Managing Utility Infrastructure Data in Both a CAD and GIS Environment

Sandeep Menon - Ideate Inc.

GS32-3 For most organizations that work with engineering, CAD, and GIS data there is often a need to efficiently and accurately move data from a CAD to a GIS environment and vice-versa. As a result, maximizing CAD and GIS operations as well as ensuring the coexistence of both is a real challenge. This workshop focuses on a real-world example of how a city utility department in Northern California effectively leverages both Autodesk and ESRI solutions by using the power of Autodesk Map to maintain both the graphical and attribute data related to the city’s utility infrastructure.

About the Speaker:

Sandeep is the director of Infrastructure Solutions for Ideate Inc, based in San Francisco. A Civil and Environmental Engineering graduate from the University of Wisconsin - Madison, he has been using Autodesk technology for over 10 years as an engineer, focusing mainly on residential and commercial site design, earthworks/grading, subdivision layout, street improvements, storm drain, sanitary sewer, and water design, a GIS specialist, an educator, and as a project manager.

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The Necessity for CAD and GIS to Coexist

If you were to look up the definitions of CAD and GIS, you might find something along the lines of the following:

**Computer Aided Design (CAD)**
Term referring to computer **software** that is used by architects, engineers, drafters, artists, and others to create **precision** two-dimensional or three dimensional **designs**, drawings, or technical illustrations.

**Geographic Information System (GIS)**
An organized collection of computer, **hardware**, **software**, geographic **data**, and **personnel**, designed to efficiently capture, store, update, manipulate, **analyze**, and display all forms of **geographically referenced** information.

Paraphrased, CAD is a software tool, whereas GIS is an overall system comprised of hardware, software, data, and personnel used to analyze data that corresponds to some geographic location on the earth’s surface. In CAD objects are primitive: points, lines, polylines. In GIS objects are modeled after real-world objects. For example points can represent manholes, lines can represent water mains, and polygons can represent parcels.

CAD is an excellent tool for engineering design, requiring precision such as the laying out of new water lines and structures. GIS is good for more in-depth spatial analysis and modeling, such as analyzing pump control strategies for energy-saving operations, peak, average, minimum, and other demand scenarios, or flushing alternatives for emergency contamination events.

The main differences between CAD and GIS are:

- In CAD there is no concept of geographic coordinate systems, datums, or projections
- In CAD there really is no way to view or query attribute data
- In CAD you can only open .dwg, .dxf, or .dgn files
- In CAD there is no concept of topology so you’re limited to what types of spatial analysis can be conducted

Keeping these differences in mind there are a few very important items to consider when importing CAD data into GIS:

- Are polygons closed?
- Do network lines connect?
- Are there dangling or clustered nodes and do they intersect the network?
- Are their duplicate objects?
- Do data layers need to be simplified in order to efficiently transfer data?
- Who should be responsible for data cleanup?

All this being said, neither technology is a replacement for the other- each has its purpose, and as a result compliments one another very nicely.
For example, survey data usually gets imported into CAD where the engineering design is done. It is this engineering data that then gets exported into a GIS, acting as the foundation for all subsequent data layers being created in the GIS.

Conversely, GIS data can often times be helpful in an engineering environment. For example data such as zoning, wetlands, school district boundaries, FEMA flood map, etc, can be downloaded online in a GIS format, i.e. shapefile, coverage, and imported into CAD during the due diligence phase of a project.

These are just two examples of where GIS data would go into CAD and vice versa. The real challenge is being able to integrate CAD and GIS, in order to maximize your investment in technology without compromising productivity and data integrity.

**Case Study: Bridging the Gap Between CAD and GIS**

In this workshop we will go through a real-world example of how a Utility implemented Autodesk Map 3D to bridge the gap between their CAD and GIS platforms. Because of CAD’s superior drafting tools they wanted to leverage their Autodesk technology to do all of the data maintenance, while still being able to use their ESRI software for modeling.

The following serves as a reference for the different project tasks that were performed and that will be demonstrated in this workshop.

**Task 1**

Replicate all graphical and attribute data being stored in ArcSDE in Autodesk Map 3D.

<table>
<thead>
<tr>
<th>Action Performed</th>
<th>Why?</th>
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</thead>
<tbody>
<tr>
<td>1. Create an AutoCAD drawing template (.dwt) that contains all of the organization’s standard layers and blocks.</td>
<td>When the shapefiles get imported into Autodesk Map, specific attribute fields will be used to specify what layer the entity goes on and in the case of points, what block will be used to represent them.</td>
</tr>
<tr>
<td>2. Import all arc data. <em>Map → Tools → Import</em></td>
<td>In order to match points to AutoCAD blocks, point data and line data need to be imported separately.</td>
</tr>
</tbody>
</table>
3. From the Import dialog box select the button with the three dots inside the Drawing Layer field. This is where we specify the layer that each stormwater line will get placed on.

4. In the Layer Mapping dialog select “Use data field for layer name”.

   In the shapefile being imported there is a field called “LAYER” which specifies the CAD layer each entity should get placed on. Upon import of the shapefile, Map 3D will filter all objects to the appropriate layer by matching the value in this field to an existing layer in the AutoCAD drawing template.

5. From the Import dialog box select the button with the three dots inside the Data field.

   This is where we will specify which attributes we want to import from the shapefile into the drawing.
6. From the Attribute Data dialog, select create object data and choose which attribute table you want to import.

![Attribute Data dialog](image)

Because the attribute data is being maintained in ArcGIS, we chose to import the attribute data from the shapefile to Map as object data. However, we could have also imported the data to a database such as Access, SQL, Oracle, or ArcSDE running Oracle.

7. In the Object Data Mapping dialog you can check and uncheck which fields you want to import.

![Object Data Mapping dialog](image)

Under Target Fields, you can re-map the attribute field in the shapefile to another field name in Map 3D. It’s critical that you specify all the correct field names here, because Map 3D does not give you the ability to rename fields later.

We did use a third party application, Geotools, which does give you the ability to rename object data table fields.
8. After specifying how the data should be imported, the dialog will look similar to the following:

Upon clicking OK, the line data gets imported into Map, in California State Plane Coordinates, Zone II, on the correct layer with the specified object data.

Note these import options can be saved in an import profile by clicking on the Save... button at the lower left.

9. Next all the point data gets imported from a separate shapefile.

Everything will be the same as steps 2-8, however we also want the points to be represented by AutoCAD blocks.

10. From the Import dialog box select the button with the three dots inside the Points field

This is where you specify which block gets associated to which point.

11. In the Point Mapping dialog select the “Get block name from data” option and select the field in the table that contains the name of the block that should be used to represent each symbol.

In the shapefile being imported there is a field called “TEXT” which specifies which block name should represent each point. Upon import of the shapefile, Map 3D will insert the correct block at each location.

Note, make sure that the “Get attribute values from fields” is checked if blocks have attributes associated to them. Therefore, if an attribute name on the block matches a field name on the incoming point, the data for the block gets populated in the object data table.

Note, each block gets inserted the way it was defined. Unfortunately that meant that unsymmetrical blocks such as water boats, valves, etc., needed to be manually rotated to match up to the water line. Symmetrical blocks such as manholes pose no problem.
**Task 2**

Replicate the attribute data tables being stored in the ArcSDE geodatabase, in Autodesk Map 3D as object data tables.

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<td>1. Add any additional fields that need to get added to the table. <strong>Map→Object Data→Define Object Data.</strong> Select the table you want to edit from the drop-down and click on the Modify button...</td>
<td>In this case there were a few fields that did not exist in the geodatabase that we needed to add, in order for Map 3D to interact with Hansen’s asset management software.</td>
</tr>
<tr>
<td><img src="image" alt="Modify Object Data Table" /></td>
<td></td>
</tr>
<tr>
<td>2. From the Modify Object Data Table dialog type in the field name, type, and click Add.</td>
<td>Now the new field is added to the object data table stored in the drawing and can be exported to ArcSDE if so desired.</td>
</tr>
<tr>
<td><img src="image" alt="Modify Object Data Table" /></td>
<td></td>
</tr>
<tr>
<td>3. Isolate the layers that correspond to a certain table and use the AutoCAD “wblock” command to export graphical and attribute data to another drawing.</td>
<td>We wanted to split the two object data tables into six separate object data tables. Map 3D does not give you the ability to export certain fields to another table. The only way to get around this was by wblocking the data that we wanted and deleting what we didn’t want.</td>
</tr>
<tr>
<td><img src="image" alt="Modify Object Data Table" /></td>
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</table>
4. Rename the table. When we import all the various wblocked drawings back into one basemap there will be multiple object data tables with different names.

5. In the basemap drawing use the AutoCAD “insert” command to recompile all wblocked components.

6. Populate lines and points with attribute data by isolating all structures or lines of a particular type, selecting them and using the AutoCAD “properties” command. Most lines and structures of a particular type had common attributes. The easiest way to populate the attributes was to select those objects and typing the attribute value into the AutoCAD properties dialog.

Task 3
Minimize data entry errors by using Feature Classes to graphically add any water line data while capturing all necessary attribute data.

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<tr>
<td><strong>1. Map Utilities Login</strong></td>
<td>Feature classes are a way of standardizing drafting. As a result they are meant to be created by a CAD Manager, GIS coordinator, or someone with administrative privileges.</td>
</tr>
<tr>
<td>By default: Username: Superuser Password: SUPERUSER</td>
<td></td>
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2. From the Map Explorer workspace right-click on “Feature Class” and select “New Definition File”. All feature classes get stored in a XML definition file.

3. From the Map Explorer workspace right-click on “Undefined Classes” and select “Define Feature Class.” Feature classes can represent different type of water lines, stormwater lines, sewer lines, manholes, waterboats, etc.

4. Select an existing line in the drawing for which you want to create a representative feature class. In order to create a feature you must have an existing representative feature in the drawing.
5. Specify the AutoCAD properties and object data that the feature should have by default.

When you create a feature, by default it will have the properties specified in the Define Feature Classification dialog. You can restrict features to certain values in the Property Attributes, ensuring that drafters and technicians don’t accidentally put linework or points on incorrect layers with incorrect attribute values.

6. Right-click on the feature and select “Create Feature”

Regardless of what layer is current, the feature will always get created on the layer specified within the feature class, with the correct color, linetype and object data associated with it.
Task 4
Create Map 3D export profiles to quickly export all graphical and attribute data from CAD into ArcGIS.

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<tr>
<td>1. Map → Utilities → Export</td>
<td>Create an export profile for each table that must get exported. Each export profile can export only one object data table.</td>
</tr>
<tr>
<td>2. Select the type of entity that is being exported, in this case either point or line and what layer the entity exists on.</td>
<td>The exported shapefile will contain only the graphical data specified here.</td>
</tr>
</tbody>
</table>
3. Click on the “Data tab”, then click on the “select attributes” button and choose which attributes you want to export. The exported shapefile will contain only the attribute data specified here.

4. Under saved profiles, click on save and specify a name for the export profile. Every time the most current CAD data needs to be exported to ArcSDE, simply run each export profile. A script can also be created to automatically create updated shapefiles every day.