Lesson 1

Using Geospatial Data

Overview

Geospatial technology and Geographic Information Systems (GIS) have rapidly evolved in the civil engineering industry over the last twenty years. A vast majority of city, municipal, and utility organizations maintain active GIS that serve the needs of both internal and external clients. Naturally, there are a large number of industry software vendors that are trying to meet the ever-increasing demand for reliable geospatial technologies and data.

In typical civil engineering projects, such as land development design, many departments are involved in using and integrating geospatial information. Software applications that address all project phases seamlessly are most beneficial. Software system architecture needs to enable individual programs and departments to communicate efficiently with each other. AutoCAD® Civil 3D® software includes Autodesk® Map 3D tools and supports many other industry file types such as Microstation DGN files and ESRI shapefiles.

There are many geospatial data types that must be handled by today's software. In general terms, a data layer is either vector or raster. Vector data consists of points, lines, and polygons and represent features such as road centerlines, fire hydrants, and parcel boundaries. Raster data can generally be thought of as an array of data, either a set of cells representing data like land use or a set of pixels showing an aerial image. Both types of data are vital to a functional GIS.

The following image displays both raster and vector data layers.

Autodesk Map 3D tools enable connection to geospatial data using two major methods: the Feature Data Objects (FDO) method and the DWG query method. The FDO method accesses features and geospatial data from many different types of data file types. The DWG Query method accesses features and geospatial data from other DWG files. These other DWG files are called *source files* and are attached to the current drawing prior to being queried.

Objectives

After completing this lesson, students will be able to:

- Describe raster and vector data formats.
- Describe the different types of raster data.
- Describe different methods of connecting to data.
- Connect to and work with vector and raster data.

Exercises

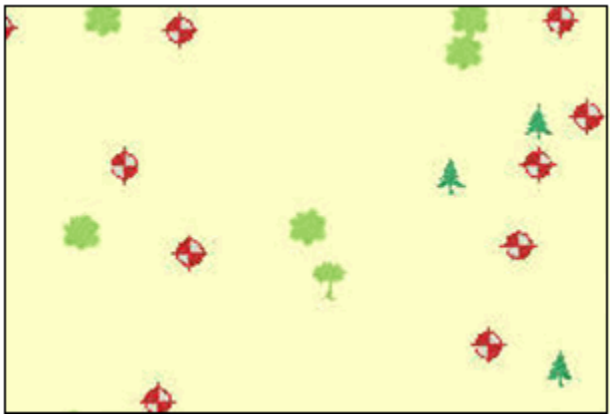
The following exercises are provided in a step by step format in this lesson:

1. Connect to Raster Image Data
2. Connect to Raster DEM Data
3. Connect to Vector Data

About Vector Data

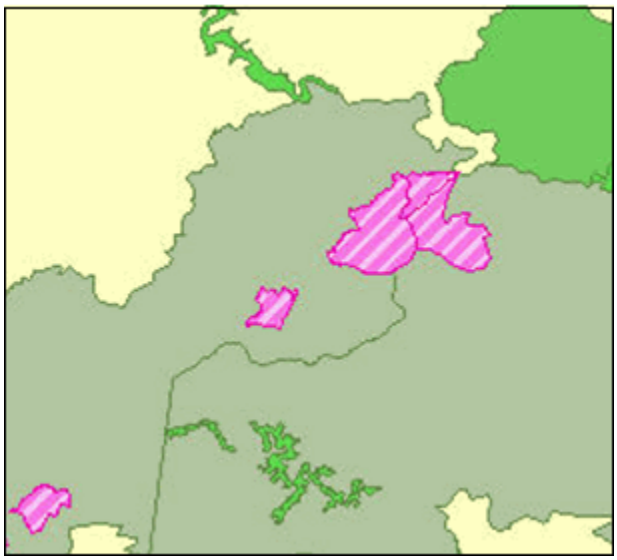
Vector data is composed of points, lines, and polygons. The geometric information stored for this data type consists of an *x, y*, and optional *z* coordinate. Attribute, or database, information is stored along with the geometric information corresponding to that point, line, or polygon. Vector data is usually generated from Total Station or GPS survey data, and can also be generated from other types of mapping data.

A *point* is a discrete location in space and can represent real or abstract features. Points can be above, below, or on a surface. Points represent features such as survey points, manholes, trees, and water valves as shown in the image.



Polylines are formed by connecting multiple data points. Individual line segment lengths are calculated from endpoint coordinates, and polyline lengths are the sum of the line segment lengths. Polylines represent features such as road centerlines, water lines, and rivers as shown in the image.

Polygons are closed areas created by connecting lines and polylines and are often an irregular shape. Polygons can represent different types of data such as land use areas, political boundaries, and right-of-way areas as shown.



Topology is the relationship of spatial objects to each other. Based on the structure of the underlying database, software can determine which lines are connected or which polygons lie next to each other. Vector data can represent topological relationships more easily than raster data formats. Vector data can also represent real-world features more accurately than raster data, and typically has a smaller file size for the same area of coverage.

About Raster Data

Raster data graphically represents features using an array of identically sized square cells. Raster data falls into two major categories: thematic data and image data. Thematic data layers are typically constructed, or derived, from a source data layer. The individual cells carry attribute values such as a land cover type or an elevation. Image data consist of some type of digital image such as a satellite image, an aerial photograph, or a scanned map.

Resolution is an important concept to understand when working with raster data. Each cell (thematic data) or pixel (image data) represents a fixed area on the earth's surface with an x and y dimension. For example, an image with one meter resolution means that each pixel represents one square meter on the ground. The smaller the ground distance (resolution) a pixel covers, the greater the image detail, and the higher the resolution.

Sometimes it is useful for engineers and planners to work with hard-copy photographs, mapping, and design documents. These hard-copy documents can be scanned to create raster image data that can be used in conjunction with vector data. Engineers will sometimes "vectorize" scanned raster documents to convert pixel paths into lines and polylines for use in the design process.

Thematic Data

Thematic data show information for a theme, such as land cover or elevation. Each cell contains a value, or attribute, associated with that theme. Thematic data can be categorized

into two general types: continuous or discrete. Cells in continuous data layers hold floating point values that represent continuous data, such as elevation of a surface. Cells in discrete data layers hold integer values and represent a finite number of possible values. Land cover is a good example of a discrete thematic data layer in which cells that represent forest cover may have an assigned value of 5 and be colored green.

The following image shows continuous thematic data representing elevation. This is commonly called a digital elevation model (DEM).

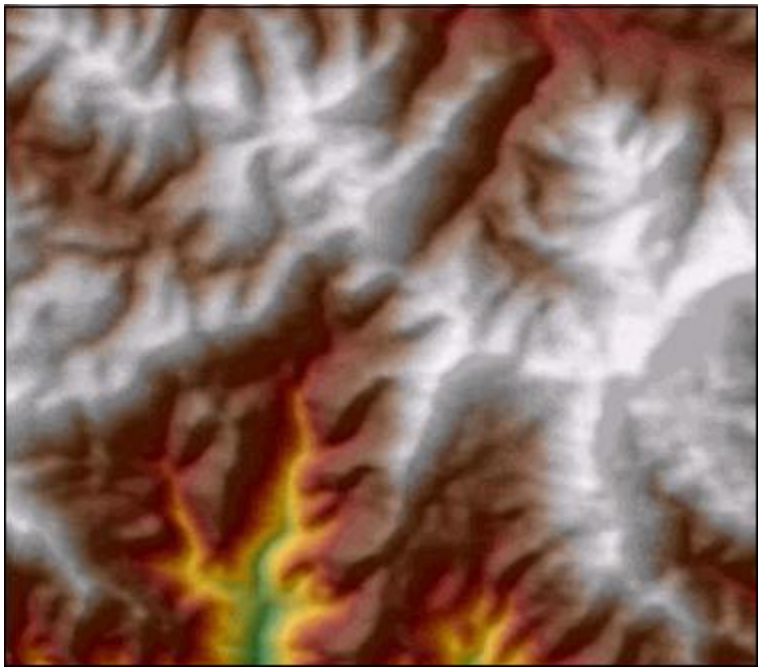
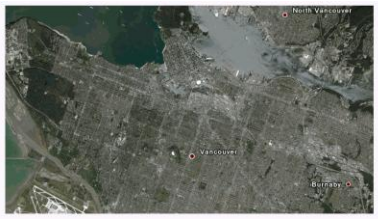


Image Data

Aerial photographs, satellite imagery, and scanned documents are examples of image data. It is typical to use the term *pixel* for an individual element when discussing image data, as compared to *cell* for thematic data. Pixel data in an aerial image indicate the location and color of each pixel. The color can be black and white (values of 0 to 255 – 8 bits) or color. Color images are commonly comprised of 8 bits each for red, green, and blue (RGB).

The following are images of the City of Vancouver extracted from Google Earth. The images are sourced from both satellite imagery and aerial photography.



About Feature Sources

A feature is the spatial description of a real-world entity such as a road, a utility pole, or a river. Features and the data describing them are stored in a geospatial database. Geospatial databases are external files that store both spatial (coordinates and elevation) data as well as attribute data. These geospatial databases are referred to as *feature sources*. Feature source data can be read and created by a number of geospatial software applications including Autodesk, ESRI, Bentley, and Intergraph.

There are four types of feature sources, including:

Feature Source Type	Example
Database	Oracle, ESRI ArcSDE, SQL Server, My SQL
File based	Autodesk SDF and ESRI SHP
Web server	Web Feature Service (WFS), Web Mapping Service (WMS)
Table	Microsoft Access

Feature source data resides in files external to Civil 3D. Therefore, it is a much more efficient means of storing and working with large amounts of municipal and utility infrastructure data. When working with feature source data in the Civil 3D environment, you work directly with the data in external file. Also, feature source data contains no information about how the data is to be displayed. Civil 3D makes use of styles and themes to display feature source data.

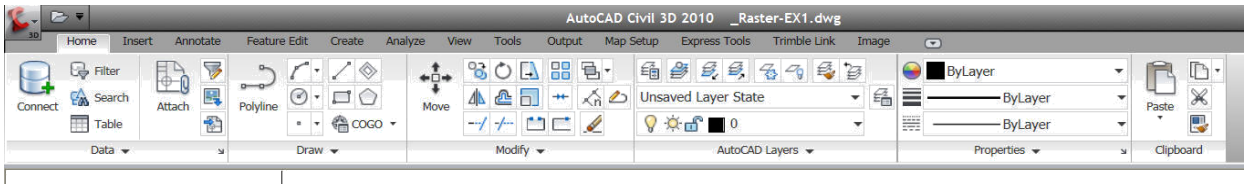
Connecting to Data

The two major methods for connecting to data are the FDO method and the DWG Query method, which is used when gathering data from other DWG files. Either method permits querying to select the data to display in the current DWG file.

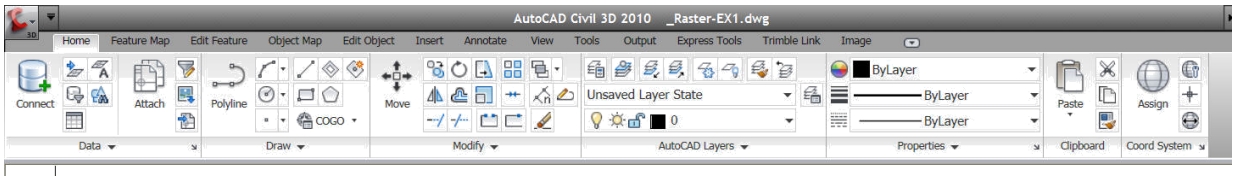
FDO Method

The FDO method sets up a connection to a folder or file and reads the designated geospatial file type. If the data layer has associated information about the coordinate system, it is assigned. One important note on the FDO method is that a "connection" to the original data source is established; the data is not copied to the drawing. The data can be viewed, stylized, analyzed, and if edited, updates can be saved back to the source data.

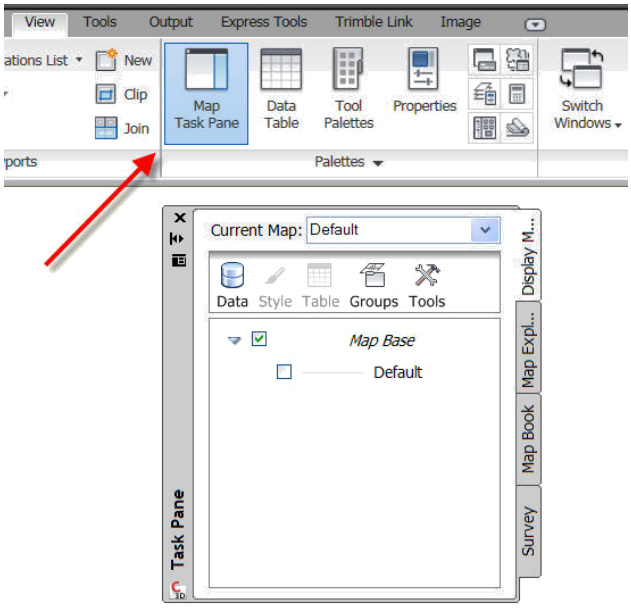
Whether the connection is for raster data or vector data, the process is similar. Map 3D tools are included with Civil 3D, but the workspace needs to be changed to make the tools accessible. There is a Tool-Based Geospatial workspace and a Task-Based Geospatial workspace. The Tool-Based Geospatial workspace organizes the ribbons and panels based on their functionality, such as Insert Tools, Create Tools, and Analyze Tools.



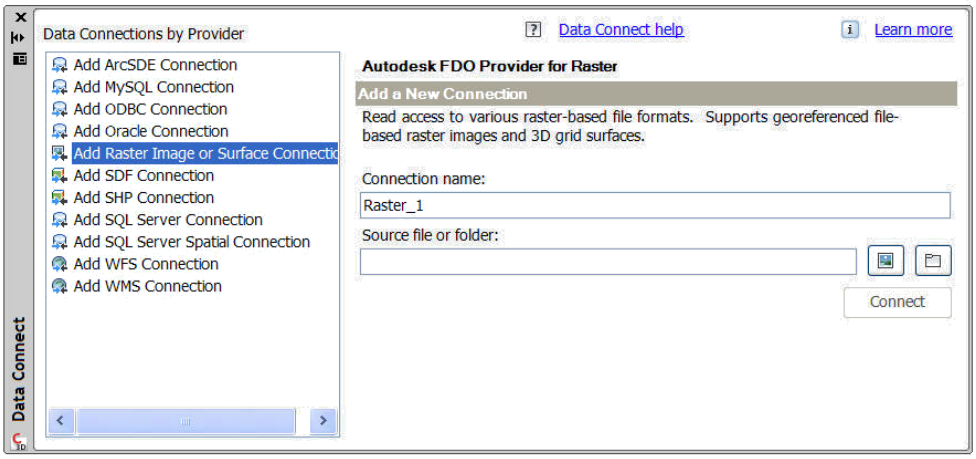
The Task-Based Geospatial workspace configures the ribbons and panels based on a specific task, such as creating a feature map or an object map.



The Task Pane is similar to Toolspace for Civil 3D and enables tasks such as connecting to data, setting style, and editing data. The Task Pane is opened on the View tab of the ribbon, on the Palettes panel.



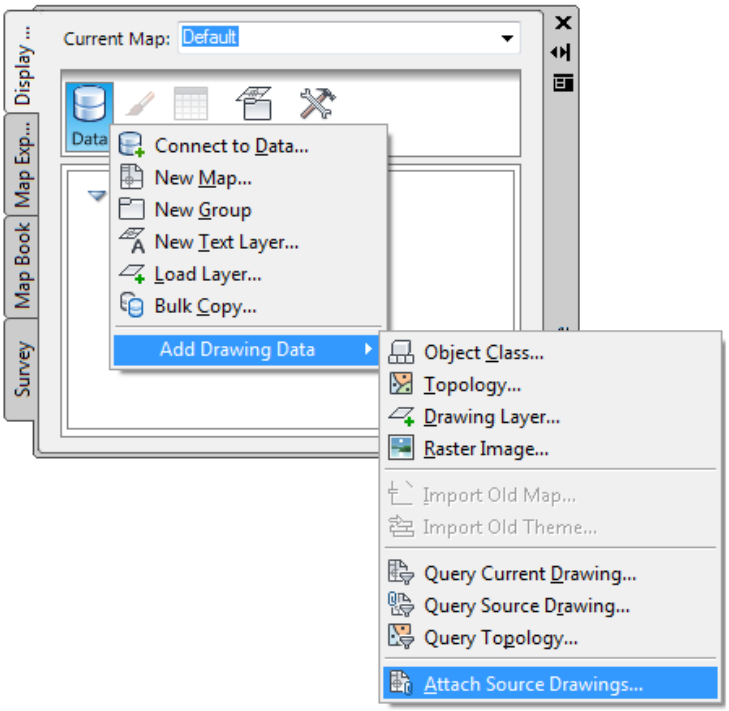
To connect to data, click the Data button on any of the Task Pane tabs, and then click Connect to Data. This displays the Data Connect window, where the type of FDO connection can be specified. The Data Connect window is as shown.

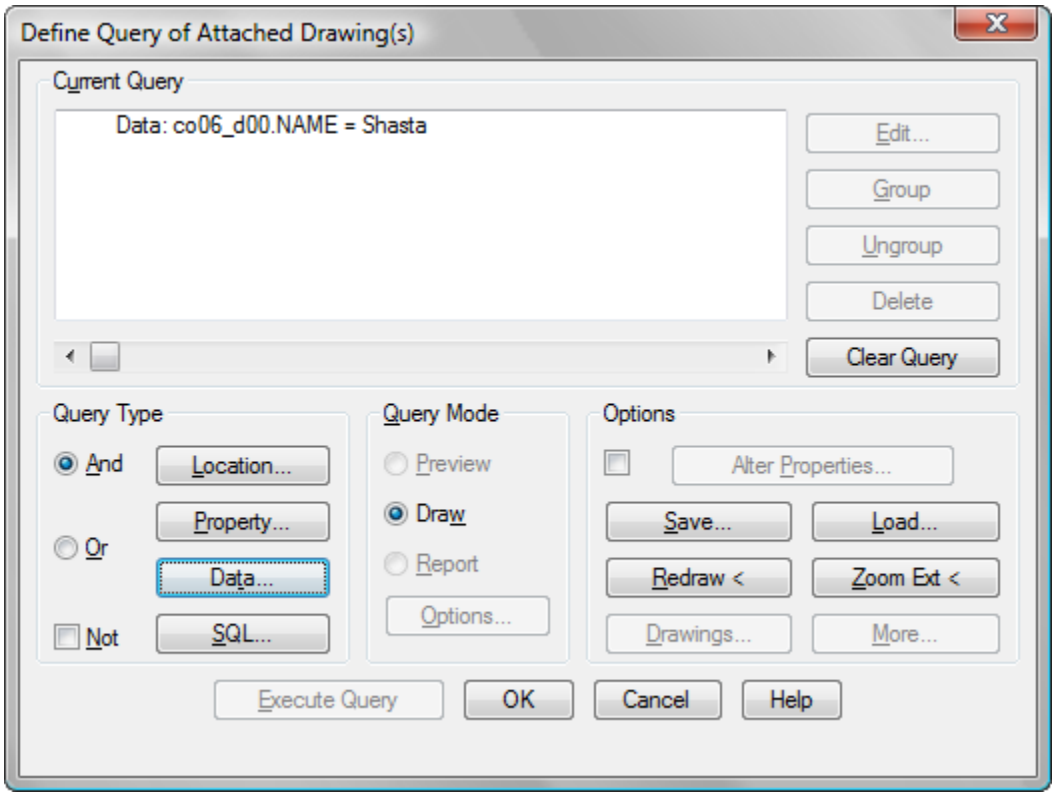


DWG Query Method

The DWG Query method is used when required data is stored in one or more DWG files, called *source files*. In order to view, query, and even copy data from these source files, they must be *attached* in a *drawing set*. A query can then be set up and executed to copy the desired subset of data into the current drawing. This imported data can be stylized, or symbolized, as it is imported into the current drawing. Edits can be made to the original data and saved back to the original source drawing.

The following images display the attachment and query process.





About Object Data

Object data is custom attribute data that is attached to individual objects and stored in tables in the DWG file. Object data tables store text and numerical information related to an object. Object data can be useful for smaller GIS projects, but large projects with a lot of attribute data can grow the DWG files to be quite large. The object data as viewed in the Properties palette is shown in the following image.

OD:co06_d00	
AREA	1.0627
CO06_D00_	7.0000
CO06_D00_I	6.0000
COUNTY	089
LSAD	06
LSAD_TRANS	County
NAME	Shasta
PERIMETER	5.5025
STATE	06

Key Terms

GIS	GIS is an acronym for Geographical Information System and is a collection of hardware.
Vector Data	Vector data represents points, lines, and polygons.
Raster Data	Raster data graphically represents features using a matrix of identically sized square cells. Raster data falls into two major categories: thematic data and image data.
Thematic Data	Thematic data represents data of a theme, such as land cover or elevation.
Image Data	Image data are essentially digital photos in which each pixel represents a color.
Cell	A cell is the smallest element of a thematic raster data layer.
Pixel	A pixel is the smallest element of an image raster data layer.
Resolution	Resolution is the amount of area covered by one pixel/cell of the raster. For example, an image with one meter resolution means that each pixel in the image represents one square meter on the ground.
FDO	The Feature Data Objects method sets up a connection to a folder or file and reads the designated geospatial file type. If the data layer has associated information about the coordinate system, it is assigned.
DWG Query	The DWG Query method is used when required data is stored in one or more DWG files called *source files*. In order to view, query, and even copy data from these source files, they must be *attached* in a *drawing set*.
Object Data	Object data is custom attribute data that is attached to individual objects and stored in tables in the DWG file. Object data tables store text and numerical information related to an object.

Exercise 1: Connect to Raster Image Data

In this exercise, students use the Data Connect feature to connect to raster images. The images are in an SID file format and consist of multiple tiles correlated to create an image for the project site.

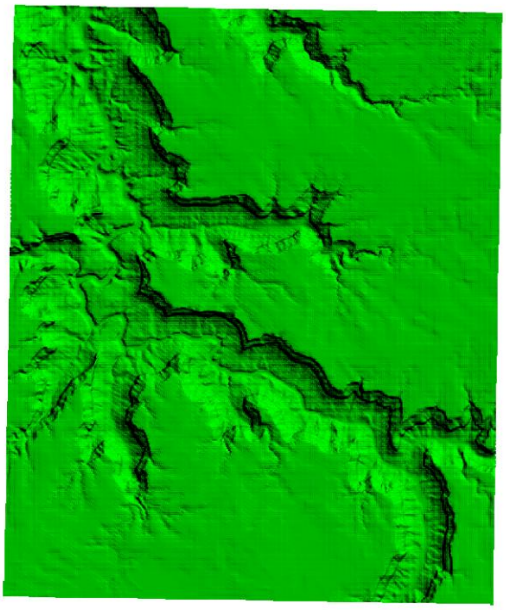
The completed drawing is as shown.

For this exercise, open *…\I_GeospatialData-EX1.dwg (M_GeospatialData-EX1.dwg).*

Exercise 2: Connect to Raster DEM Data

In this exercise, students use the Data Connect feature to connect to Raster DEM Data.

The completed drawing is as shown.



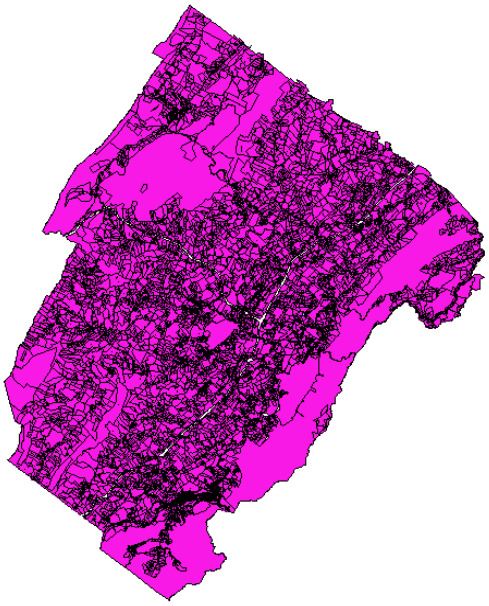
For this exercise, open *…\I_GeospatialData-EX2.dwg (M_GeospatialData-EX2.dwg).*

If students have changed to the Tool-based Geospatial workspace and opened the Task Pane, skip to step 3.

Exercise 3: Connect to Vector Data

In this exercise, students use the Data Connect feature to connect to vector data. Vector data can be provided in many different formats. For this exercise, students connect to ESRI shapefile (SHP) data.

The completed drawing is as shown.



For this exercise, open *…\I_GeospatialData-EX3.dwg (M_GeospatialData-EX3.dwg).*

If students have changed to the Tool-based Geospatial workspace and opened the Task Pane, skip to step 3.

Assessment

Challenge Exercise

Instructors provide a master or challenge exercise for students to do based on this lesson.

Questions

1. Vector data is made up of which three primary geometric shapes?
2. What is the difference between thematic and image data?
3. Is higher resolution more accurate?
4. What is a DEM?
5. Describe the difference between continuous and discrete thematic raster data.
6. What is the difference between the FDO and the DWG Query method for connecting to data?
7. What is object data?

Answers

1. Points, lines, and polygons.
2. Each cell of thematic data represents data related to a specific theme, such as land cover. Image data represents a photo, or image, in which each pixel's value is a color.
3. Yes. Higher resolution generally means that more data is available for the same area. For raster data, the cells or pixels each cover a smaller area to more detail.
4. A Digital Elevation Model (DEM) is a form of continuous thematic raster data representing the elevation of an area. This is also called a surface.
5. Continuous raster data holds floating point attribute data that represent continuous values. Discrete raster data hold integer values and one cell is not necessarily related to the adjacent cell.
6. The FDO method connects a data source to the current DWG file, regardless of the type of geospatial data. The DWG Query method is used to connect the current DWG file to other DWG source files that have relevant data that can be queried.
7. Object data is custom attribute data that is attached to individual objects and stored in tables in the DWG file. Object data tables store text and numerical information related to an object.

Lesson Summary

In this lesson, students learned about geospatial data types, including raster and vector. In addition, students learned about the FDO and DWG Query methods of connecting to data. In the exercises, students used the Task Pane to connect to raster image data and to elevation data. Finally, students used the same tools to connect to vector shapefile parcel data.