Migrating CAD into GIS – Best Practices

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FOUNDED 1981
INCORPORATED 1987

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- Civil Engineering & Surveying
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Why am I here?

Engineers and Designers need more data earlier in the design process to make better decisions.

There is a huge disconnect between CAD and GIS.

More and more people are relying on data that is inaccurate, out of date, or incomplete.

Developers need more complete presentations and exhibits for plan review submittals.

This makes BAD THINGS HAPPEN.

GIS needs more accurate and complete design as-built data for data stores.

transportation

INFRASTRUCTURE

ENR.com Engineering News-Record

Sinkhole Shuts I-25 in Denver; 66-in. Water Main Ruptures

2/8/2008

By Melissa Leslie

A 66-in. water main beneath Interstate 25 in Denver burst on Feb. 7 in the afternoon, creating a sinkhole about three lanes wide and 16 ft deep, shutting down all northbound lanes of the highway.

On Feb. 8, Denver Water employees remove aging, damaged pipe section that broke the day before. Massive sinkhole buckled a large segment of I-25.

The cause of the break is still under investigation; however, Denver Water officials said it was likely from a pressure surge in the pipe after a water pump failed. The water built up until the roadway collapsed, creating a sinkhole 40 ft wide by 60 ft long near the 58th Avenue exit ramp in north Denver, according to Stacey Stegman, spokeswoman for the Colorado Dept.of Transportation.

Bulldozer hits gas line; worker killed

Joey Bunch and John Epperson The Denver Post
November 12, 2006; Page C-01
Section: DENVER AND WEST

Cheyenne - A jet-black, 300-acre burn site surrounded the skeletal hulk of a bulldozer that struck a natural-gas pipeline Saturday morning and produced a powerful explosion 2 miles north of the Wyoming-Colorado line.
The bulldozer's operator, Bobby Ray Owens Jr., 52, of Louisiana was killed in the blast, but 13 pipeline workers escaped, authorities said

Why is this becoming an issue?

Historically:

ESRI (Environmental Systems Research Institute) has been the leading software development company for GIS desktop and enterprise level applications.

Autodesk has been the leading software development company for Engineering, Design and Drafting (CAD) applications.

Recently:

Both industries (GIS and CAD) have become more integrated.

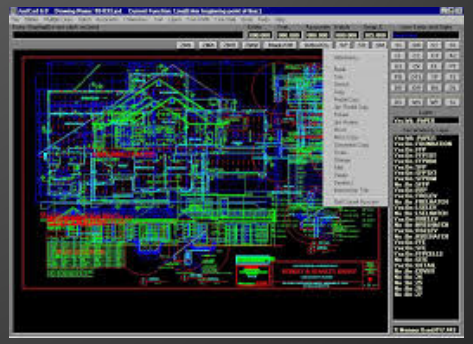
Surveyors, Engineers and Designers are utilizing GIS data during planning stages and for bid preparation. GIS data is free (mostly) and readily accessible.

GIS analysts are absorbing as-built CAD data for generating database layers. CAD data has survey-level spatial accuracy as well as important attribute information.

Some important notes about the tools

The applications are not so dissimilar

- Both are used to compile maps of real-world conditions
- Both can input and create survey-level data
- Both are susceptible to GIGO



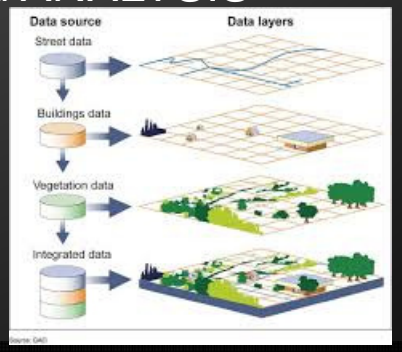
Each tool has it's uses, strong and weak points

CAD is used for DESIGN and DRAFTING

- Great for designing to survey level precision
- Useful for Construction Documentation
- Intelligent Design (BIM) tools

GIS is used for DATA GATHERING, DISPLAY and ANALYSIS

- Adding attribution to features
- Display (Theme) mapping
- Data Analysis



On to the definitions…

In order to better integrate these two industries you need to learn how to speak both languages. Missteps could lead to wrong datasets, incorrectly geo-referenced files, bad decision making and wasted resources.

BASIC TERMS:

Data Store - A collection of feature data in a single storage location (a file or database such as Oracle). [AutoCAD=DRAWING]

Feature Class - A category of features with rules that define the allowable data types, default values, and constraints for its member features. For example, you might have feature classes for a set of roads, utility poles, and so on. [AutoCAD=LAYER with no color or linetype]

Schema – A schema is the structure of the database that defines the objects in the database. [AutoCAD=Drawing Template with predefined layers, styles, etc.]

Feature - The spatial representation of a real-world entity, such as a specific road or an individual utility pole, that specifies the geometry and other properties of the feature [AutoCAD=ENTITY]

For example, you might use a data store such as Oracle, which can encompass multiple schemas. The database might define the utilities for a town, with schemas for different types of utilities, such as electrical and water. The electrical schema would include feature classes for utility poles and boxes, while the water schema would include feature classes for pipes and hydrants, each feature class would contain one or more features.

More definitions…

Feature Type – GIS supports three distinct feature types – **Point** (Node), **Line** (Curve) and **Polygon** (Surface). Points are any feature defined by one location (text, hatch, blocks). Polygons must be closed areas defined by one object. Only a few datastores will allow multiple feature types in one database.

Spatial Database – Any database type (Oracle, SQL, Access, etc) that can store spatial data (lines)

Enterprise Database – Large database type which allows for multiple-user access (via versioning) and management. (Oracle, SQL Server)

Layer – A Feature Class with stylization applied.[AutoCAD=LAYER with color and linetype assigned]

Attribute – A property of a feature (manhole type, road width) [AutoCAD=ATTRIBUTE or TEXT LABEL]

Metadata – Information about a GIS database (coordinate system, attribute definitions, etc.) typically held in an HTML or XML document.

Version – A file which maintains a list of all of the edits made to a GIS datastore (by a particular person.) The datastore is not updated until all of the versions are "checked in". Versions are incorporated into the datastore through rules.

Constraints / **Domains** – Drop-down lists for adding attributes.

Transform – The act of moving an existing map to a known coordinate system. Typically this involves moving, rotating, and sometimes scaling of the existing map. Two known coordinates (or locations) are required. (This term is often mixed up with Translate)

Translate – The act of moving data from a datastore from one coordinate system into another. Unlike transform (above) this requires a high level of math to shift each node of the data from one coordinate to another. (This term is often mixed up with Transform)

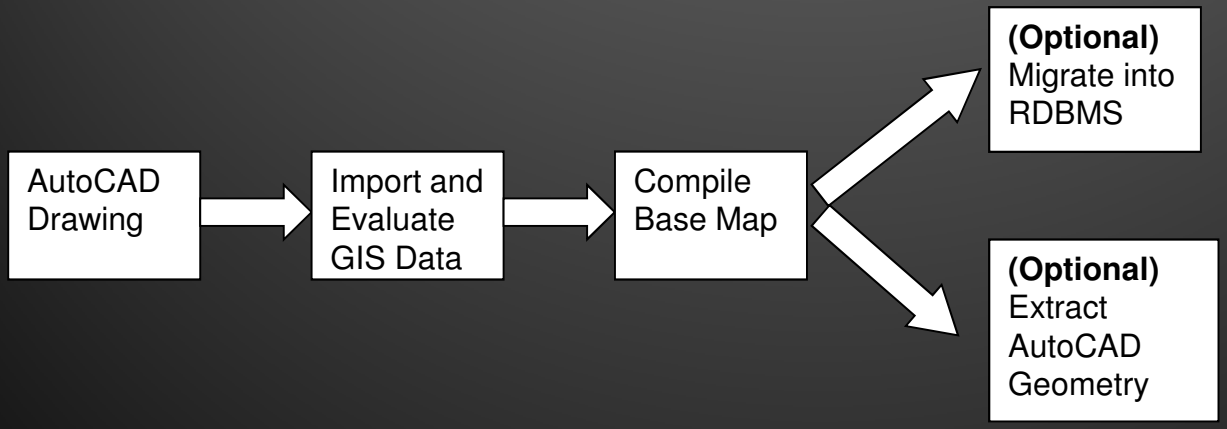
Data Formats

- Data formats (How many?)
  - GIS (ESRI)
    - Shape file
      - SHP
      - DBF
      - SHX
      - PRJ
      - **DELETE .IDX FILES**
    - GDB (File Geodatabase)
      - AutoCAD CANNOT use this without 3rd party software
        - FME from SAFE Software
  - AutoCAD DWG
    - Can contain Point, Line and Polygon
    - Can include attributes
    - Can be exported to SHP
    - Civil 3D Can export design data

GIS into CAD Workflow

GIS into CAD Workflow

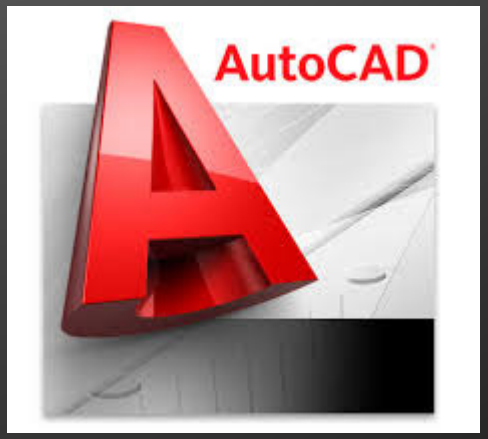
- Build list of required data.
- Start with one type of data and begin searching.
- Have a good idea where to look. Don't just look blindly.
  - Understand that you may need multiple sources to combine into one datastore for all of the information you need.
- Check each type before moving on
- Import data and compile base map.
- Look at which data sets can be combined and/or migrated into a data store



How to get GIS Data into CAD

Enough with

On to



GIS Needs Defined

- Data must be **clean** – no drafting errors
- Data must be **pertinent** – no "extra" layers
- Data must be **transformed** – a "real" coordinate system
  - Can be in ground units – but needs the grid scaling factor supplied (also called a "project" scaling factor)
  - Can be in grid units – but this makes design and cost estimating in real-world units difficult
- Data must have **metadata** – list of what is being supplied(layers, attributes, coordinate system, etc.)
- Data must have **standards** applied – organization is the key.
- Data must have **attributes** – Object Data, text labels, link templates. Layers and linetypes can be used but afford very limited attribution.

Drawing Cleanup

Clean Objects

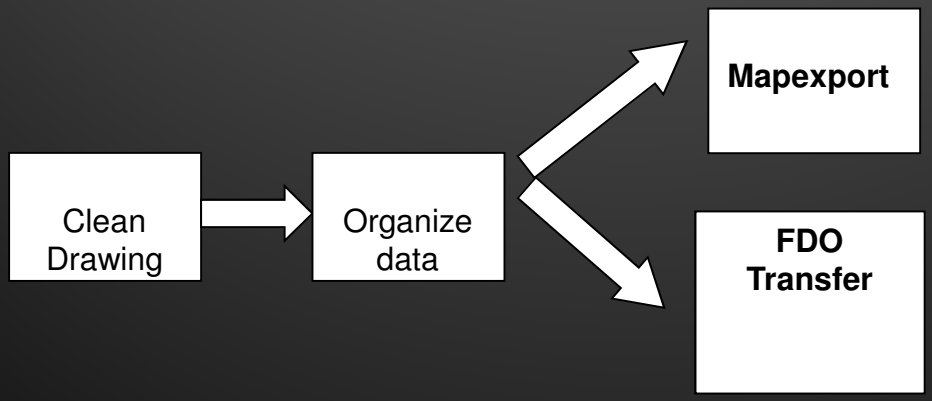
Layer Standards

Coordinate Systems

CAD into GIS

CAD into GIS Workflow

- Clean CAD data drafting errors
  - Map Cleanup
  - Purge
  - Audit
  - Remove attachments
  - TRANSFORM data
- Change layers
  - Layer Manager
- Remove unnecessary data
  - Layer Delete
- MAPEXPORT to SDF file (Easier to attribute)
  - Map any properties (Layer, Linetype, etc.) available
  - Quickest method to move a large amount of data
- Add attribution as needed
- Export to SHP or use other tools for entry into GIS



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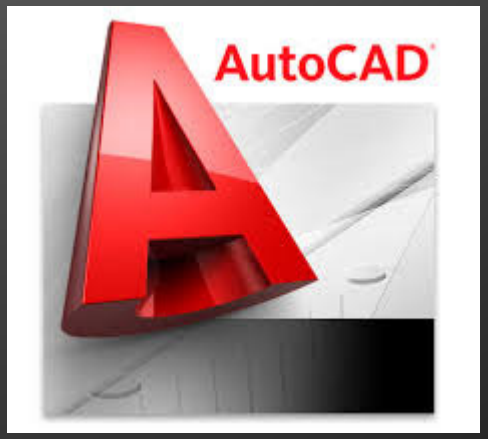
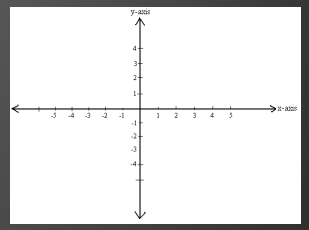


Important notes on coordinate systems

Coordinate systems are a mathematical means used to translate the somewhat round shape of the Earth to a flat medium (Paper maps).



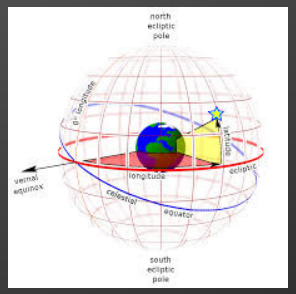
There are several coordinate systems in use.

Coordinate systems can be (and have been) developed to account for GRID to GROUND translation.

Both GIS and CAD have tools to translate data from one coordinate system to another

The biggest hurdle in coordinate system management is getting **the correct information** from the source**.**

A coordinate system designation has a minimum of TWO and up to FOUR distinct attributes.



1. **DATUM: NAD 27, NAD 83, WGS 84, HARN/HPGN**
2. **PROJECTION: Lat/Long, UTM, State Plane**
3. **ZONE: UTM Zone 13, State Plane CENTRAL zone**
4. **LOCAL CONDITIONS: Units, Scaling Factor, Directions**

EXAMPLES:

WGS 84….is NOT a coordinate system
NAD 83 Colorado State Plane Central Zone US Foot IS a coordinate system

“Modified State Plane” – HOW IS IT MODIFIED?? HOW IS THE SCALE FACTOR APPLIED??

And Lastly….5000,5000,5000 IS NOT A PROPER COORDINATE SYSTEM!!!!

A quick check-up on Coordinate Systems

- What do they consist of?
  - Datum (where am I measuring from?)
  - Projection (How am I flattening the Earth?)
  - Parameters (Where am I?)
- Grid vs. Ground?
- Survey Level Accuracy
  - ~ 2cm /0.79” (ALTA 1999)
- Hand-Help GPS?
  - ~ 3m
- Lat-Long – DMS What is 1 second?
  - Denver~ 90’
- AutoCAD supported precision?
  - Floating Decimal (16 places)
- What do we design and as-built to?
  - 0.01’

Grid to Ground Issues

Scale factors

- How are they acquired
- How are they applied

Single point of reference

Two Reference Points

MAP 3D Coordinate systems

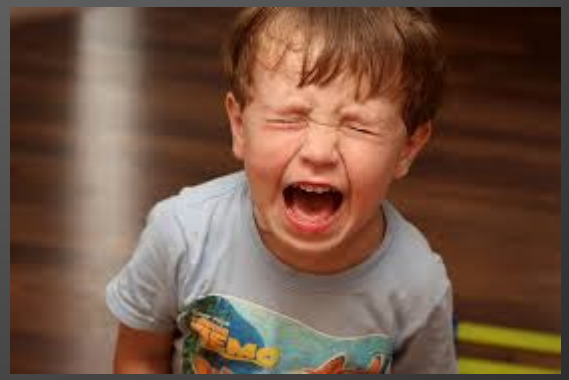
- New 2007 & 2011 adjustment system issues

GIS Coordinate systems

- New 2007 & 2011 adjustment system issues

A word on Civil 3D and Proxy Graphics

- Much of what was shown today will NOT WORK ON CIVIL 3D OBJECTS!!!



EXPORT:

- SDF – Linear Data
- DEM – Surface
- DWG – Other
  - EXPORT to AUTOCAD

- Note: The ESRI Data Interoperability Extension (FME) can absorb almost any data formats

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