A New Approach for Data Conversion from CAD to GIS

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SUMMARY

Data conversion from Computer Aided Design to Geographic Information System is in increasing trend. During this process users are encountered with many different problems and tried to solve these problems with conventional methods. Data conversion problem varies according the type of data and the software used.

Main scope of this study, analyze the errors which are not so common during conversion Computer Aided Design data's to Geodatabase format in Turkey. This study also includes defining steps which is the first process during conversion Computer Aided Design data to Geographic Information System format and gathered errors under a title and intended to be a guide for users who unaware these kind of problems.

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1. INTRODUCTION

Computer Aided Design (CAD) and Geographic Information Systems (GIS) are used to solve problems about the land and resources. On the other hand, CAD and GIS have different perspectives; CAD users have a drawing perspective of layers, symbology, dimension and labels where GIS users have a feature perspective like; attributes data structure, relational tables, connectivity and analysis.

CAD is powerful graphic software in which the important thing is lines and the drawing is itself attributed where GIS is database software in which a single feature like point, polyline and polygon means of representation of data from geodatabase. GIS has one very critical difference from CAD. On CAD both vector data and cartographic symbolization melded together into a single entity. GIS separates spatial data from cartographic symbolization and inserts the power of the computer between them. This simple separation of spatial data and cartographic symbolization is the key to power of GIS (Training Material, GII-01).

There are many inconsistencies between CAD and GIS. Lack of database style structure found in CAD files is fundamental issue. Display properties in CAD files are used to represent attribution, for example an annotation means diameter of a pipeline or means a building number. During the conversion process, from CAD to GIS, a text for a diameter should be placed into the pipeline layer, and a text for building number should be placed into the building table as an attribute (URL 1). Data should be flexible to move GIS from CAD, to integrate with other data, to strengths of GIS formats.

Subjecting the data due to the different process, conversion has to be analyzed under 4 main heading which are point, polyline, polygon and annotation. This study presents a new approach of converting CAD data into GIS to prevent human based errors. The goal of this study is, detect the possible errors in the vector data sets before using them in GIS as alternative new solutions. Errors only occurred in identify section of 5 steps is considered.

2. VECTOR DATA STRUCTURE

The applicability of GIS project directly depends on the accuracy and topological consistency of the vector in GIS. The existence of errors or inconsistency in the vector data could easily prevent a reliable GIS analysis (Feuchtwanger, 1989). Therefore it is necessary to accomplish an overall check for data in order to obtain precise analysis. Data collection is the most vital step in GIS is in terms of cost and time. In creating data procedure phase, using CAD software is more practical than GIS.

Geographic objects with vector geometry are mostly represented with geographic data types which are well suited for representing features with discrete boundaries, such as wells, streets, rivers, states, and parcels. The vector data model uses points and edges to represent basic types of spatial features: points, lines and polygons. All of these types are capable of storing attribute data about the particular feature they represent also in database in GIS. In addition to the three standard vector data types, annotation feature class represents text in a geodatabase is used in Turkey frequently.

Types of vector data:

- **Point Data**
  Point data can be represented as a single location on a map (Such as GPS observations). Point data is the simplest type and is very good for storing data which feature doesn't have length and width. Point data are represented by an XY coordinate pair.
- **Line Data**
  Line data represents the shape and location of geographic objects that have a location, a length, but no width. Examples of some features well represented by lines are streets, contours, roads, rivers, and electricity lines.
- **Polygon Data**
  A set of many features that represent in a GIS are going to have a width and an area such as countries, lakes, and land use zones. Lines and polygons are stored in the same way geodatabase however a polygon must be consist of at least one line, and must enclose an area.
- **Annotation Data**
  Map text including properties for how the text is rendered. For example, diameter of a line, name of a street can represented using annotation and requires convert to attribute (URL 2).

3. CONVERTING CAD TO GIS

Conversion from CAD to GIS is enhancing CAD drawings with spatial information and attributes. It is known where objects in the drawing are located as well as all their relevant details. Inserting specialized CAD information into a different data structure which supports attribute information (URL 3). Building GIS features from CAD drawing is to find a way to preserve and represent the CAD information that including labels, text, blocks, dimensions, styles, and symbols is the key issue of mentioned process. Steps of a successful conversion CAD data to GIS is displayed in Figure 1. As seen in this figure, conversion starts with identifying the CAD data type to be positioned accurately in the GIS database. After this step converting data to geodatabase without any control is realized to prepare data for topological controls. The aim of the topological controls in GIS is to eliminate errors and increase spatial analysis opportunities. One of the most important functions of a GIS is being able to determine the neighbors of selected objects. Thus, although not necessary for any CAD software, GIS software should cover topological relationships. With the results of topological controls evaluation of these results steps is realized. Data includes of topological errors should

be purified from topological errors to get a geodatabase model for GIS.

The identification step as seen in Figure 1 is the objective of this study during the conversion of CAD data to GIS.

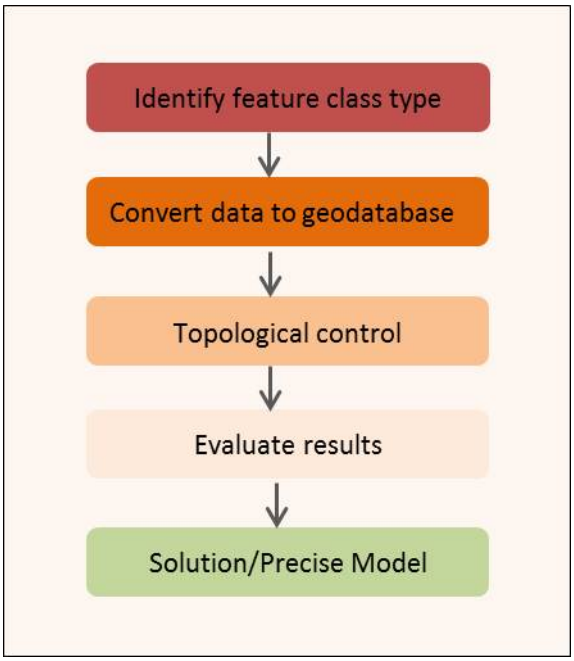

Figure 1. Steps in a successful conversion

Identification of Data Type: The first step in determining the type of data seems like a very simple step, even if in some cases the type of data should not be created in correct type in Turkey. Before trying to convert CAD data to GIS, identify and solve issues that affect the data's quality is the most necessity process. Examples for the most common errors types for this situation:

Conflict between polyline and point:
In this case the feature class was created polyline which must be point. The reason of this error is users have no idea about logic of Geographical Information System. The aim is only showing the related object without any GIS function and analysis. For example; a door for a building can be is illustrated with arrow figure. To analyze this data is not possible with this polyline thus it must be converted to point data type. After point data obtained it should be controlled with near analysis whether points are inside the building or not because of the arrow situations. Near analysis determines the distance from each feature in the input feature to the nearest feature within the search radius.

Conflict between polylines and polygon
Polygon geometries represent area shapes, and can be used to represent geographical features such as countries, lakes, or land parcels. In some cases polyline feature data type is using to create a closed area by snapping first and last point of a line. If data doesn't converted to a geodatabase to realize these kinds of errors is not possible. Solution for this situation is

creating polygons from polyline automatically by using appropriate GIS tool. In some cases it is impossible to create polygon automatically such as a polygon was divided into areas by a line. After polygon feature converted to polyline it needs to execute spatial analysis between these two kinds of data to sort out polyline data.

Conflict between symbols and point

Often CAD software's have their own symbology/cell/block and library defined by a large number of formats attributes. Symbology is element type in CAD format datasets. They are a point feature that is represented by a symbol of some type. It can be very time consuming to create database table fields to store all of these attributes. CAD data includes so much complex symbology that the mere thought of carrying this to GIS and back is enough to induce confusion (URL 1).

Symbology need to be converted to point in order to be able to analyses vector data with procedures like network analysis (e.g. finding connected utility equipment). For a successful conversion for symbology user need to check the justification of symbology whether centered or not. After justification process data should be converted to point with attributes on it. If symbology converted without setting justification, the object does not appear in the exact coordinates.

Conflict between annotation and attribute

The annotation texts are not parts of the geodatabase, they are stored separately. In general, labels are more suited on-screen display, web applications, etc. while annotation isn't preferred for dynamic applications. CAD annotations are rife with value, typically associated only by proximity to the feature they are describing.

Annotation class is the most confused data type in Turkey because of the CAD structure and user behaviors having to tendency to produce annotation instead of point, polygon or polyline. In a basic conversion from CAD to GIS, it can be lost valuable information like text from the CAD dataset. This can be detrimental to data that relies on annotations to make sense like floor plans, and road design. Annotations should be interpreted as attributes on the target GIS data model.

The annotation process differs according to the type of data to be converted. If annotation will be converted to attribute which is stored in polyline class it can be preserved by transferring them to the nearest line or polygon. When annotation will convert to a polygon attribute, spatial join function should be preferred (Figure 2).

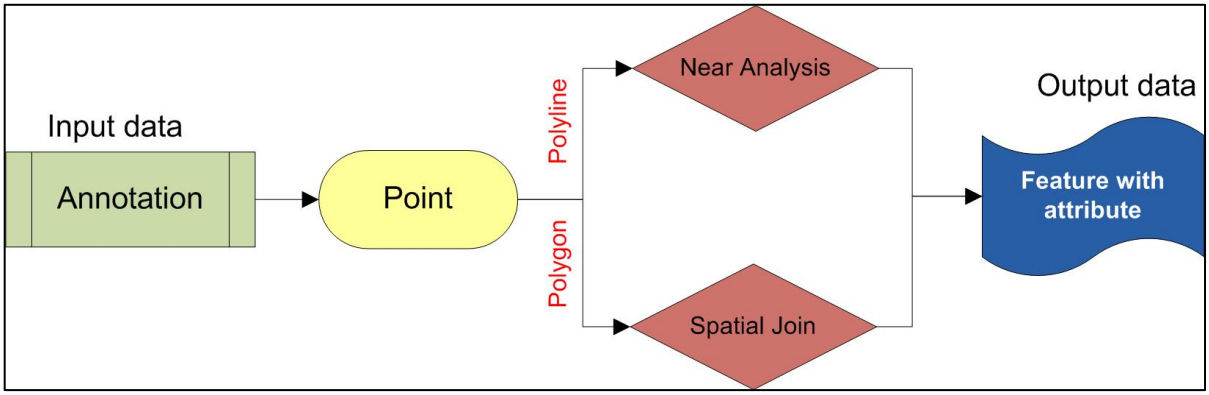

Figure 2: Annotation flowchart

But in some cases annotation was located outside the polygon after conversion to point process. For this situation a code should be developed to move points into the polygon otherwise annotation will be lost. Example of annotation for a building data to polygon attribute was displayed in Figure 3. CAD annotation data displayed in Figure 3(a) is converted point data with attribute (Figure 3(b)) before polygon attribute in Figure 3 (c).

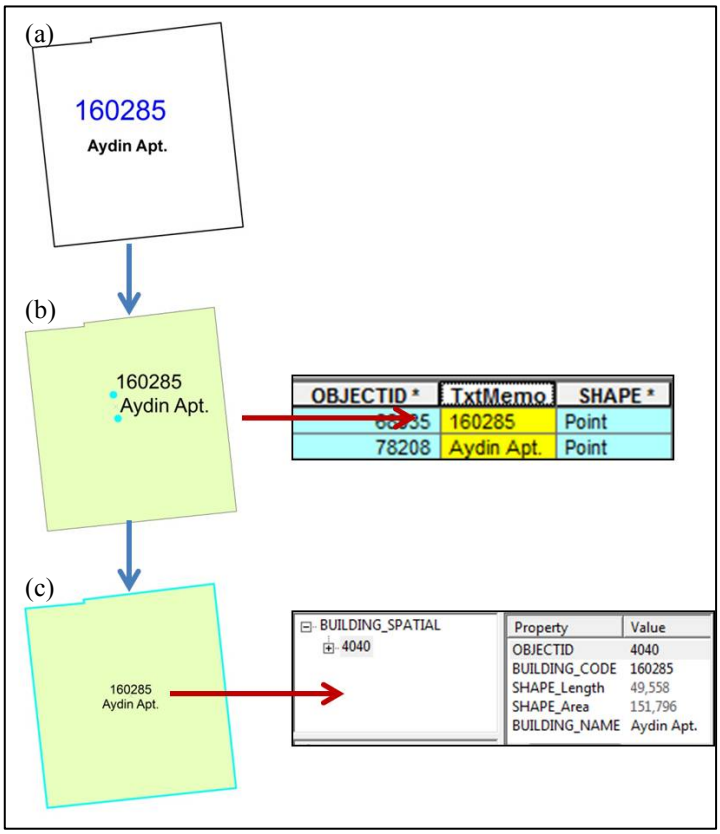

Figure 3: a) Annotation in CAD b) point data (with attribute) b) polygon data (with attribute)

4. RESULTS AND CONCLUSION

CAD data in Turkey includes so much annotation and symbology that carrying this data to GIS and back is enough to induce confusion. Data need to be corrected before storing in database in order to be able to analyses vector data with procedures like network analysis, attribute and locations queries. Conversions between CAD and GIS developments are significant for another reason as well: Geographical Information Systems are contributing to the migration away from the other software's/ systems which have dominated the GIS market for so long.

The conversion between CAD and GIS strategies described in this study is an approach for the users. Users may use this approach in complementary ways, as appropriate for specific environments or data serves. They may develop different conversion tools among their own data and requirements. As increasing third-party systems which are using GIS data and as the underlying technology mature, high quality GIS data are expected. Working with CAD data, it's often needed to enhance a CAD drawing with GIS information and attributes.

This approach provides a collection of helpful methodologies and techniques for converting CAD data to GIS format. Considering these controls is an early step for accurate conversion and a key for conversion between two systems without losing any structure and geometry. Converting data without eliminating these kinds of errors can cause to fail the subsequent steps especially topology controls. The solutions for identify step allows to data getting up quickly conversion. Identify data steps for conversion CAD to GIS is necessity process which should not be neglected.

The errors mentioned in this study are the well-knowns in Turkey and depends on the CAD data and user behavior. To prevent errors which will be increased in the future, data and data structures used in Turkey should be examined and studied carefully.

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BIOGRAPHICAL NOTES

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