AutoCAD Civil 3D 2010

Education Curriculum Instructor Guide, Unit Overview

Unit 6: Geospatial

Unit 6 – Geospatial

Unit 6 addresses geospatial capabilities in AutoCAD® Civil 3D® software. The geospatial functionality is available through AutoCAD® Map 3D, which is the base platform for AutoCAD Civil 3D. The lessons in the Geospatial unit address the connecting to and analyzing of a number of different geospatial data types. In the engineering profession, geospatial analysis is usually done at the beginning of a project during the conceptualization and planning phases. Geospatial analysis enables you to work with a variety of data sources that organize data spatially.

Geospatial data has a spatial component (the location and spatial orientation of the features and a data component (the data attached to the features). For example, a map showing parcel data would not only show the location of the parcels, but also contain information such as parcel owner and zoning. A geospatial county plan would show the location of state counties on a map, and would also provide information on the populations of the individual counties.

The lessons contained in Unit 6 include the following:

- Lesson 1 – Using Geospatial Data
- Lesson 2 – Geodetics
- Lesson 3 – Queries
- Lesson 4 – Cartography
- Lesson 5 – Spatial Analysis

Lesson 1 introduces the student to the concept of connecting to different types of geospatial data. Lesson 2 on geodetics addresses coordinate systems and coordinate system transformation. Lesson 3 teaches students how to perform spatial and data queries to extract specific information from data sources. Lesson 4 introduces cartography and discusses techniques for creating different types of maps in AutoCAD Civil 3D. Lesson 5 discusses spatial analysis and includes exercises on buffer and overlay analysis.

A detailed summary of the lessons in Unit 6 follows:

Lesson 1 - Using Geospatial Data

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 AutoCAD 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.

AutoCAD 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, you 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

Lesson 2 - Geodetics

Geodetics is the study of the measurement of the earth. The shape of the earth is generally an ellipsoid, but often represented as a flat surface on a map. Laying a piece of flat paper on a round globe suggests obvious problems with this type of representation. The most significant problem is distortion, suggested by folds in the paper when pressed against the globe. While geodetics is a complicated topic, this lesson addresses three major definitions in geospatial reference systems: projections, datums, and coordinate systems. Using a common “coordinate system” basically means using the same projection, datum, and coordinate system in order for data layers to correctly correlate to each other.

Utility and land development business processes are lengthy and involve many different project phases. An inherent aspect of these business processes is geospatial data transfer and leveraging throughout the entire project lifecycle. A typical project involves planners, surveyors, engineers, GIS technicians, and data analysts.

Planners extract data from a GIS for project conceptualization and preliminary design. Surveyors create base plans and existing ground surface models, and hand off pre-engineering data to engineers. Engineers create detailed design construction documents and hand off construction staking data to construction surveyors. Surveyors and engineers give post-construction “as-built” data to GIS technicians for input into a GIS. Some projects also use satellite imagery, aerial photographs, and other types of overlay data such as environmental data. GIS technicians create and manage data in a geospatial database that is in turn used by those involved with municipal/utility planning and growth management.

Land development and utility business processes must consider the use of a consistent coordinate system throughout all project phases. Data created to a locally assumed coordinate system, which is a common occurrence, needs to be transformed to a defined and common coordinate system prior to handoff to the next group involved in the process.

Objectives

After completing this lesson, you will be able to:

- Describe Cartesian and polar coordinate systems.
- Describe the principles of projections.
- Discuss horizontal and vertical datums.
- Discuss UTM and U.S. State Plane Coordinate Systems.
- Assign a coordinate system to a drawing and a data layer.
- Assemble data layers that use multiple coordinate systems.

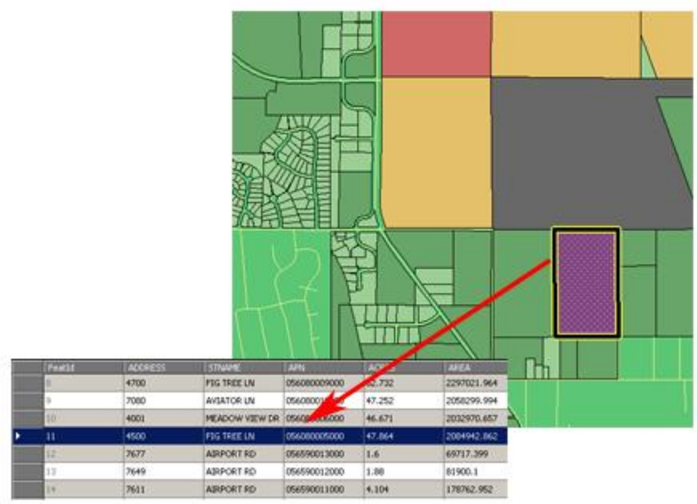
Exercises

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

1. Assign a Coordinate System to a Drawing
2. Assign a Coordinate System to Data
3. Assemble Data from Multiple Coordinate Systems

Lesson 3 - Queries

The basis of a GIS (Geographic Information System) is geospatial feature data that is linked to a database. Records in the database are linked to a feature such as a point, line, polygon, or raster cell. For example, a parcels database can have attribute data that lists the owner, the address, and the value of the property.



Either the geospatial features or the database can be queried to find a subset of particular interest. In some cases, you may want to bring in all the data in a certain geographic area by drawing a rectangle or a circle on the base map. This is a type of location-based query. In other cases, you may want to find a specific subset of a data layer, such as all parcels with value greater than a certain amount. These are called property-based queries. The following illustration shows an empty grid on the left, a location-based query in the center, and a property-based query on the right.

Objectives

After completing this lesson, you will be able to:

- Discuss the different types of queries.
- Perform spatial queries from feature sources.
- Perform data queries from feature sources.
- Combine queries.

Exercises

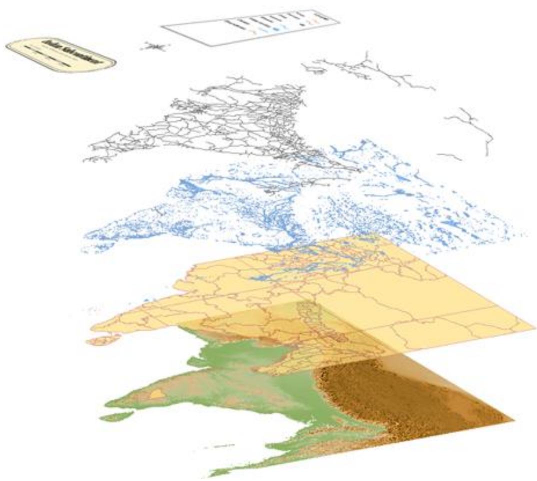
The following exercises are provided in a step-by-step format in this lesson:

1. Perform a Spatial Query
2. Perform a Data Query
3. Perform a Compound Query

Lesson 4 - Cartographic Basics

Cartography is the art and science of making maps. Mapmaking involves many considerations, including the function of the map, data required for display, scale, colors, symbology, classification, generalization, and distortion. Maps are communication tools that provide a way to visualize data for specific locations. With GIS, maps can also present information in an analytical paradigm, presenting data or even results of models or calculations overlaid on a location.

In digital cartography, a map is made up of layers that overlay one another. You need to arrange these layers in the correct order, so that every feature in the map is in its proper place in the vertical arrangement. Features should be overlain so that they do not obscure each other. Typically images, such as satellite photographs, are located on the lower layers, that is, at the bottom of the *draw order*. Polygon layers, such as state and city boundaries, are typically placed above the images, followed by the layers of line features and point features. Finally, elements such as the map legend, scales, and North arrows provide the finishing touch.



Objectives

After completing this lesson, you will be able to:

- Describe the basic elements of cartography.
- Stylize features based on attribute data.
- Label feature objects.

Exercises

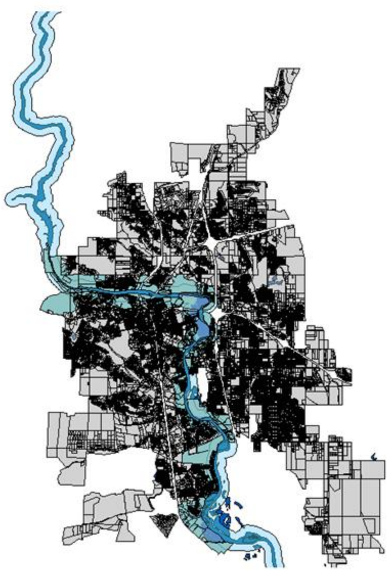
The following exercises are provided in a step-by-step format in this lesson:

1. Create a Population Map
2. Create a Site Map
3. Create a Zoning Map
4. Create a Slope Analysis Map

Lesson 5 - Spatial Analysis

Spatial analysis is the process of working with geospatial data layers to create new data layers in order to answer questions and make decisions during the engineering planning project phase. One of the most common operations is to create a buffer around a feature and then identify features on other layers based on their proximity to the buffer. Another useful method of spatial analysis is called an overlay. Overlays combine two geospatial layers to create a new layer.

In the following illustration, the blue buffer defines an area within 100 feet of the river. This buffer could be used to identify the land parcels that lie within the flood zone.



The following illustration overlays two layers, a flood zone, and a parcel layer, in order to determine where the two intersect. The intersected parcels layer becomes a new layer, which can be styled and used for additional analysis.

Objectives

After completing this lesson, you will be able to:

- Describe buffer and overlay analysis methods.
- Analyze data using a feature buffer.
- Analyze data by creating a feature overlay.

Exercises

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

1. Create a Buffer Analysis
2. Create an Intersection Overlay Analysis

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