CAD: Introduction to using CAD Data in ArcGIS

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What we will accomplish today

- Overview of CAD Support in ArcGIS Desktop (ArcMap and Pro)
- Georeferencing CAD data for ArcGIS
- How Mapping Specification for CAD can help
- Loading CAD features into a Geodatabase
- Creating CAD Data (Export to CAD)
- Using ArcGIS for AutoCAD
CAD/GIS Interoperability Patterns

- ArcGIS user who needs to...
  - Display CAD data in maps
  - Load CAD data into their Geodatabase
  - Deliver GIS data in a CAD format
CAD in the Geospatial context

- CAD drawings are a large source of GIS data
  - Surveying
  - Cadastre
  - Civil engineering
  - Architecture
  - Landscape Architecture
  - Planning
  - Geodesign
ESRI has long provided CAD support and integration tools

- **Out of the box**
  - No extension required
- **Direct read**
  - Conversion not required

**Current version support:**
- AutoCAD DWG/DXF: Up to 2017 (read/write)
- MicroStation DGN: Up to V7 (read) & V8 (read/write)
CAD Drawings

• Geometry, text, and symbols
  - comprise CAD entities/elements

• Organized into layers or levels

• Symbology represents information

• Can have data attached to entities
## CAD Datasets in ArcGIS

<table>
<thead>
<tr>
<th>Geometry</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD entity geometry organized into feature classes</td>
<td>CAD properties, tags, and database links are stored in attribute tables</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coordinate System</th>
<th>World File</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD data can be reprojected to overlay with other GIS layers</td>
<td>CAD drawings can be transformed from local coordinates to projected coordinates</td>
</tr>
</tbody>
</table>
Contents of a CAD Dataset

- **Annotation**: Text, tags, and attribute definitions
- **Multipatch**: Polygons and is useful for 3D representation
- **Point**: Points, blocks, and cells
- **Polygon**: Closed areas such as polygons, ellipses, and circles
- **Polyline**: Lines, polylines, and arcs
- **City.prj**: Projection files define a coordinate system for a CAD dataset. They are recommended but not required.
Filter CAD Features in ArcMap

- Use Definition Queries to create subsets
  - Saved in the .MXD or .LYR
  - Expressions can be saved to .EXP files for re-use

Example SQL query:

```
SELECT * FROM Polyline WHERE:
"Layer" = 'BLDG' AND "Color" = 5 AND "Linetype" = 'CONTINUOUS'
```
CAD data in Pro
Feature Layers organized by Level/layer

- Group layer created with the feature class name and a suffix "Group"
- Feature layers based on CAD layer/Level names
  - Feature Class will be included with layer visibility turned off
  - Feature Layers for each Level/layer geometric type
- Feature Layers can be used as input to GP tools
  - Maintains Layer color with conversion
  - Honor CAD layer level visibility

*Removed Blocks/Shared Cells as own Group layer
CAD file support is simple feature classes
- ANNOTATION features are currently added as a POINTS
- Labeling of CAD POINT
- Standard with other data sources

Convert on Add Option (off by default)
- Automatically converts CAD data to GDB
- Simplifies data migration of conversion
Positioning CAD data in Pro

Georeferencing
Assigning coordinate systems and Georeferencing CAD in ArcGIS
Georeferencing Process

- Assigning a coordinate system
- Applying a transformation
- Stop Tracing
- Not all CAD datasets require these steps
Headline Here

Select a CAD file in your TOC

Use Georeference Contextual Tab
Georeferencing

• Two-point Similarity transformation method
  - Move, Rotate, and Scale
  - Aspect ratio always maintained
  - Cannot skew or ‘rubber sheet’ CAD drawing

• Transformation managed by World Files
  - ArcGIS is not modifying the CAD drawing

*NOT required for drawings that are drawn in real-world coordinate location.
Georeferencing: World Files

- File based, two point transformation for CAD data
- Uses the .wld file extension
- Simple text file containing two lines with two pairs of coordinate values:
  <From X1, From Y1> <To X1, To Y1>
  <From X2, From Y2> <To X2, To Y2>
Universal Projection and World Files

- **Universal World File**
  - ESRI_CAD.WLD
  - Applies identical transformation to all CAD files in workspace
  - Useful for set of tiled CAD drawings

- **Universal Projection File**
  - ESRI_CAD.PRJ
  - Applies same coordinate system to all CAD files in workspace
Loading CAD data into Pro
Conversion to GIS model
CAD/GIS Interoperability Patterns

- ArcGIS user who needs to...
  - Display CAD data in maps
  - Load CAD data into their Geodatabase
  - Deliver GIS data in a CAD format
Loading CAD data Demo: Campus example
Loading CAD data in ArcGIS Pro

- Add to Geodatabase feature classes or create new Geodatabase from CAD
  - As-built updates
  - Editing requirements
  - Advanced Geodatabase tasks (i.e., Geometric Networks, Topology, etc.)

- Conversion supported by the Geoprocessing framework in ArcGIS Pro

- Can be combined with other Geoprocessing functions
  - Spatial Joins
  - Geometry manipulation
Geoprocessing Conversion Patterns

- CAD text inside polygons
  - 3744
  - 3745
  - 3746

- CAD text near lines
  - $12^\circ$

- Line segments to polygons

- CAD to Geodatabase

- Append to existing Geodatabase

- Merge with other layers
Converting to CAD data
CAD/GIS Interoperability Patterns

- ArcGIS user who needs to…
  - Display CAD data in maps
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Export to CAD

- Output features to native CAD format
  - DGN V8
  - DWG/DXF Release 14 to 2017 (ArcGIS 10.4.1)

- Supports appending to existing CAD drawings

- Creates Seed files
  - CAD feature Classes (MSC)
  - Fields and default values, layers color, linestyles...

*Available at all license levels*
Reserved CAD Fields

- **Reserved CAD fields**
  - Fields understood by Export to CAD
  - Creates shared cells, blocks, layers, colors
  - Creates MSC feature classes, fields, field values.

- **Resources in help system**
Data submittal
Demo:
ArcGIS for AutoCAD 365 - Free Download from Esri

- **Access to GIS content**
  - Basemaps
  - Image services, Map Services
  - Location Services
  - LISP API

- **Access to Feature Services**
  - Direct editing GIS data
  - Subtype, domains

- Mapping Specification for CAD

AutoCAD 2013 - 2017
GIS content in AutoCAD
Mapping Specification for CAD (MSC)
Provides improved interoperability between CAD and GIS

• Open source framework developed by ESRI
  - GIS feature classes + attributes
  - Coordinate systems

• Utilizes CAD data structures to define schema and store data

• Leveraged by ArcGIS Desktop CAD tools
  - CAD direct read/import tools
  - Export to CAD
CAD data structure in ArcGIS

- Subset feature class

- AutoCAD Query
  - Layer, color, linestyle
  - Etc

- Invisible in AutoCAD

- Better than a SHP file

City.dwg

- Annotation
  - Text, tags, and attribute definitions

- Multipatch
  - Polygons and is useful for 3D representation

- Parcels
  - MSC feature class that represents parcels (subset of polygons)

- Point
  - Points, blocks, and cells

- Polygon
  - Closed areas such as polygons, ellipses, and circles

- Polyline
  - Lines, polylines, and arcs

- Roads
  - MSC feature class that represents roads (subset of polylines)
Export to CAD Demo: Multipatch
Best Practices

• Tips and best practices for CAD & GIS
  - Seed/template file
  - Layer standards (Plan ahead)
  - Coordinate systems
  - Drawing in proper locations
  - Only use Model Space

• Export to CAD
  - template
  - Coffee and donuts
  - ArcGIS for AutoCAD
What did we talk about

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## More CAD at UC2017

<table>
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<tr>
<th>Session</th>
<th>1st Offering</th>
<th>Room</th>
<th>2nd Offering</th>
<th>Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using CAD Data in ArcGIS: An Introduction</td>
<td>Wednesday 01:30 PM - 02:45 PM</td>
<td>Rm. 08</td>
<td>Thursday 01:30 PM - 02:45 PM</td>
<td>Hilton – Sapphire ballroom A/B</td>
</tr>
<tr>
<td>CAD: The ArcGIS for AutoCAD CAD Plug in</td>
<td>Tuesday 01:30 PM - 02:15 PM</td>
<td>Rm. 31 B/C</td>
<td>Wednesday 10:15 PM - 11:30 PM</td>
<td>Rm. 14 A</td>
</tr>
<tr>
<td>CAD: An Introduction to the ArcGIS for AutoCAD Plug-in (Demo Theater)</td>
<td>Tuesday 11:30 PM - 12:15 PM</td>
<td>Geo Data Demo theater #6</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>CAD: Lining Up CAD Data in ArcGIS</td>
<td>Tuesday 11:00 AM - 11:30 AM</td>
<td>Tech Theater #18 Exhibit Hall A</td>
<td>Wednesday 02:00 PM - 02:30 PM</td>
<td>Tech Theater #18 Exhibit Hall A</td>
</tr>
</tbody>
</table>
Want to learn more?

• Documentation

• Related Esri Training and Tutorials
  - CAD in ArcGIS:
  ArcGIS FOR AUTOCAD training video’s:

• Additional Resources
  - Margaret Maher’s book “Lining up Data in ArcGIS”
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