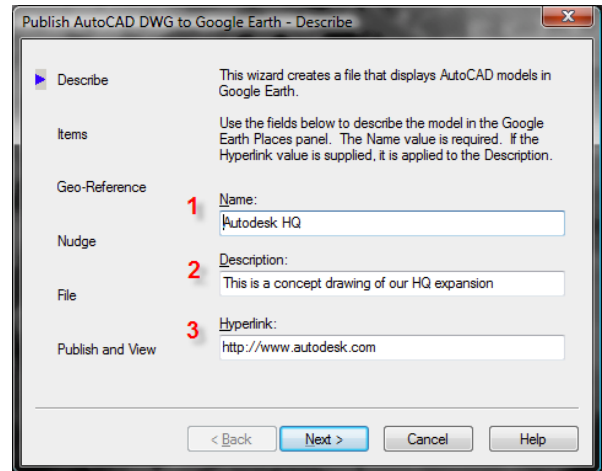


To publish model space data to Google Earth, use the *PublishKML* command.

Prior to publishing data to Google Earth, you should know the position of where the model will be placed on the Earth's surface. The simplest method to geo-reference the DWG model space data with a location on the Earth is to use the procedure described in the section **Import Image from Google Earth**.

After activating the *PublishKml* command, you will be presented with a six step series of dialogs, or Wizard, walking you through the process of publishing the data. The following paragraphs are descriptions for each item in the publishing Wizard.

- 1: Required value specifying the name of the DWG model as displayed in the Google Earth Places panel.
- 2: Optional value specifying the description of the DWG model as displayed in the Google Earth Places panel.
- 3: Optional value specifying the hyperlink to be applied to the full Description text string. If this value is specified, then a Description should also be provided.
- 4: Specifies that all model space entities should be published.
- 5: Allows you to select specific entities for publishing to Google Earth.
- 6: Temporarily hides the publishing wizard and allows selection of model space entities for publishing.
- 7: If toggled on, text strings in the drawing will be published as Google Earth named place marks.
- 8: Publishes additional textual information about DWG entities (for use with AutoCAD Civil 3D, AutoCAD Map 3D, or AutoCAD Architecture only.)
- 9: Includes any materials attached to AutoCAD entities in the published file.



10: Specifies that the map projection defined in the drawing should be used to transform from AutoCAD coordinates to Google Earth coordinates. (For use with AutoCAD Civil 3D 2008 and AutoCAD Map 3D 2008 only.)

11: Specifies that a user-defined transform between drawing coordinates and Google Earth coordinates is used to transform the drawing data.

12: Collects location information from an imported Google Earth image to assist in positioning the DWG model data on the Earth's surface.

13: Defines the location in the DWG model space that is geo-referenced to a specific location on the Earth's surface.

14: Allows interactive selection of location for 13.

15: Defines the location on the Earth's surface that is geo-referenced to a specific location in the DWG model space.

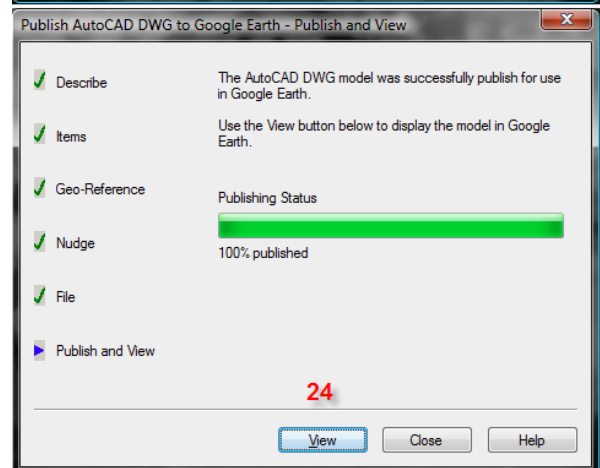
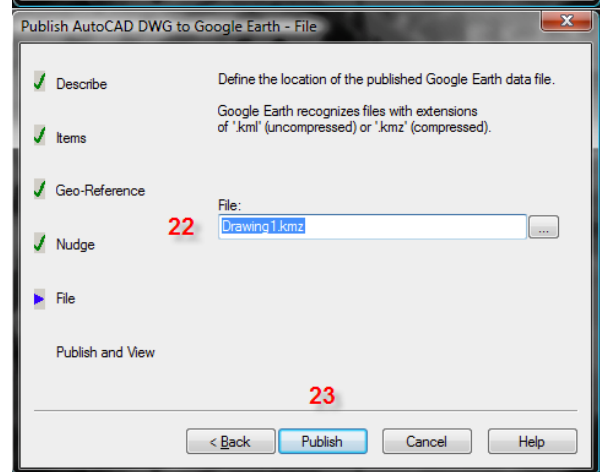
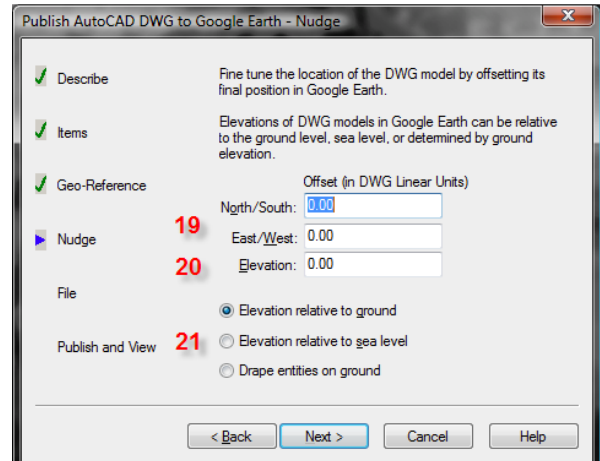
16: Allows approximate definition of a geographic location using AutoCAD's *Geographic Location* dialog.

17: Defines the rotation (if any) of the positive Y-axis for AutoCAD model space to the North direction in Google Earth.

18: Allows approximate definition of the Y-axis orientation using AutoCAD's *Geographic Location* dialog.

19: Defines an amount to offset the DWG model in the North/South or East/West directions. Specify the value in the same units as defined by the AutoCAD INSUNITS system variable.

20: Defines an amount to offset the elevation or altitude of the DWG model data. Use this value to fine tune the position of the model in Google Earth. Specify the value in the same units as defined by the AutoCAD INSUNITS system variable.



21: Controls how the model space Z-coordinate of entities is mapped to elevations in Google Earth. You can specify that model space Z-coordinates are:

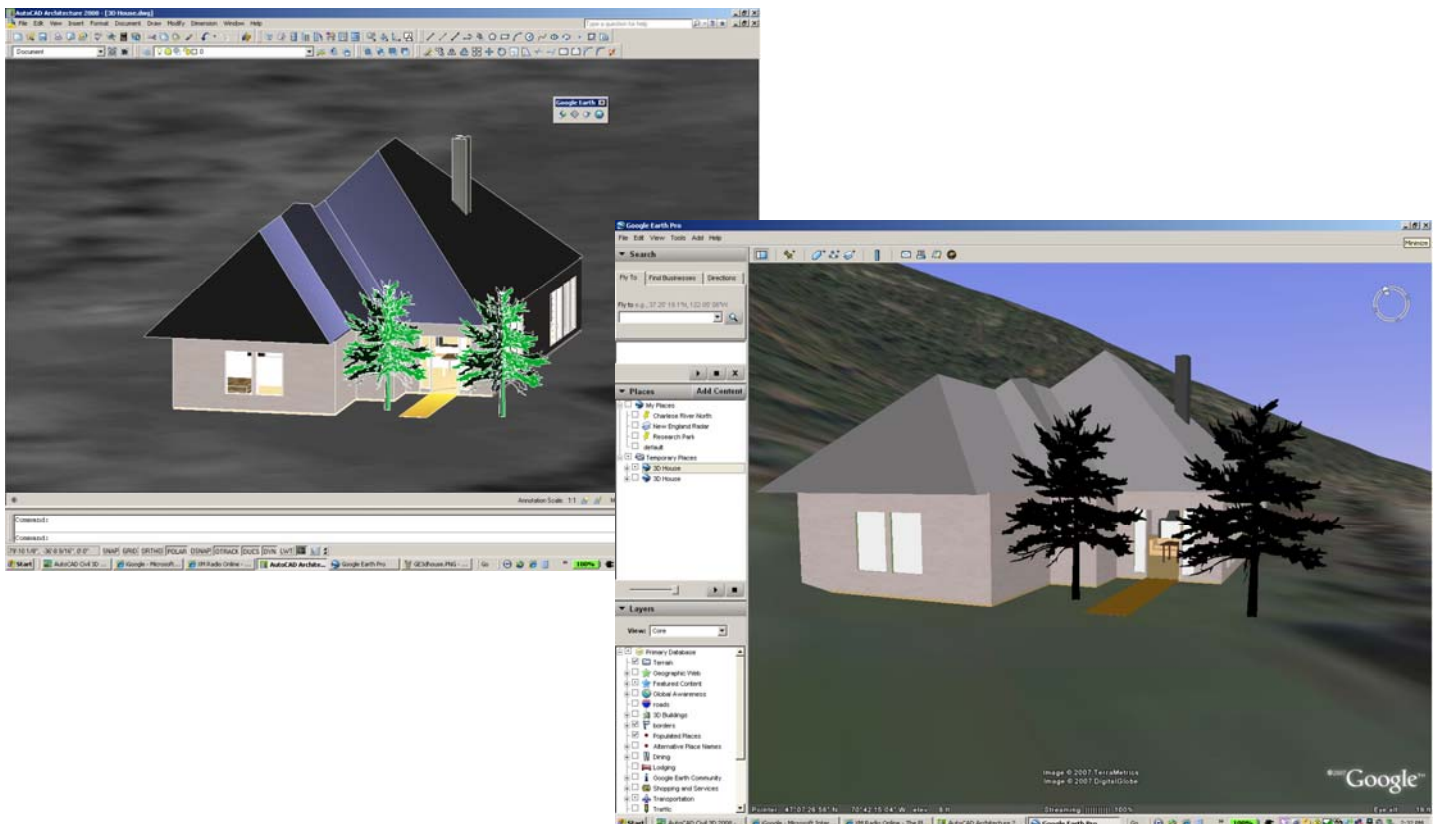
- Relative elevations: added or subtracted to the elevation of the Earth's surface in the area where the model is being published.
- Absolute elevations: added or subtracted to the sea level height.
- Drape: Ignores the Z-coordinate value of entities, and uses the elevation of the ground where the entity is located.

22: Defines the file name of the published data file for use in Google Earth. Extensions of KMZ (compressed) and KML (uncompressed) are both recognized by Google Earth. Published DWG models can result in large data files if the KML extension is used. A large reduction in file size will occur when using the KMZ extension. Note that when publishing materials (item 9) an extension of KMZ will always be used.

23: Initiates the publishing process and creates the data file.

24: Opens the published data file in Google Earth, and zooms to the area where the published data is located.

Here is an example of AutoCAD building model (left) published to Google Earth (right).





The following items are important to note about the publishing process:

- Published models can be shared with others by simply sharing the published data file.
- You can share models with others using Google's 3D Warehouse located at http://sketchup.google.com/3dwarehouse/upload_details?webupload=true&uptyp=mn.
- DWG model data is grouped under the Model folder in the Google Earth Places pane.
- Cameras and paths are grouped in the Cameras and Paths folders in the Places pane.
- Colors of published entities in Google Earth are closely matched to AutoCAD colors.
- Only model space data may be published.
- When using the publishing tool within AutoCAD Civil 3D 2008 or AutoCAD Map 3D 2008, and a map projection is defined, the default behavior is to automatically use the map projection formulae (item 10) to convert from drawing coordinates to Google Earth coordinates. You can optionally manually define the AutoCAD to Google Earth coordinate transformation on the Geo-Reference page of the publishing wizard (item 11), but a more accurate conversion is possible if the automatic map projection transformation is used (if one is available).
- When publishing materials (item 9), Google Earth limits the model size to 21845 triangles when materials are included. If your model is larger than this, publish the model several times in smaller partitions.
- When publishing materials (item 9), the data file will always have a KMZ extension.
- When publishing Entity Information (item 8), additional attribute information associated with the entities is viewable in Google Earth by clicking on the Model item in the Places pane. A pop-up window anchored on the entity in the Google Earth view will list the attribute data. The attribute information published varies by product:

AutoCAD Product

Entity Attribute Information Published

AutoCAD 2008	None.
Civil 3D 2008	Predefined set of attributes that varies by entity type.
Map 3D 2008	Predefined set of attributes that varies by feature type.
Architecture 2008	Utilizes Property Set data. See AutoCAD Architecture 2008 help for information on attaching Property Set data to entities.



Including Temporal Information with Publishing Entities

Google Earth provides the ability to conditionally display published model data based on start and end times attached to each piece of model data. These start and end times are referred to as an entity's time span. This is a useful tool where you need to present development progress over a period of time. Attaching time span information to AutoCAD entities is entirely optional. If you decide to attach start and end times to AutoCAD model space entities when the model is published to Google Earth, you can use the timeline tool within that application to control the display of the model data.

Prior to attaching time information, you should analyze your model and decide on the best technique to associate time with the various entities. This will vary from model to model. For example, for a structural framing model, you might associate one time span with the first floor columns, a second time span with the second floor beams, and so on. Using this technique would allow you to animate the upward construction of the building framing.

To attach time span information to AutoCAD entities prior to publishing the data use the *GETime* command.

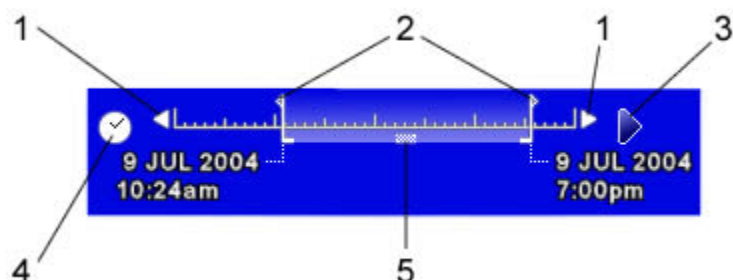
After activating the command, you will be prompted to select one or more model space entities. Then, the *Timespan for Google Earth* dialog appears. Define the (optional) start time and (optional) end time for the selected entities.



After the AutoCAD model space entities are published to Google Earth, use the Timeline slider control to display your model data over the defined time period.

Features of the Timeline slider include:

- 1: Click these arrows to move the time range earlier or later.
- 2: Drag these range markers to the right or left to re-define the time range of data displayed.
- 3: Click this to play an animation of the sequence. This works best if you move the range markers to define a time range smaller than the whole set.
- 4: Click this to set options for the time slider.
- 5: Drag this to move the time range earlier or later.





Note the following important points related to attaching time information to model space entities:

- If a start time is not attached to an entity, then the entity will display starting at the beginning of the time slider tool in Google Earth.
- Similarly, if an end time is not attached to an entity, then the entity will display from the start time through to the end of the slider bar.
- An entity without any time span information attached to it will always be displayed in Google Earth.
- Time information associated with AutoCAD model space entities is attached to those entities using X-Data.
- Time span information attached to entities in models is not published when materials are published; either time information can be published or material information can be published, but not both.
- If you hover over an entity with time span data attached, a tooltip with the start and end times will be displayed.
- Existing time span data attached to an entity can be updated by rerunning the *GETime* command on the entity.



Comparison of Various Autodesk Products that Interact with Google Earth

This presentation has concentrated on AutoCAD and the AutoCAD-based vertical applications interaction with Google Earth. Autodesk’s Revit Architecture and MapGuide products also can also send data to Google Earth.

The following table delineates the various types of data exchange that can currently occur between Autodesk products and Google Earth.

2008 Product	Import GE Image	Import GE Mesh	Import GE Terrain Model	GE Time	Publish to GE	Supports Map Projections
AutoCAD	✓	✓		✓	✓	
AutoCAD Civil 3D	✓	✓	✓	✓	✓	✓
AutoCAD Map 3D	✓	✓		✓	✓	✓
AutoCAD Architecture	✓	✓		✓	✓	
MapGuide					✓	✓
Revit Architecture	✓				✓	



Accuracy of Google Earth Data

Google Earth has digital elevation model (DEM) data collected by NASA's Shuttle Radar Topography mission. In Google Earth, the resolution of the cells of the source data is approximately 30 meters over United States territory; for the rest of the world, only 90 meter spacing has been made available. Google Earth has improved their results using a specialized interpolation process, and by adding data from other sources. Since 2006, the 3D views of many areas around the globe, including many prominent mountains, have been improved by the use of supplementary DEM data to fill the gaps in the SRTM coverage. Elevation data was recently updated to 10-meter resolution for much of the United States and several other parts of the world. In summary, terrain data varies by country from 10- to 90-meter resolution.

Elevations below sea level (e.g. Death Valley, CA and the Dead Sea) are presented as sea level.

The accuracy of image data in Google Earth also varies by locale. Most land is covered in at least 15-meters of resolution per pixel, with some areas (e.g. Las Vegas, NV and Cambridge, MA) at the very high resolution of 15 centimeters per pixel. Certain locations around the world use ortho-rectified imagery. Improved imagery for locations around the world is updated on an on-going basis. The imagery is generally current to within three years.

Use of Google Earth Data

To import terrain and image data from Google Earth to AutoCAD, the publishing tool utilizes several public Google Earth Application Programming Interface (API) function calls.

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- <http://earth.google.com/support/bin/answer.py?answer=21422>