



ArcGIS® CAD Translation in Geoprocessing

An ESRI® Technical Paper • October 2004

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ArcGIS CAD Translation in Geoprocessing

About This Document

Purpose This document is intended to provide an overview of computer-aided design (CAD) translation within ESRI® ArcGIS® 9 geoprocessing (GP). Included is a discussion of the tools and various common translation scenarios along with suggested strategies for completing those tasks. This document should convey the philosophy behind the CAD translation tools and the techniques, suggested methods, and level of effort required to perform your own translation tasks.

Scope This technical paper assumes the reader has a working knowledge of ModelBuilder™ and the ArcGIS geoprocessing framework. The scope of this document includes the use of ArcGIS 9 geoprocessing to solve common CAD translation tasks. This document outlines solutions that can be assembled using the standard system tools within ModelBuilder or scripting.

There are various ways to load CAD data in ArcGIS. Other methods of data loading, such as using the simple data loader or simply saving the data assembled using a composite data set from the ArcGIS Data Interoperability extension, are outside the scope of this document. There are other possible solutions that could be created using the various application program interfaces (APIs) provided in ArcGIS including geoprocessing scripting and ArcObjects™, which are also outside the scope of this document. You should not overlook the potential to use these other methods when appropriate. You might also consider the advantages of using the various data loading methods in combination to create the ideal CAD translation solution for a given application.

Introduction: The Philosophy of CAD Translation in Geoprocessing

The purpose of CAD translation tools in geoprocessing is to create high-quality ArcGIS data from CAD drawings and to create the best possible CAD files from ArcGIS data. GP translation tools are used to move and reformat data from one data type to another.

The solution for CAD translation within ArcGIS is based on the premise that CAD and geographic information system (GIS) data are different. Their file format is different.

The data models are different. And the reason for the two technologies' very existence is different. CAD translation within geoprocessing recognizes these differences by exposing as much of the CAD file as possible. To enable the translation task, there must be a common ground upon which the tools can operate. Geoprocessing tools work most effectively on geodatabase feature classes. By converting the data model of a CAD file into its analogous ArcGIS geodatabase equivalent, the data is accessible in a format that

ArcGIS geoprocessing tools can easily manipulate. The resulting geodatabase version of CAD files may be of little use without further interpretation, reconfiguration, and manipulation. Although you may be able to express the contents of a CAD file using tables and various GIS data types, the problem of meaning, or design intent, is still an issue. Although the data is converted to a GIS file format, the data organization, attribute encoding, and the CAD designer's data construction techniques can still hide information. This hidden information can only be extracted when the CAD data standards are known.

Geoprocessing tools provide a framework for creating translation models. When GP tools are used in combination and assembled with knowledge of the CAD standards, they can form geoprocessing tasks that serve as interpretation rules. These geoprocessing tasks can be encoded and stored in scripts or ModelBuilder models as reusable, customizable, semantic CAD translation tools.

***Direct Read, ArcGIS
Data Interoperability
Extension, and the
Import From CAD
GP Tool***

ArcGIS can use a CAD file as a feature class source with its direct read capability. The direct read functionality treats the CAD file as a database of spatial features. The direct read CAD feature class provides a predefined database "view" of the spatial features contained in a CAD drawing. A detailed description of the schema of these CAD file database views is contained later in this document. A direct file read CAD feature class is usable within the geoprocessing framework directly without conversion as a GIS feature source. The various CAD properties, including attribute tags, are exposed in the virtual feature attribute table of the polyline, polygon, point, annotation, and multipatch feature classes.

The ArcGIS Data Interoperability extension provides functionality to read and write more than 70 spatial data formats including variations of AutoCAD and MicroStation. The ArcGIS Data Interoperability extension provides its own direct file read capability that has some subtle differences from the native direct CAD file reading capability of ArcGIS. The ArcGIS Data Interoperability extension also provides a means to build a composite data source from the combination of one or more CAD drawings and external tables to generate a customized feature data source (a more powerful customizable form of direct file read).

The Import From CAD tool should be considered when many CAD files are being processed at one time or if the direct file read CAD feature class lacks the necessary geometry or extended attribution needed to accomplish the desired CAD translation task. Working with many vertically or horizontally tiled drawing files may be easier to manage using the Import From CAD tool. However, using the direct file read CAD feature classes typically requires less effort. The direct file read CAD feature class is usable in ArcGIS as is—without conversion. The direct file read CAD feature class can also be used as a data source in a geoprocessing translation model. The ArcGIS Data Interoperability extension provides access to a similar set of potential CAD file attributes that can be used to build a composite data set. Subtle differences between methods used to access the various extended CAD attribution available in the ArcGIS Data Interoperability extension and the Import From CAD tool will be developed further in this document. The fundamental difference between the Import From CAD geoprocessing tool and the composite data source created in the ArcGIS Data Interoperability extension workbench or the ArcGIS Data Interoperability extension data mapping file is that Import From CAD creates an intermediate staging geodatabase from

the input CAD data in normalized tables that can be further processed using geoprocessing, whereas the ArcGIS Data Interoperability extension assembles data sources in memory that can, in turn, be used by geoprocessing for further manipulation. Clearly, however, there is considerable functional overlap.

The Import From CAD tool is designed to recast a CAD file as a geodatabase sorted into tables of geometry and related CAD property tables. The resulting CAD staging geodatabase contains more data than is exposed by the direct file read CAD feature classes. The granularity of the data exposed by the Import From CAD tool in the CAD staging geodatabase is especially useful when dealing with CAD files containing various forms of extended attribution.

The ArcGIS Data Interoperability extension includes a combination of static database views of CAD files as well as functionality to access extended CAD attribution not contained in the default data views. Consult documents relating specifically to the ArcGIS Data Interoperability extension for more information.

Creating CAD Files From GIS Data

The geoprocessing tool Export To CAD recognizes key named or aliased fields to determine how CAD objects are created. You can drive all the various CAD properties based on key named or aliased fields including the creation of named block or shared cells. For example, you can generate text entities from a point feature class or choose between lightweight or standard polylines when generating linear CAD data from a line feature class.

The Export To CAD tool can support the simple export of a list of feature classes to a single drawing with no other user interaction. The default behavior is to create a single CAD file in which the feature class name is used as the drawing layer name and analogous CAD features are created in the drawing based on the geometry of the input feature classes. Or extensive details about symbology, entity type, and advanced data structures can be controlled through data driven values in key named fields of the input feature's attribute tables. Using a database lookup table of CAD symbology joined to exported feature classes allows you to control the creation of CAD objects according to your exacting CAD standards.

By including a CAD seed file with block or cells defined, you can specify the creation of CAD drawings populated with complex block and cell objects. If the tag names of the blocks match the feature table's column names, then blocks will be created in the CAD file and populated with corresponding values from the feature attribute tables.

The ArcGIS Data Interoperability extension includes tools to generate CAD files in a similar manner in which feature classes are defined from a CAD file, but in reverse. The export functionality of the ArcGIS Data Interoperability extension allows you to create CAD files as well as generate data in more than 70 other spatial data formats.

Tips for Building CAD Translation Models

The bidirectional geoprocessing CAD translation tools can be used to perform simple file conversions as well as complex semantic data translation. There are only five CAD specific geoprocessing tools; of the five, Import From CAD and Export To CAD are the only tools that actually read and write CAD data specifically. The other three are

supporting tools for the Export To CAD tool. CAD translation can leverage the entire geoprocessing framework and its collection of more than 400 tools to perform translation tasks. CAD specific tools are useful alone, but semantic translation is possible only when combined with the entire toolbox of geoprocessing tools. Other methods for accessing data in CAD files that can be further manipulated by geoprocessing are the native direct file read capability of ArcGIS and the direct file read and composite data sources that can be created using the ArcGIS Data Interoperability extension.

This document will focus on the development of CAD translation models that can be assembled in the ModelBuilder environment. ModelBuilder will help you visualize and assemble all the steps in the process of translation and give you a repeatable tool from which you can rerun, test, and modify your solution.

Important Tips for Successful CAD Translation in Geoprocessing:

- You should start the process of CAD to GIS translation with a preference for the ArcGIS direct file read CAD feature classes instead of Import From CAD, unless you need the functionality provided specifically by the Import From CAD tool or the ArcGIS Data Interoperability extension as the extraction of AutoCAD Xdata or if you are aggregating data from vertical or horizontally tiled drawing sets.
- In ModelBuilder, you can only perform a table join using the Add Join tool with a geoprocessing feature layer or table view. These objects are created using the Make Feature Layer or Make Table View tools. You cannot join a table directly to a feature class or another table. The "join" information has to "live" somewhere. In ModelBuilder, the join lives on a feature layer object or a table view object. Creating a query table using the Make Table View tool can also be used to perform table joins in the process of data translation.
- Use the Expression parameter of the Make Feature Layer and Make Table View tools to filter data.
- Use the Select Data tool to choose from the contents of the CAD staging geodatabase or a direct read CAD file feature data set. Although you can browse to the various data elements in a data set and use them in a model, by using the entire data set as an input to a tool, you can anticipate the names of the prenamed feature classes and tables to create more general use tools that could work with any input CAD file or CAD staging geodatabase.
- Using a MicroStation seed file with the properly defined units and coordinates is required to obtain good results when applying the Export To CAD tool to create MicroStation files.
- To generate annotation, first consider using labels instead. Next, consider the Import CAD Annotation tool. You could also use the points generated by the Import From CAD tool to generate labels and convert the labels to annotation in ArcMap™.
- To generate CAD text from annotation, you can use the Export To CAD tool to export a geodatabase annotation feature class. Or you could use the Export To CAD tool with a point feature class in which both the key named field CADType is specified to be the value "TEXT" and the feature class includes a field named, or

aliased to the key field name, TxtValue. Using the other text-related key named fields will also give you further control on the formatting of the text that is generated in the CAD drawing.

- The easiest way to generate well-formatted CAD data is to specify the CAD layer name for each exported feature and provide a CAD seed file with the Export To CAD tool. When the exported features include a key named or aliased field called LAYER in their feature attribute table or a joined table, Export To CAD will create CAD objects on layers named by the values in that field. If the layers specified by those values already exist in the CAD seed file, the default behavior is for the newly created objects to inherit the default symbology defined for the layer in the seed file.
- Using a lookup table to dictate entity specific symbology is another way to both implement and document the process of exporting geodatabase feature classes to CAD files according to a specific CAD layering and/or drafting standard using the Export To CAD tool.

Simple translation or data conversion can be accomplished without much knowledge of the subtleties of the CAD file. Depending on the needs of the data translation task, there are powerful tools available to do serious work. There is no getting around the fact that you must understand both the CAD data model and the GIS data models to perform good, sophisticated translation.

The Importance of Spatial Reference in CAD Translation

The spatial reference associated with any data set is important when working with ArcGIS. There is no exception when working with CAD data. Although every attempt is made to provide useful behavior when the spatial reference information is not provided or known, some situations will arise when various ArcGIS tools generate incomplete results if the spatial reference is not defined.

If a CAD file has been drawn in real-world coordinates, such as State Plane feet, and you know it, that is good. However, ArcGIS does not know what the drawing coordinates mean unless it is told. A projection file is used to identify the coordinate system being used by a CAD file.

Many CAD files are not drawn in a known coordinate system. An ArcGIS world file can be used to move, rotate, and scale a drawing into a given coordinate system. If the CAD file is drawn in some arbitrary local coordinate space or page unit, then it should also be associated with a world file in addition to the projection file, which identifies what coordinate system the coordinates are being moved, rotated, and scaled into. The inclusion of a world file will trigger the recalculation of the drawing coordinates according to a set of offset coordinates and apply the appropriate scale and rotation to put the drawing file into a given coordinate system. However, the spatial reference of a feature class created from the CAD file with just a world file will still be unknown. The projection file accompanying a CAD file provides this coordinate system identification information.

If you append to data that already has a defined spatial reference, then it will be assumed that whatever adjusted coordinates are in the CAD file are the same coordinate system as the target.

If the CAD file is drawn in a real-world coordinate system, but that coordinate system is of a different projection than the target feature class, and you want to append data to it, the CAD file must have an accompanying projection file. When a direct file read CAD feature class is used for translation, the CAD file should include a world file if the coordinates need to be adjusted. It should include a projection file to identify the complete spatial reference.

ArcGIS makes the following assumptions about the coordinates of CAD files:

- **When creating a new stand-alone feature class from a CAD file without a world file or a projection file.** The coordinates in the CAD file are used unchanged as they appear in the CAD file to create new features. The new feature class is created with an unknown spatial reference.
- **When creating a new feature class in an existing feature data set that has a defined spatial reference from a CAD file without a world file or a projection file.** The coordinates in the CAD file are used unchanged as they appear in the CAD file to create new features. The coordinates are assumed to already be in the coordinate system of the target feature data set.
- **When appending features from a CAD file without a world file or a projection file to any data source for which a spatial reference has already been defined.** The coordinates in the CAD file are used unchanged as they appear in the CAD file to create new features. The coordinates in the CAD file are assumed to be the same as the target. The target feature class retains its existing spatial reference.
- **When creating a new stand-alone feature class from a CAD file with an associated world file but without a projection file.** The coordinates in the CAD file are adjusted according to the offset, rotation, and scale specified in the world file. The new feature class is created with an unknown spatial reference.
- **When creating a new stand-alone feature class from a CAD file with an associated world file and a projection file.** The coordinates in the CAD file are adjusted according to the offset, rotation, and scale specified in the world file. The new feature class will be assigned the spatial reference according to the projection file.
- **When adding CAD data with a world file and a projection file to any feature class or feature data set for which a spatial reference has already been defined.** The coordinates in the CAD file are adjusted according to the offset, rotation, and scale specified in the world file. The coordinates of the new feature are projected to account for the differences between the defined spatial reference of the CAD file and the defined spatial reference of the target feature class.

The Import From CAD geoprocessing tool has a spatial reference parameter. The spatial reference can be chosen for all the CAD drawings that are input into the Import From CAD tool, and the resulting feature classes in the CAD staging geodatabase will have the selected spatial reference. You cannot mix CAD drawings with different coordinate systems in the same CAD staging geodatabase. The following is a description of the behavior of the Import From CAD tool in respect to selecting a spatial reference.

XYZM Domain Extents

- If the user specifies a spatial reference that includes domain
 - The specified domain is used.
- If the user specifies a spatial reference that does not include a domain
 - The domain specified in the geoprocessing environment settings is used.
- If no domain is specified in the geoprocessing environment settings
 - The domain is calculated from the source drawings.
- If the user does not specify a spatial reference (default)
 - The domain specified in the geoprocessing environment settings is used.
 - If no domain is specified in the geoprocessing environment settings, the domain is calculated from the source drawings.

Spatial Grid Parameters

The user cannot specify the grid with the Import From CAD tool.

- The grid parameters specified in the geoprocessing environment settings are used.
- If not specified, the grid parameters will be calculated from the input values or set to the values [1000,0,0].

Known Limit—If the Grid Is Set to [1000,0,0]

Features could "fall through" the grid. To calculate a better grid size, use the Calculate Spatial Index tool on the input CAD drawings to find a better grid size, then set those values in the geoprocessing environment settings.

If the spatial reference is not selected for the CAD staging geodatabase, then the spatial reference will remain unknown. If data is used for translation from a CAD staging geodatabase with an unknown spatial reference, the coordinates of the translated features will be used as is and will be mapped directly to the target feature class without modification. This situation is fine when you are assured that the CAD drawings were created in the same coordinate system as the target feature classes. However, if for example, a CAD file were created in a State Plane coordinate system and the target feature class is some Universal Transverse Mercator (UTM) projection, then the data will be added without modification and appended in the wrong geographic location.

When the spatial reference of all data sources in an ArcGIS geoprocessing task are defined, they can be combined and the data will be projected on the fly and the appropriate output will be created.

The Importance of the ArcGIS Repaired Geometry

Data stored in ArcGIS personal or enterprise geodatabase feature classes has a structure that maintains a collection of points and parametric descriptions to form the various supported geometric types. It is possible to generate objects in an ArcGIS feature class that do not conform to the data construction rules required by various ArcGIS analysis or data storage tools (such as the consistent direction of arcs within a polygon boundary). Some of the data loading tools, such as the Copy Features tool, do not check for conformity to these data construction rules.

The Check Geometries tool checks for geometric conformity. The Repair Geometries tool fixes any problems in the data.

This is especially important when dealing with CAD data that may otherwise be converted without issue. However, various spatial and topological functions may not work as expected on these converted objects in the future.

When using the CAD direct read feature class with the Append or Copy Features tool, this process does not automatically occur. Using the Check Geometries and/or Repair Geometries tools before using the Append or Copy Features tool will ensure that CAD translated data will be the most usable by all ArcGIS functions.

The process of ensuring geometric conformity is applied to all new objects when generating features with ArcMap editing tools. Using the Check Geometries or Repair Geometries tools is not necessary when using the Import From CAD tool. The Import From CAD tool automatically checks for errors and repairs the geometry if needed.

CAD Specific Geoprocessing Tools

There are six tools included in the Geoprocessing Conversion toolbox that are CAD specific. These tools are designed to work in combination with all the other tools within geoprocessing and the geoprocessing framework as a whole. The direct file CAD feature data set is not technically a tool but rather a form of conversion that happens automatically. Within geoprocessing this automatic conversion is presented simply as a read only feature class.

The six CAD specific geoprocessing tools are as follows:

Import From CAD

The Import From CAD tool recasts one or more CAD drawings into a geodatabase of a predefined schema on disk. The resultant geodatabase, called the CAD staging geodatabase, is composed of a predefined schema of geometry feature classes and several tables. The tables are highly normalized to accommodate the various one-to-many, many-to-many, and many-to-one relationships that exist in the data model of CAD files. The tables containing the CAD object properties and attributes are separated from the geometry to avoid making assumptions about how the CAD data was constructed. This flexibility also increases complexity.

You should not use the Import From CAD tool if it is not needed. The CAD feature data set (represented in ArcCatalog™ with the blue folder icon) contains five feature classes and provides a more direct access to data within a CAD file. You should consider using these CAD feature classes instead of the Import From CAD tool unless the translation task requires more sophisticated access to the CAD data constructs within one or more CAD files.

Why would you use the Import From CAD tool?

Some reasons to use the Import From CAD tool might involve

- AutoCAD extended entity data (EED) "Xdata"
- The use of CAD text or CAD attribute objects as point features
- Access to CAD layer properties (not just the entity layer property)
- Access to CAD file document properties such as the drawing name
- Access to text style properties
- Manipulation of block attributes per block rather than including the attributes of all blocks
- Combining data from multiple files (appends data automatically)
- Combining data from multiple CAD files of different file types

Effective use of the Import From CAD tool requires that you define the process by which the attributes, properties, and extended forms of attribution are interpreted and reassembled to create useful GIS content. Effective use also requires a good working knowledge of both the original CAD data constructs and the desired GIS output. CAD translation tasks that utilize the Import From CAD tool most commonly require that you use additional geoprocessing tools to isolate data, join tables, and sometimes convert geometry and/or generate spatial relationships before the data can be used as GIS content. The CAD staging geodatabase is designed to be a temporary holding place for the CAD data from which the data is accessed, manipulated, then written out to another destination.

Import CAD Annotation

This tool is identical to the Import Coverage Annotation tool except for the input data type. The direct file CAD annotation feature class uses a coverage style annotation format. This tool is used to convert a direct file read CAD annotation feature class into a geodatabase style feature class.

Why would you use this tool?

This tool is the only geoprocessing tool that can create geodatabase annotation from a CAD file. The Import From CAD tool's resulting staging geodatabase does not create annotation. Instead, the Import From CAD tool generates point features with attributes from CAD text. Another method of converting CAD text to annotation involves utilizing the labeling functionality of ArcMap and converting the resulting labels to a geodatabase annotation feature class using the tools in ArcMap. The convert label to annotation functionality is not available in geoprocessing.

Export To CAD

The Export To CAD tool accepts one or more ArcGIS feature classes and generates one or more CAD files based on the type of each feature and any key named attributes that

are found in the input feature classes' feature attribute tables. The values found in any key named fields are used by the Export To CAD tool to drive various CAD object properties, symbology, and forms of extended attribution. If no key named fields are found by the Export To CAD tool, features are created in the specified CAD drawing based on a predefined default object type on a CAD layer named after the input feature classes.

The Export To CAD tool can append new CAD objects to one or more existing CAD files. The Export To CAD tool can generate a new CAD file or use a seed drawing as a template to generate a new CAD file. (A seed drawing is a good way to include block or cell definitions or to predefine layer, line, and text symbology in a new drawing.)

Why would you use this tool?

The Export To CAD tool can generate a useful CAD drawing by simply specifying input feature classes and an output CAD drawing. Or by using combinations of a seed file and/or key named fields, one can generate a sophisticated CAD drawing or drawing set according to exacting CAD standards.

Add CAD Fields

The Add CAD Fields tool adds sets of key named fields of the appropriate name and type to an input table or feature class. You can use this tool to add the key named fields recognized by the Export To CAD tool. You can use the more generic Add Field geoprocessing tool to add the key named fields instead. The tool is provided as an alternative to adding the columns to a table one at a time.

Why would you use this tool?

The Add CAD Fields tool is also useful in the creation of a lookup table that can be joined to a feature class to drive the CAD properties of a feature class that are input to the Export To CAD tool. For feature classes that might be often output to CAD files with a desired format, you may want to add the desired key named CAD fields directly to a GIS feature class attribute table.

Set CAD Alias

The Set CAD Alias tool modifies one or more columns in an input feature class or table to contain an alias name that is one of the key named fields recognized by the Export To CAD tool that drives the CAD properties of objects created in the CAD file.

Why would you use this tool?

The Set CAD Alias is an alternative to creating a lookup table of key named CAD fields or adding key named fields to a feature class. The Export To CAD tool will recognize the key named fields of either the true field name or an aliased field. Creating a field alias is a way to make a permanent record of a column being renamed for use with the Export To CAD tool.

For example, if you have a feature class containing the countries in South America and you want to create a CAD drawing in which each country is generated on a separate CAD layer named for that country, you could use the Set CAD Alias tool to "alias" the Country_Name field to the Export To CAD key name of "Layer." Using the resultant

feature class layer containing the aliased field in a translation task that also includes the Export To CAD tool will generate the desired result in the output CAD drawing without modifying the schema of the input feature class. Renaming a column using the field info parameter of Make Feature Layer is a similar technique that does not permanently modify the input feature class.

Create CAD Xdata

The Create CAD Xdata tool adds a column to an input feature class or table and populates it with the selected column values coded into a special XML string. The key named field XDLIST and the format of the XML string are recognized by the Export To CAD tool as an indicator to generate AutoCAD extended entity data on the exported CAD objects.

Why would you use this tool?

The Create CAD Xdata tool is used to encode one or more ArcGIS feature attributes into a single column that is, in turn, recognized by the Export To CAD tool as a trigger to create AutoCAD entities with Xdata according to the coded values in the XDLIST column.

Key Geoprocessing Tools Supporting CAD Translation

The processes required to support CAD translation have had a significant impact on the development of the geoprocessing framework and include methods to support processes based on derived data, the creation of table joins, and working with selected sets of data. These concepts, although originating from the needs of CAD translation, have far reaching applications in many nontranslation geoprocessing tasks. The following are some general geoprocessing tools that are key to CAD translation.

Pivot Table

The Pivot Table tool was originally designed to make better use of the one-to-many relationship exposed in a CAD file's storage of block attributes and MicroStation tags. The tool is useful, however, on pivoting any table in which the column values can be used to build a normalized version of a table based on the aggregated data. The Attrib table from the CAD staging geodatabase contains one record for each block attribute, or tag, in the entire drawing. The Attrib table contains the name of the attribute tag, the name of the attribute grouping, and the unique identifier of the parent entity that it references. Unlike a database table of attributes that are included as fields of a table, the attribute tags in a CAD file are themselves entities. The CAD attribute tags have a reference, or foreign key, that links them to the parent entities. The tags may be loosely grouped by a logical name (RefName or SETNAME) but are not organized in the form of a table. The CAD staging geodatabase records each of these attribute tags in the way they are stored in the drawing (as a many-to-one relationship between the attribute entities and the parent entity).

To make use of the attribute entities in the Attrib table as feature attributes of a parent feature, it is best to select only the attribute entities that belong to a specific Block, Cell, or SETNAME. It is most useful to pivot only those selected records to generate a table in which the ATTRTAG value becomes a column in the table and the ATTRSTR value becomes the value of that ATTRTAG column. The resulting table also collapsed on the OWNERID value such that all the newly created columns that reference the same parent entity are collected into one single record with the OwnerID as the foreign key that links the attributes to the parent feature.

Why would you use this tool in CAD translation?

The Pivot Table tool is needed to normalize the one-to-many relationship between parent CAD entities and attribute tags that are represented in the *Attrib* table of a CAD staging geodatabase. You can access the attributes of a block without using the Pivot Table tool if, for example, the desired block contains only a single attribute. To utilize a collection of more than one attribute linked to a block or *SetName*, you should use the Pivot Table tool.

The ArcGIS CAD feature data set direct read functionality includes the attributes of blocks in a virtual table for all features from a drawing, but it does not distinguish between the different blocks, cells, or *SetNames*. All the attribute fields are included on every object within the CAD feature data set. The result is that many records have unused fields containing blank values. Therefore, using the Pivot Table tool on a CAD staging geodatabase can result in a cleaner conversion or translation of data.

Make Feature Layer

This tool generates an ArcMap feature layer in memory. The feature layer in geoprocessing is used to store a selected set and to rename columns. In translation scenarios, this is fundamental to the process of isolating, moving, and reconfiguring data. Furthermore, table joins are only possible between tables and feature layers or table views. The Make Table View tool is the equivalent tool to work with stand-alone tables.

Why would you use this tool in CAD translation?

This tool was included in geoprocessing originally to accommodate CAD translation's need to join tables to feature geometry and to provide a means to generate a selected set of features. Within the data model of ArcGIS, the feature layer is the data construct for geometric features that ArcMap uses to maintain the information about selected sets and joined tables. Joining tables is used extensively in CAD translation. If you want to join a table or create a selected set using a query expression, you will need to use this tool to create a joinable feature layer.

Using the field renaming functionality of the Field Info property is a fast and easy way to rename columns in an existing feature class to key named fields recognized by the Export To CAD tool.

Save To Layer File

The schema of the CAD staging geodatabase is not very useful without the highly normalized tables joined together in one way or another. Creating an ArcMap layer file on disk is a useful way to persist the table join relationships between the data tables within the CAD staging geodatabase without duplicating the data.

Why would you use this tool in CAD translation?

The intermediate feature layer data that is assembled during the process of CAD translation is held in memory. It is not until the information has been written out to disk that the final process is complete. The Save To Layer File tool is used to persist a selected set of features or a number of table joins without actually writing a new set of

features to disk. Creating layer files from the CAD staging geodatabase is a useful way to browse the information before you perform a large translation process.

Make Table View

This tool is analogous to the Make Feature Layer tool, but for stand-alone tables. There is no analogous geodatabase file object like an ArcMap layer (.lyr) at this time, so the table view object is solely an in-memory object. The table view is used to define a selection set and rename columns and as an in-memory object to store table join information within the geoprocessing framework.

Why would you use this tool in CAD translation?

Joining tables is used extensively in CAD translation. If you want to join a table to another table or create a selected set using a query expression in geoprocessing, you will need to use this tool.

Add Join

This is a tool that performs table joins between tables, feature layers, feature classes, and table views, or feature layers and table views. In geoprocessing, the definition of the table join must "live" somewhere. Within geoprocessing a table join lives on a feature layer created by the Make Layer tool on an ArcMap .lyr file, or a table view created by the Make Table View tool. It is worth repeating. Joins can be performed when one of the tables is based on a table view or feature layer. As you might expect, the Add Join tool joins tables together based on selected foreign key fields. The optional Inner and Outer join parameter can also be used to generate meaningful subsets of data based on the joined tables.

Why would you use this tool in CAD translation?

The joining of external tables and the process of joining normalized tables generated by the Import From CAD tool's CAD staging geodatabase are fundamental to the process of CAD translation. The Add Join tool will be used in most CAD translation scenarios involving the CAD staging geodatabase.

Make Query Table

This is a tool that performs table joins between tables, feature layers, feature classes, or table views in which the result is a feature layer. Unlike the process of using a combination of the Make Feature Layer and Add Join tools, the Make Query Table tool can perform the same function in a single step. Unlike tables joined using the Add Join tool, the tables joined by the Make Query Table tool are not editable.

Features To Polygon

This tool is used to generate polygons from line and point information originating from any feature data source including CAD. It is common in CAD to have a network of line segments that are used to define the visual boundary of polygons and to use a separate point object, such as a block or text entity, to identify the "inferred" polygon. This tool generates true polygons from the line network and attributes of the selected points that are bounded by the newly formed polygons. The tool becomes useful in the context of CAD translation when those source lines and/or points originate from the contents of a CAD file.

Why would you use this tool in CAD translation?

Generating polygons from a network of line geometry is a common task in CAD translation. It is much easier to draft polygons as a collection of line segments than it is to draw closed polygons. It is, therefore, useful to be able to generate polygons from line work. Because there is no standard method for generating areas in CAD, there is also no proficient method to annotate these inferred areas. Often separate text elements or blocks are used to provide the identification of the "would be" polygons. Because this tool can accept both points and lines as input, it is very useful for the task of building polygons from lines and obtaining attributes from other point features, such as text or blocks, that fall within the newly formed polygon boundaries.

When there is a high degree of confidence in the data, this tool can be used as is to generate polygons from lines and points. If the data's quality is not known or contains dangles and undershoots, you should first generate a topology and establish a more controlled method of fixing any errors rather than relying on the automated snapping that occurs when features are snapped using the cluster tolerance. Using the cluster tolerance to modify or mitigate geometry errors does not provide adequate control that you might want in the creation of polygons from lines. You should consider using the topology tools, including validation, to spot and fix errors when accuracy is a concern.

Copy Features

This is a general use tool that takes the current in-memory feature layer and writes it out to a data set. This tool is used extensively in CAD to GIS translation, often as the final step in a multistep translation process, or as an intermediate step.

Why would you use this tool in CAD translation?

The intermediate data that is assembled during the process of CAD translation is generally held in memory. It is not until the information has been written out to disk that the final process is complete. The Copy Features tool is one of the most useful for completing the CAD translation task. By specifying one of many different output workspace types, this tool can be used to make a final translation between all the different writable ArcGIS file formats such as coverage, shapefile, or personal or enterprise geodatabase feature classes. One quick way to convert CAD files to shapefiles is to simply invoke this tool to provide the input direct file read feature class and specify the output as <filename>.shp.

Update

This is a general use tool that takes the current in-memory feature layer and modifies an existing polygon network of data. This tool is used extensively in CAD to GIS translation, often as the final step in a multistep translation process involving polygons. You should consider using the Check Geometries and Repair Geometries tools, as well as the Integrate tool to create good polygons.

Why would you use this tool in CAD translation?

The task of CAD translation performed in a geoprocessing model is not complete until the information has been written out to disk in the desired location. This may be its final destination, or it may be used for further processing or analysis in other operations. The Update tool is one of the most useful for completing the CAD translation task when

appending new polygons to an existing set of polygons or when subdividing an area into new, smaller areas. The Update tool combines spatial analysis functions with an append-like function. This tool might be used in the process of adding a subdivision to an existing basemap.

Append

This is a general use tool that takes the current in-memory feature layer and writes it out to a data set. This tool is used extensively in CAD to GIS translation, often as the final step in a multistep translation process. Its ability to relax the schema matching requirement is especially helpful when adding newly created geometry to existing feature classes. By renaming columns or appending to data with already matching column names, the attributes of the input features can be included in the attribute table of the output features.

Why would you use this tool in CAD translation?

The Append tool is one of the most useful for completing the CAD translation task when appending new data to existing data. If the output of the Append tool does not already exist, the tool functions like the Copy Features tool. Special care must be taken to rename columns of attributes that are intended to be used along with geometry that is appended to existing data. Since joining a table includes the table name in the fully qualified field name, you must copy data participating in a join to a feature class before you can rename the columns to perform an append with attributes.

GP Geometry Manipulation Tools Used in CAD Translation

There are various scenarios in the process of generating CAD data from GIS data, and vice versa, that may require the manipulation of geometry to make the best representation of the data in one or the other system. In geoprocessing there are a number of geometric editing tools that can be used to process information and perform various types of geometric manipulation. These tools are useful in CAD translation as well as many other GIS tasks.

Although not within the scope of this document, you should not overlook the usefulness and relative ease of generating your own geometry manipulation tools using the geoprocessing scripting environment or ArcObjects to perform many different kinds of custom geometry manipulation tasks that might be required for your specific CAD translation needs.

The following is a list of geometric translation tools available in ArcToolbox™ and how they might be used to perform CAD translation-related tasks.

Project (coordinate projection)

Like all forms of geographic data, it is useful to be able to change the geographic coordinate system between one projection and another. For example, it may be useful to project CAD data that may have been drawn using a State Plane coordinate projection and convert its coordinates into UTM or a geographic coordinate system. Projecting data from one coordinate system to another is a common part of data translation.

Split

The process of changing a CAD object or set of drawings to conform to a potentially different GIS schema often requires both the aggregation of data as well as the splitting of data. The Split tool is a classic GIS function that can generate multiple output feature classes from a single input, based on splitting geometry. For example, a CAD drawing

may include areas that need to be broken down further into separate data sets based on geographic zones.

Clip The process of changing a CAD data model or set of drawings to conform to a potentially different GIS data model and schema often requires both the aggregation of data as well as the filtering of data. The Clip tool is a classic GIS function that can generate a subset of features from a larger collection of input, based on a clip geometry. For example, a CAD drawing may include various areas with larger geographic boundaries than necessary. The Clip tool will generate new, external boundaries based on the geometric intersection with the constraining clip set of geometry.

Union Union is a classic polygon overlay function, which has many uses in geoprocessing and various forms of spatial analysis. In the context of CAD translation, it would typically be used as a way to add new data to an existing data set. Data originating from various sources, including CAD, can be combined using the Union tool to create new GIS data.

Buffer Buffer is a classic GIS function, which has many uses in geoprocessing and various forms of spatial analysis. In the context of CAD translation, it would typically be used as a way to modify CAD geometry into a polygon form. For example, you may only have point features represented in a CAD drawing. In the process of translation, what you really want is a group of circle area features where the radius is derived from some joined table, CAD property, or specified value. One could also generate areas of interest, such as a buffer of roadway centerlines that might be used to clip some other set of geometry, or to provide a means of selecting other geometry.

Integrate Integrate is a geometry cleanup tool that combines features from multiple sources that are expected to have coincident boundaries but are not drawn accurately and merges them together, so features that are within a given tolerance are re-created as coincident.

You should consider the method by which errors are mitigated before using this tool. The cluster tolerance used by this tool will modify the geometry but afford you little control over how the geometry is moved. To gain better control over how data errors are fixed, you should first generate a topology and establish a more controlled method of fixing errors rather than relying on the automated snapping that occurs when features are snapped using the cluster tolerance. Using the cluster tolerance to modify or mitigate geometry errors may not provide adequate control in many situations. You should consider using the topology tools, including validation, to spot and fix errors when accuracy is a concern.

Check Geometries As discussed earlier in the section "The Importance of ArcGIS Repaired Geometry," the Check Geometries tool can be used to ensure that data conforms to the strictest rules of geometric integrity for all ArcGIS functions. Various internal data variations are allowable in ArcGIS feature classes. Some of these variations, such as nonsequential vertices, however, are not supported by all ArcGIS functions. You should consider using this tool to ensure that all ArcGIS functions can manipulate data imported from CAD.

Repair Geometries As discussed earlier in the section "The Importance of ArcGIS Repaired Geometry" and the Check Geometries tool, this tool can be used to reorder vertices and repair geometry

when geometry is suspected of containing troublesome data definitions. Use this tool to fix any internal data definition variations found by the Check Geometries tool.

Feature Envelope To Polygon

This geometric tool can be used in translation to generate polygons representing the coordinate extents of any feature. Using this tool on a set of polyline features will result in a set of areas in which the attributes of the linear features are ascribed to polygons generated from the spatial extent of the line features. Although there may not be a common use for this function in CAD translation, this and other forms of geometric manipulation can be helpful when translating nonstandard CAD data.

Eliminate

Eliminate will remove sliver polygons from a data set. Overlapping definitions of the same polygon usually generates sliver polygons. This can be common when merging data from multiple CAD drawings. Often the definition of one polygon in a drawing may vary slightly from the definition of a polygon in another drawing. The Eliminate tool will combine the sliver polygon into the larger of the two polygons that share a border with the sliver polygon.

In the case of line features, Eliminate can merge line segments or join polylines together when they do not form a crossing intersection. For example, using the Eliminate tool with the Line option can be useful in creating a single pipeline feature from many CAD pipeline segments or polylines.

You should always consider the method by which errors are mitigated before using this tool. The cluster tolerance used by this tool will eliminate the slivers by modifying the geometry but will afford you little control over how the geometry is moved. To gain better control over how data errors are fixed, you should first generate a topology and establish a more controlled method of fixing errors rather than relying on the automated snapping that occurs when features are snapped using the cluster tolerance. Using the cluster tolerance to modify or mitigate geometry errors does not provide adequate control that you might want in the creation of polygons. You should consider using the topology tools, including validation, to spot and fix errors when accuracy is a concern.

Polygon To Line

This tool is especially useful when generating nonredundant polygon boundaries for export to a CAD file. It is common practice in CAD that areas are visually inferred. There is not much use for area networks in CAD. Therefore, drawing closed polygons within CAD for each polygon in a polygon network is considered redundant. Using the Polygon To Line tool will generate a single line feature for each shared boundary of the polygon network.

Feature To Point

The Feature To Point tool generates point features from line or area features. This tool is useful in generating network nodes or generating a point feature to define the insertion point of text that is to be created by the Export To CAD tool. Various options on the Feature To Point tool allow you to control whether the points are created at the midpoint, end point, or all points on a line or boundary including the centroid of a polygon.

Feature Vertices To Point

The Feature Vertices To Point tool generates points at all the vertices of a feature. This tool is useful in generating network nodes or generating a point feature to define the insertion point of text that is to be created by the Export To CAD tool.

Split Line At Vertices This tool is useful when CAD standards dictate that only simple segments be used to prepare features for exporting to CAD. Likewise, a GIS schema requirement may dictate that CAD polylines be broken into segments when imported from the CAD file.

Dissolve This tool is useful in the aggregation of linear or polygon CAD data in which similar data features are merged together or considered a single feature. Aggregating similar data from CAD into the target schema of ArcGIS or the same function in reverse would be a common task in CAD translation when two data models are not likely to be identical.

Line Simplification This geometric manipulation tool generalizes a line to remove vertices that do not contribute to the general shape of the overall feature. The tool removes extraneous bends and small changes in direction. You might use this tool when translating detailed CAD data into a small-scale highway map in which the details do not add much to the shape of the line. The exporting of detailed feature data to a generalized CAD map would also be a common task in CAD translation.

Line Smoothing This geometric manipulation tool generates smooth curves between vertices of linear features. The tool can also generate splined curves based on various parameters. Importing CAD lines generated from sample points intended to represent a linear feature would be an excellent candidate for the use of this tool. The exporting of similar GIS data to a CAD map would also be a common task in CAD translation.

Other Common Translation Scenarios and Suggested Solutions CAD translation tasks may involve the use of direct read CAD feature classes or a combination of the tables and feature classes from a CAD staging geodatabase created by the Import From CAD tool. The choice of methods is up to you and is dependent on the requirements of the translation task. Most translation tasks can be performed using either approach. The ArcGIS direct read feature class is easier to use and would, therefore, be preferred unless its predefined schema is not sufficient to complete the data translation task.

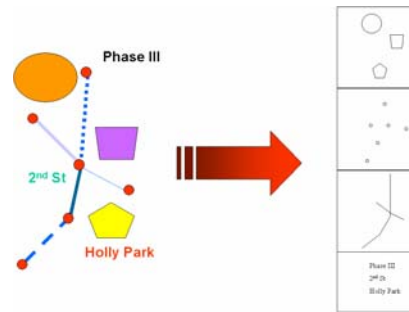
The following is a list of sample data translation tasks that are common in CAD translation and some suggested ways to create a CAD translation model using geoprocessing tools to solve that task.

A CAD file has coordinates that may or may not represent the coordinates of a known real-world coordinate system. All the following strategies for CAD to GIS translation must take into consideration the issues of relative coordinate systems and spatial reference.

To limit which CAD parameters are included in the final output, you should consider using the Field List parameter of the Make Feature Layer tool to turn the visibility of unwanted fields to False. The same parameter can be used to rename fields.

More complex translation tasks may require the reading of tables, or looping, functionality that is only accessible through scripting. Although highly recommended, a description of such strategies using scripting is outside the scope of this document. There are, however, some useful scripting examples included in the sample models provided in the Sample CAD Translation toolbox.

***Creating a Point,
Line, or Polygon
Feature Class
Without Attributes
From CAD Data***



This task describes the process in which the geometry from a CAD file is used to generate features in an ArcGIS feature class. All translation tasks must take into consideration the issues of spatial reference. When you want to simply convert all the same type of features in a CAD file into a feature class of the same type, there are a few different ways to accomplish the task.

Direct File Read Approach

For any direct file read CAD feature data set feature class of a CAD file, you can use the Copy Features geoprocessing tool to copy the feature class to the desired output feature class. The standard CAD attributes will be included in the output of the Copy Features tool. Using the Append tool will append the CAD geometry to the output feature class.

Generally you will want to select a subset of the lines within a CAD file to include in the output feature class. This is accomplished in geoprocessing by creating a feature layer with the Make Feature Layer tool and specifying a filtering query in the expression parameter. Using the resulting feature layer, the Append or Copy Features tool will honor the selected set of features when the output is generated.

Using Data From the CAD Staging Geodatabase Approach

Using the Import From CAD tool will result in the creation of a CAD staging geodatabase. The geometry features are contained in the CAD staging feature data set class called line, point, or area. The line feature class, for example, contains all the linear geometry of one or more CAD files input into the Import From CAD tool. If all the features are to be copied and no CAD properties are to be retained, use the Copy Features or Append tool to copy the features to the target output feature class.

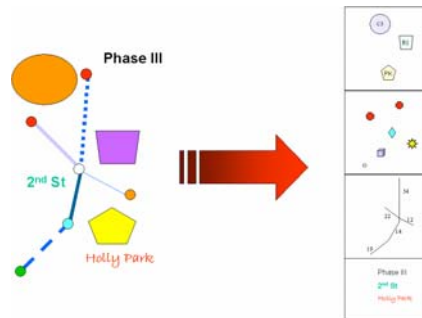
Generally, you will want to select the lines inside the CAD file to be included in the output target feature class. This is accomplished in geoprocessing by creating a feature layer with the Make Feature Layer tool and supplying a filtering query expression. Using the resulting feature layer, the Append or Copy Features tool will honor the selected set of features when the output is generated. However, before you can generate a meaningful expression within the Make Feature Layer tool, you must join one or more of the CAD entity property tables to the feature class.

You can use the CreateLayerFilesFromCADStaging sample model tool that generates standard layer files of the contents of a CAD staging geodatabase or build a model that

includes the appropriate table joins as well as the CAD properties, such as layer or color, from which you want to generate a filtering query expression.

You might also consider the Simple Data Loader option from the context menu of the data found in either the ArcCatalog data browsing window or the ArcMap table of contents.

Using CAD Graphic Properties as Feature Class Attributes



The process of creating feature class data from CAD data that includes CAD properties is identical to the process of creating the feature class data without properties, except you will want to be sure to retain some or all of the CAD properties as useful content in the resulting feature class. It is very common in CAD drawings to use symbology as a form of an object's identification or description.

A redline on a specific layer can be used to identify and describe much about what the CAD line is to represent in the CAD file. Extending this concept to include lookup tables that may further enumerate the meaning of CAD symbology can be very productive when generating an ArcGIS feature class schema with data from a CAD drawing. For example, color may be used in a CAD drawing to denote material type. The CAD layer may be used to identify the data system (sewer network, water pipes, electrical distribution lines, etc.).

Furthermore, the line weight or line style might denote further description of the data, based on the CAD author's CAD standards. When dealing with conversion, you will have access to the various CAD property values such as an integer that represents the color. The integer itself in a database gives some information, but not necessarily the desired content for inclusion in the final schema of the target feature class. More useful would be the material type that is associated with a particular CAD color number. You can use a database lookup table to enumerate or "teach" the resultant ArcGIS feature class the meaning of the color "1," which in AutoCAD is generally red, but by the CAD designer's intent may denote a pipe material type of ductile iron. You could join this lookup table to the converted CAD drawing based on the CAD color. The lookup table would contain at least two fields: the CAD color with the possible color values and a field name such as `Material_Type`, which would include the actual material value such as PVC, ductile iron, or concrete. Joining the lookup table with the converted feature class now generates a translation process where the CAD standards are mapped intelligently using a form of semantic translation to improve the usefulness of the cryptic CAD data in the more richly descriptive GIS environment.

Using the Frequency tool on one or more properties can assist in the process of generating lookup tables, since it will generate a new table based on the occurrences of unique values or data combinations in an input table. You can use the Add Field tool and manually populate that column with meaningful values based on some CAD property or combination of CAD properties to form a lookup table that will enhance the final feature class output.

Using the Frequency tool can also assist in building a list of domain values from CAD drawings.

Using combinations of the Make Feature Layer tool with query expressions and the Calculate Field tool is another way to add more meaning to the resultant data. By selecting various features with a particular CAD graphic property, you can use the Calculate tool to provide a more descriptive value. This technique could also apply to combinations of varied symbology in which color and line style together have a different meaning than either value alone.

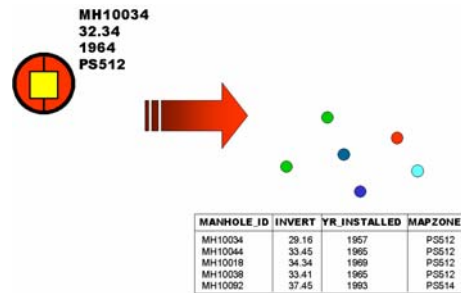
CAD File Direct Read Approach

Using the direct file ArcGIS CAD feature classes is generally the easier and preferred method of working in translation. This view of the CAD file contains the most popular CAD entity properties in a straightforward and easy-to-use way. As such the CAD properties, such as layer name, may be usable as is or you may want to rename a column with the field list parameter of the Make Feature Layer tool. Or, as described above, you might use a lookup table or the Make Feature Layer and Calculate Field tools to further enumerate the CAD graphic properties with more descriptive and useful values.

Using Data From the CAD Staging Geodatabase Approach

The more highly normalized schema of the output of the Import From CAD tool includes more attributes and geometric types than the direct file read CAD feature classes. The structure of the joined tables is also not predefined; therefore, you have more flexibility as to how geometry and the various CAD properties are assembled to help you unlock the meaning contained within a CAD file. Generally, this added flexibility comes at the cost of more complexity in assembling a usable solution. A quick study of the structure and foreign keys that link the various tables together within the CAD staging geodatabase may at first seem challenging but, with a little use, become easily manageable. You will soon find that the most useful entity property information is found in the Entity table, that attributes are found in the Attribute table, and text properties are found in the TxtProps table. Using the Make Feature Layer tool with or without filtering query expressions and renaming fields and the Add Join tool are used in similar, albeit slightly different, combinations repeatedly when building CAD translation models.

*Working With
AutoCAD Block
Attributes and
MicroStation
Elements With Tag
Sets*

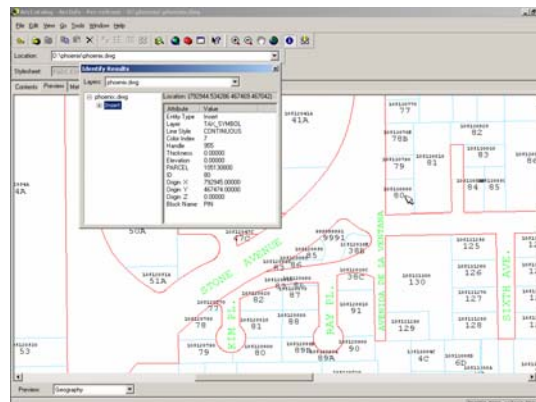


AutoCAD and MicroStation have different strategies for handling attribute tag sets. In AutoCAD, one or more attributes can be associated with the definition of a complex object that may contain a collection of other entities (a block). All instances of a given block insert entity are identical except for the attribute tags, which can be used as a variable attribute. The resultant object in CAD is treated as a single symbol object with single point geometry based on its insertion point.

In MicroStation, a similar collection of attributes might be defined as a tag set, which is a collection of attribute tags. Unlike the block definition in AutoCAD, the instances of a tag set can be associated with any CAD objects in the design file, or they can stand alone. When associated with other geometric elements in the CAD file, the primary geometric representation remains unchanged, so a line remains a line and a polygon element remains a polygon.

Making use of these attributes either attached to existing geometry or as part of a complex object is handled differently based on which method of translation you are working with. (There are sample models included on this scenario in the CAD Translation Sample Model toolbox.)

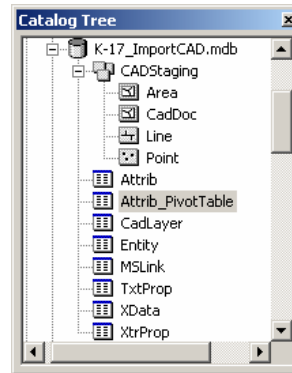
CAD File Direct Read Approach



When blocks with attributes, or tag sets, are present in a CAD file, ArcGIS will include all the possible attribute fields to the feature attribute table of each of the CAD feature classes. Although not every feature actually has each of these attribute tag values, they share the same table with other objects in the feature class. All CAD features that do not

have a particular attribute will have null values in the feature attribute table for those fields. The name of the feature attribute field is governed by the CAD tag name property.

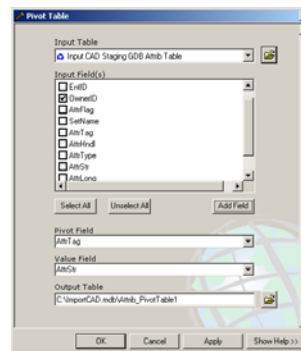
Using Data From the CAD Staging Geodatabase Approach

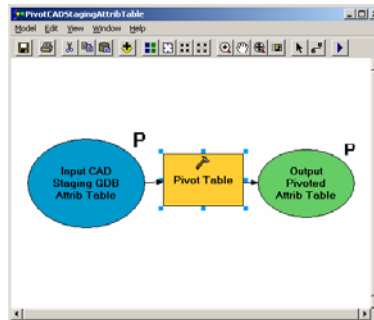


CAD objects and attribute tag values have a one-to-many relationship. One entity may have one or more attributes and, in the case of MicroStation, may have one or more sets of information attached to a parent element. The CAD staging geodatabase models this relationship with normalized tables. The Attrib table contains a single record for each attribute tag. The table contains foreign database key fields that help you reconfigure this attribute information in various ways. The most common use (although not the only use) of the Attrib table is to associate these tag value sets with their parent object's primary or a subgeometry geometry representation.

The Attrib table must be filtered and pivoted to be useful as a table of feature attributes. Unlike the CAD feature classes, which include all the attributes of all blocks or tag sets on every feature, filtering and pivoting the Attrib table can result in only the attributes being associated with a single block or tag set.

The Pivot Table tool is used to take records in a table and generate a new table where unique values in one field are used to name the fields in the new table and values in another field of the input table are used to populate new records in those fields.





The Attrib table contains records for each attribute tag entity. Each attribute entity has a tag name, a tag value, and the entity ID of any parent entity, and the name of the attribute collection is called the Set Name. (In the case of AutoCAD blocks, the set name is populated with the block name, or reference name.)

By filtering the Attrib table based on the desired Set Name, you can isolate only those attributes belonging to a specific set of attributes (such as a particular block), which are likely to belong to a common system of geographic features such as the attributes of a manhole or property owner information.

A more usable attribute table is created by the Pivot Table tool. The ATTRTAG value is used to define new column names, and the ATTRSTR value is used to populate the new records in that column. The Pivot Table tool will also coalesce the table based on the unique combinations of values contained in the selected Input Fields parameter. You will select the OWNER_ID field to coalesce the table. The result is a table in which each of the attribute values for a given parent feature are in a single record in a table. Use the Add Join tool to add this resultant table to a feature class based on the resultant table's OWNER_ID and the ENTID of the parent object's feature layer.

In the case of AutoCAD blocks, the OWNER_ID will reference the corresponding block insert entity. The block insert entity's primary geometry is a point feature. As described below, you may want to choose a subgeometry to attach the attributes to instead. In this case, you would be joining the OWNER_ID of the pivoted table to the OWNER_ID of the subgeometry. You would then use the Add Join tool to join the result to a geometry feature class by ENTID. (Using the Inside Join option of the Add Join tool would ensure that only the geometry with attributes would be included in the output.)

Creating Point, Line, or Polygon Feature Class From MGE or Geographics Data Using MSLinks

The task is to create a feature class from MicroStation elements that contain MSLink values and to attach that geometry to any external table referenced by the MSLink information.

The solution uses the MSLink and MSCatalog CAD properties to reestablish a database connection to externally linked files. Using MSLink and MSCatalog values is the standard method of attaching external tables to elements within MicroStation. The structure in database terms is somewhat awkward. The MSCatalog value references a record in the catalog table to denote which table the MSLink value references.

The associated record in the catalog table contains a field that denotes which other table the element's MSLink value is related to. The MSLink value is the record number for this other table. The MSLink value and the MSCatalog value combine to specify which table and which record in that table an element is linked to. This nonstandard database schema is difficult to model using the standard database tools supplied in ArcGIS. Because the goal for the translated data is to reside ultimately in a geodatabase, this nonstandard database linkage need not be replicated.

To perform the translation, select all the elements with records linked to a specific table by specifying a query expression to select elements based on a certain MSCatalog value. Make a note of which table this MSCatalog value is referring to. Knowing which table is appropriate may require browsing the MicroStation catalog table according to the MSCatalog record number to determine the table's identity. With the knowledge of which table the data is to be joined to, a simple table join is performed using the Add Join tool in which the join fields are the MSLink value and the (record number) in the joined table.

CAD File Direct Read Approach

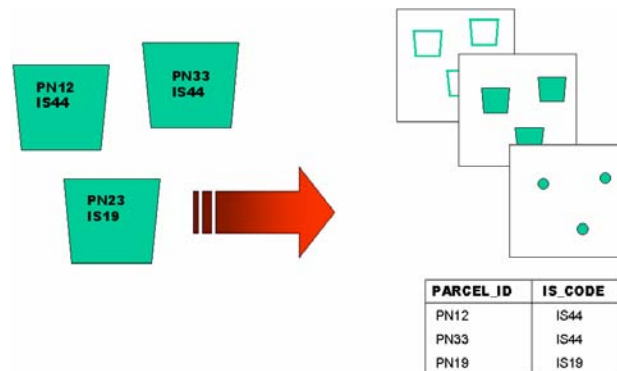
The MSLink and MSCatalog values are included in the feature attribute tables of a direct file read CAD feature class. You should consider first preselecting all the objects based on the same MSCatalog value. With the knowledge of the appropriate external table, join the result to that table based on the MSLink value and the associated record number in that external table.

Using Data From the CAD Staging Geodatabase Approach

The MSLink values are contained in a separate MSLink table within the CAD staging geodatabase. Join this table directly to a geometry feature class based on the corresponding ENTID field found in each table.

Once the geometry is linked to the appropriate MSLink information, the result can then be joined to the external table based on the MSLink value.

Creating Line or Polygon Feature Classes From AutoCAD Block Subgeometries



Lines or areas used to represent geographic features are sometimes created as block inserts by AutoCAD users. This is done so that standard block attributes can be used to

hold attribute values. Managing block attributes is much simpler for the AutoCAD user than other forms of extended AutoCAD attribution such as object data, extended entity data, or the various forms of linking CAD objects to external databases. The resultant CAD object's primary geometry then becomes a single point, even though it may have a complex shape. Graphically it is displayed according to all the included subgeometries.

This practice is not common in MicroStation where tags can be added to any object. Creating attribute tags inside MicroStation does not require the creation of its complex object equivalent, a cell. Both the ArcGIS direct file read CAD feature classes and the Import From CAD tool can include the subgeometries of all blocks and cells as valid features.

CAD File Direct Read Approach

Direct read CAD feature classes contain all the subgeometries of blocks and cells in the various CAD feature data sets according to their feature types (point, polyline, polygon, annotation, and multipatch). The parent blocks and cells are still included as point features in the point feature class. The points, lines, and areas of both the primary block features and all the subgeometries of the complex block entity will include any attribute tag values associated with the parent cell or block insert entity.

Consider the situation in which a cell or block entity with a polygon subgeometry boundary was used in a CAD file to represent a building footprint. Furthermore, consider that a unique building identifier is included as an attribute tag. You could use the block or cell as a point feature according to its primary geometry. The unique building identifier attribute value would be included in the feature attribute table of the CAD point feature class. You could also use the polygon boundary subgeometry as a polygon feature, and the same unique building identifier would be included as an attribute in the feature attribute table of the polygon CAD feature class.

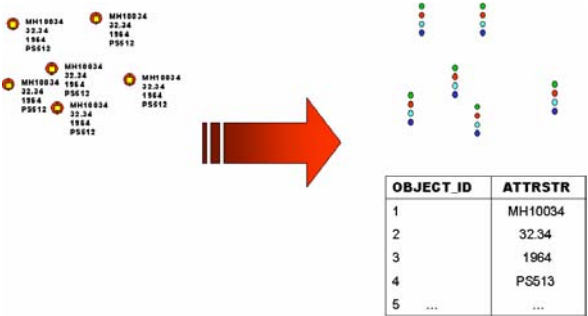
Using Data From the CAD Staging Geodatabase Approach

Using the subgeometries requires that you first select the Explode Complex Features parameter on the Import From CAD tool before you generate a CAD staging geodatabase.

The method of preparing attribute values from the CAD staging geodatabase for joining to feature classes is described above. You will use the same techniques described there to prepare the *Attrib* table. To attach the attributes to any subgeometry rather than the primary point geometry, you would join the *OWNER_ID* of the pivoted table to the *OWNER_ID* of the subgeometry instead of the *ENTID*, which would be the primary point representation only. Both the attributes and the subgeometry belong to the same owner; therefore, joining the two tables based on a common *OWNER_ID* is sufficient to define their relationship.

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Creating a Point Feature Class From Block or Cell Attribute Entities



It is common to use block attributes as a form of map text or annotation. CAD attribute tags are entities in their own right. Attribute tags have geometry, their own specific properties, and various text properties. You may want to use the geometry of an attribute rather than the geometry of the parent block insertion point. This scenario is particularly beneficial when attempting to use the attribute tag values and their locations as either points or a point feature class upon which you may want to create annotation. (There is a sample model included on this scenario in the CAD Translation Sample Model toolbox.)

CAD File Direct Read Approach

CAD feature data sets do not support attribute tags as separate features. The tag string values are included in the feature attribute tables of their parent and subgeometries.

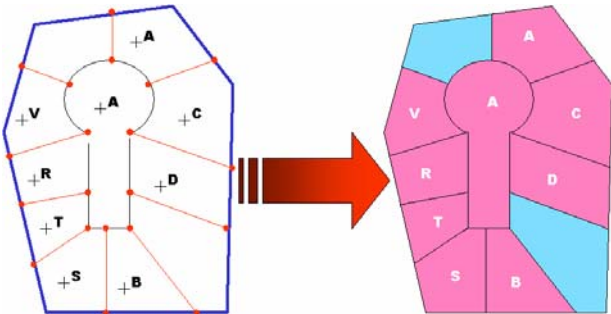
Using Data From the CAD Staging Geodatabase Approach

The text properties of an attribute entity are stored in the TxtProp table. The Attrib table contains the attribute specific properties.

The geometry of attribute entities is included in the Point feature class of the CADStaging feature data set.

It is often helpful to generate points based on the position of the attribute tags rather than the geometry of the parent or subgeometries. For example, you may want to use the position of the attribute tags to locate labels in ArcMap. The attributes tag value is included in both the Attrib table as well as the TxtProp table. You can choose to join the point feature class to either table based on ENTID.

Creating a Polygon Feature Class From CAD Lines and Text, Blocks, or Other Point Entities



This task is to create polygons from a collection of CAD lines that are not drawn as closed polygons. Furthermore, it is common in CAD to use some type of point feature contained inside the inferred boundary to describe or annotate the polygon. The solution is based on a line feature class and a point feature class. The solution can have variants based on what is used to define the points. The same solution works for lines-and-points, lines-and-blocks, and line-and-text scenarios. The only difference between the scenario variations is the CAD entities that are used to define the input point feature class.

The Feature To Polygon tool is used to create polygons from lines. The tool also allows you to associate the attributes of point features contained within the newly formed polygons to those polygons. The input for the Feature To Polygon tool is a line feature class and an optional point feature class. The attributes of the optional point feature class will be included as feature attributes on the new polygons. (There is a sample model included on this scenario in the CAD Translation Sample Model toolbox.)

CAD File Direct Read Approach

The ArcGIS direct read feature data set interprets all text objects in the CAD drawing file as belonging to the CAD annotation feature class. To associate this text with the polygons, the text must have its own point geometry. An annotation feature class is not a valid input for the Near tool. However, by using the Copy Features tool, an annotation feature class can be saved as a point feature class, and that point file can be used by the Feature To Polygon tool.

Using Data From the CAD Staging Geodatabase Approach

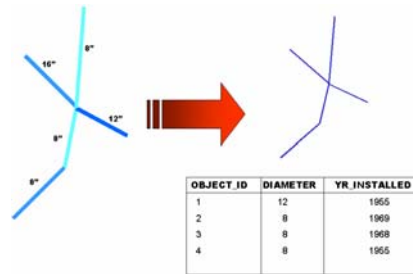
You should first generate the necessary table joins for the line features to be able to select the appropriate line feature candidates.

In the case of text entities, the text value is contained in the TxtProps table in a field called TXTVALUE. The TxtProp table can be joined to the Point feature class based on the ENTID field to provide a useful set of points to input into the Feature To Polygon tool. The resulting polygons will have TXTVALUE as one of their feature attributes.

Other point geometries can be selected along with their desired table joins to add whichever CAD properties are desired to the newly formed polygons.

To limit which CAD parameters are included in the final polygons, you should consider using the Field List parameter of the Make Feature Layer tool to turn the visibility of unwanted fields to False. The same parameter can be used to rename fields.

The process of building the polygons and associating point attributes with the polygons is handled by the Feature To Polygon tool.



Creating Line Feature Class From CAD Lines and Near Text, Blocks, or Points

This scenario requires that attributes of points nearest to a set of lines be added as a line feature attribute. The solution is based on a line feature class and a point feature class regardless of what is used to define the points. The same solution works for line-and-point, line-and-block, and line-and-text scenarios. The only difference between the scenario variations is the CAD entities that are used to define the input point feature class. To associate the points with the lines, you use the Near tool. The input for the Near tool is a point feature class and, in this case, the line feature class you want to associate with the near text. (There is a sample model included on this scenario in the CAD Translation Sample Model toolbox.)

CAD File Direct Read Approach

The ArcGIS direct read feature data set interprets all text objects in the CAD drawing file as belonging to the CAD annotation feature class. To associate this text with line, the text must have its own point geometry. An Annotation feature class is not a valid input for the Near tool. However, by using the Copy Features tool, an annotation feature class can be saved as a point feature class, and that point file can then be used by the Near tool. There is a sample tool in the CAD Translation Sample Models toolbox that can be used to solve this translation scenario.

Using Data From the CAD Staging Geodatabase Approach

The scenario is the same when using the CAD staging geodatabase. You should first generate the necessary table joins for the line features to be able to select the appropriate line feature candidates; likewise for the points with any desired attributes. The process of associating the attributes of points with line feature is accomplished with the Near tool. The CAD translation portion of the problem is in assembling a collection of the desired points and lines. The methods for extracting points and their attributes, text and its attributes, or block entities and their attributes, vary slightly, but once they have been isolated, they can be used in conjunction with the Near tool to be spatially joined to the selected lines.

Creating a Point, Line, or Polygon Feature Class With Extended Entity Data as Feature Attributes

This task requires that the AutoCAD extended entity values be used as feature class attributes. EED is one of several common methods of attaching attributes to AutoCAD entities. There is no mandated data format or schema for EED. Depending on the format of the EED, its structure may be difficult to interpret without foreknowledge of its contents. EED is only useful if the schema is known and used consistently. There are no column names associated with EED data, unless the arbitrary AutoCAD Data Extension (ADE) style of EED has been adopted. EED is generally only used by commercial software and user-customized applications. Therefore, to make use of EED, you first

need to know that it is there, and second, you'll need to have some knowledge of how it was assembled.

CAD File Direct Read Approach

The ArcGIS CAD feature classes do not expose AutoCAD extended entity data. Therefore, you must use the Import From CAD tool.

Using Data From the CAD Staging Geodatabase Approach

This scenario assumes that the structure of the AutoCAD extended entity data is of a standard type, such as integer real or string, and in a consistent order. The Import From CAD tool does not support custom data types and other binary formats.

Creating Coverage Style Annotation From CAD Text

The direct read CAD annotation feature class is essentially coverage style annotation and can be used without conversion as such within ArcGIS.

Creating Geodatabase Annotation From CAD Text

Within geoprocessing, the only way to generate geodatabase style annotation from CAD text is by using the Import CAD Annotation tool. The creation of geodatabase annotation from any features and their attributes can be performed within ArcMap outside geoprocessing using the labeling tools found in the ArcMap standard user interface. The text properties created by the Import From CAD tool can be used to generate geodatabase annotation in this way. The Import From CAD tool creates point features with a text property table for all text in a CAD file. You can use the labeling tools of ArcMap based on these points and their attributes to generate geodatabase style annotation.

Creating a Line, Point, or Polygon Feature Class With CAD Properties as Feature Class Attributes

This task requires that a feature class be created where the symbolic and graphic properties of the CAD objects are "decoded" with the use of a lookup table. You could use the actual CAD properties as feature attributes without the use of a lookup table. It is helpful to use a lookup table to populate the resultant feature class with more specific feature attributes than is provided with the literal color, line style, or layer properties.

For example, it is common for the CAD entity color to be used to designate the material property of a pipe. Rather than using the CAD color designation, which is a simple integer, you can create a lookup table in which the meaning of a color can be expanded to specify an actual material such as PVC, cast iron, or concrete. Similar lookup tables could be generated to enumerate the various coded symbolic representations of a CAD standard into their literal feature attributes.

Appending CAD Stored Attributes to Existing GIS Features

It may be helpful to extract attribute information from a CAD drawing based on its spatial relationship to existing GIS features. Because of the way in which data is abstracted within ArcGIS, you can perform geoprocessing tasks on mixed data types. You could, for example, update an existing geodatabase parcel basemap with attributes from text entities in a CAD drawing in the same geospatial coordinate space. Since the boundaries of the existing parcels have the same spatial reference as the CAD text, the geoprocessing tools can be used to perform the near or point-in-polygon type analysis to assign the text values to the appropriate parcels, thus using the CAD text values to update an existing geodatabase feature class.

Creating Geodatabase Attribute Domains From CAD Data Values

Extract text, block attributes, and/or graphic properties to generate a field domain list for a feature class attribute field. As in any data source, you can use the attribute tables generated from the CAD data to build geodatabase domain ranges or domain value lists. For example, the unique values contained in an attribute of an AutoCAD block for a given drawing or set of drawings could be used to create a list of the pipe diameters used in a given pipe network.

Building Topological Features From CAD Data

Because of the data abstractions and data conversion processes involved in geoprocessing CAD translation, defining topological rules on the converted data can be a logical end to a data translation task. At the point in which topology is applied within a data translation scenario, the data is already fully ArcGIS geodatabase feature class data. The process of selecting the CAD entities to be contained in a given linear or polygonal network will have already been defined by the time the topological tools available in geoprocessing are applied. The CAD elements will have been translated into geodatabase features before the topological tools are employed. There are no CAD specific topology tools.

CAD Lines With Gaps Left by Symbols to Continuous Closed Line Features

Populate a linear feature class using line entities from a CAD drawing and close gaps in a line left by CAD symbols.

Using Geoprocessing Tools to Reformat CAD Drawings

There may be advantages to using geoprocessing functions to edit CAD drawings. Because of the powerful spatial, database, and attribute manipulation tools contained in ArcGIS, it may be advantageous to employ ArcGIS to process and reorganize CAD drawings. CAD file reformatting can be accomplished by directly reading or importing CAD files and exporting the data within the same translation scenario. The scenario would temporarily translate CAD files or portions of CAD files, modify them, then write the result back in a CAD format.

Creating CAD Drawings

Driving CAD Properties From Feature Attributes

The Export To CAD tool is designed to honor the values of key named attribute fields when generating CAD objects. If the input feature class has these key named or aliased fields, the values will be used to drive one or more of the output CAD entities corresponding CAD properties. (These key named fields correspond to the same field names generated in the CAD staging geodatabase created by the Import From CAD tool.)

You could alias the name of existing fields if data useful in driving a particular CAD property already resides in that field. Renaming a field in a feature layer to the appropriate key named field recognized by the Export To CAD tool is also an easy way to control the creation of CAD entity properties.

Using a lookup table containing the various CAD entity properties based on some symbol number is a way to drive the creation of CAD data according to specific CAD drawing standards without duplicating the CAD symbology information within the geodatabase.

Using Export To CAD With a Seed Drawing

Using a seed file with the Export From CAD tool can provide a simple means of defining the layer properties and complex block or cell entity definitions. Export To CAD does not generate the subgeometries of complex objects in AutoCAD blocks or MicroStation shared cells. Instead, the Export To CAD tool relies on the seed file to provide this information. Export To CAD will generate instances of these complex objects according to their definitions within a provided seed drawing. The same input data can be used with two different seed files to create vastly different results depending on the definition of the complex objects in the selected seed file. If no seed file is supplied, then blocks and shared cells are created with a point type subgeometry without attributes.

Layers can be defined using a seed file, and they can also be defined using key named fields in the input feature attributes. However, it may be less difficult to use a seed file containing the desired CAD layer definitions rather than use a lookup table or other method of defining the layer definitions using key named field data.

You might use different seed files to obtain different output results from the same input data. Using different lookup tables with or without different seed files could also generate potentially very different output CAD files from the same input feature class information.

Appending Data to Existing CAD Files

You can gain the same functionality of a seed drawing by appending data to an existing CAD drawing file. You should be careful to double-check the geoprocessing environment variable for overwriting data as well as select the always append parameter of the Export To CAD tool to ensure data is appended rather than overwritten. You can append to CAD file either by specifying an existing CAD file name as the output CAD file or by including data that contains the DocPath key named field, populated with existing CAD file names as values.

Creating Blocks in CAD Files From Point Feature Classes With or Without Attributes

You can generate AutoCAD block inserts or MicroStation shared cell instances from any point feature class. You must include a key named field called CADType and be sure that the desired features have a CADType value of Insert. The input point feature class must also include a column called REFNAME with the appropriate block name included for each feature as a value in that field. Furthermore, if the block definition in the seed file or appended CAD drawing contains an attribute definition with any tag name that matches one of the input point feature classes' field names, the block will be inserted into the drawing with the matching field's value. To insert blocks with attributes, you must use a seed file or append to an existing CAD file using the Export To CAD tool. Blocks with attributes cannot be created in new drawings without a seed file containing the block definition.

Changing the Geometric Type of Data Exported to CAD Files

It is common that the geometric type used to represent information in ArcGIS may require a different feature type when exported to a CAD file. For example, in ArcGIS you may have building polygons represented that, in a CAD file, you would like to represent simply as points. There are a good number of geometric manipulation tools that allow you to modify, aggregate, split, and transform geometry. Using these tools in various combinations can be useful in generating the desired CAD output. Generating endpoints or midpoints of lines, creating lines from polygons, or polygons from lines are common tasks. Many tools considered analysis tools also modify geometry. A

discussion of some of these analysis tools is included in a previous section of this document.

Creating CAD Text From Feature Class Data

The Export To CAD tool will generate CAD text from annotation feature classes.

Another desirable use of the geometry manipulation functions is for creating CAD text from other nonannotation feature class data. For example, you might want to locate the position of some text or a block insert at the centroid of a polygon. By generating points from polygons, you could use the resultant point feature class as text entities by adding and manipulating the values in the key named fields of CADType and TextString to trigger the creation of text when using the Export To CAD tool. Blocks with attributes could be created using the techniques described for inserting blocks with and without attributes. The difference here is that the points used to define the position of the block inserts may have originated from a line or polygon feature class and been converted to points for the sole purpose of generating CAD annotation. In such a scenario, you might export both the polygon feature class as well as the point feature class derived from the centroids of the same polygon feature class.

Creating Tiled CAD Drawings From Feature Class Data

The Export To CAD tool will honor the creation of each exported feature in its own specified drawing according to the key named field DocPath. By including this key named field and populating it with the desired CAD drawing name, features can be directed to multiple drawings in a single execution of the Export To CAD tool.

You might consider using the ArcGIS overlay functions along with a polygon map of a drawing tile grid to associate features with their target output CAD file in the case in which tiles are defined geographically. There are obviously many other types of tiling strategies that might be desired. ArcGIS contains many tools to categorize, filter, and manipulate the spatial and attribute values to assist in building different types of tiling strategies to automate the process of exporting drawings to multiple CAD files.

Generating AutoCAD Entities Containing Xdata

The Export To CAD tool will generate AutoCAD extended entity data according to the information contained in a key named field called XData. The format of the data contained in this key named field is a custom XML string that contains the information necessary to generate the desired Xdata information on the exported CAD entity. You are expected to use the Create CAD Xdata tool to populate a field of this name with the appropriately formatted information. The Create CAD Xdata tool allows you to both create the field and populate it with existing columns according to the allowable ADE or standard Xdata formatting convention.

Changing Spatial Reference and Export Geodatabase Feature Data Set to CAD File

You can easily generate a tool that allows you to change the spatial reference, including specifying different coordinate projections, before exporting the data to a CAD file. Although there may be a number of ways in which to accomplish this task, one would be to create a new empty feature class with the desired spatial reference, copy the features to be output into that feature class, then export that feature class instead. The project on-the-fly functionality of ArcGIS will automatically project the data as it is temporarily copied into the new empty feature class. Export To CAD will use whatever coordinates are included in the input feature classes.