Editing Topographic Contour and Sanitary Map Layers in ArcMap ™

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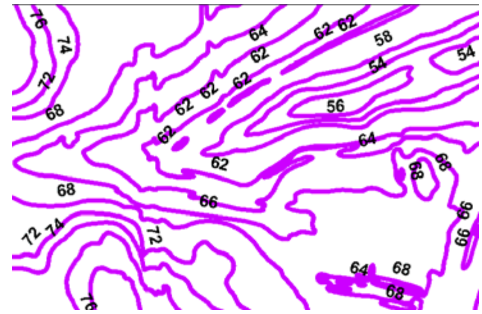
Background: Geographic Information Systems (GIS) is a type of software that allows data to be linked to location. The software reduces all geographic information to three forms of simple geometry (points, lines and polygons). This simplification allows the program to link these geometric features to database tables. Having the power of a relational database enables the software to do complex analysis of data associated with location. ESRI produces a suite of products at various levels of functionality. The levels of the program in order of complexity are ArcView®, ArcEditor®, and ArcInfo®. GIS also creates the ability for the presenter and the audience to see data visually. Each set of data or feature class can be added to a map in a layer. Layering enables the end-user to visually look for correlations between two or more datasets. GIS provides information based strategic decision making. In an increasingly complex world, GIS allows us to layer cake the world visually and access real time data. The accuracy and standardization of data models will aid problem solving and decision making. It may also pinpoint new problems that need to be solved.

Hands on demonstration of ArcGIS Online®

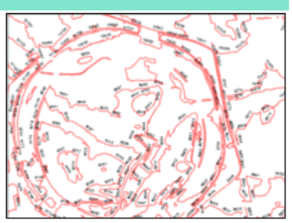
at ESRI® International User Conference



Introduction: Brookhaven National Lab (BNL) does contour surveys that assess the ground elevation at various intervals. Surveys were taken at 2ft elevation intervals and 10ft elevation intervals. The closer the lines are, the steeper the gradient is. The farther apart the lines are, the more gradual or gentle the slope is. This data is entered into a CAD (Computer Aided Design) program. ArcInfo® allows for the import of CAD files into the GIS program. During the importation process, the contours lines in certain areas may appear broken. A broken line then becomes disassociated with the elevation in the attribute table. At the Annual ESRI® International User Conference, ESRI trainers discussed a multitude of ways to go about the editing process in this program.

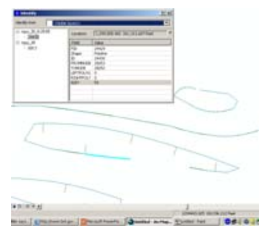
ESRI® utilizes two models for their spatial data , file based models and object based models. "File-based models include spatial data structures like coverages, shapefiles, grids, images, and triangulated irregular networks (TINs). The object relational geographic data model used by ArcGIS®, however, can be used to manage previously existing geographic datasets in a database management system (DBMS)."[1] One interesting feature of ArcInfo® 9.3.1 is the increased capabilities of the Geodatabase. The geodatabase is a container for points, polygons, and lines. Using these simple features and logic, the program becomes a database management system. Saving files in the geodatabase allows the use of Topology. Topology is a process to describe and maintain spatial relationships of map features. For example, on the BNL sanitary layer, a relationship can be established between feature classes in a feature data set. This becomes a relationship class between sanitary lines, manholes, cesspools and septic tanks. Topology allows you to set up a series of rules that can be validated for editing and management. Topology manages a set of simple feature classes that share coincident geometry.

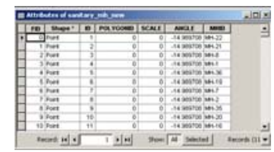
Locating conference center in San Diego



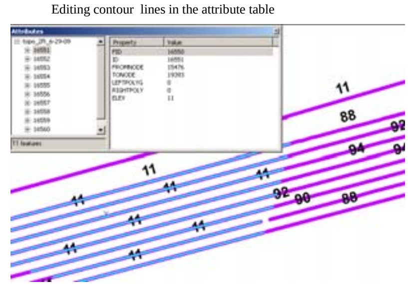
10 Foot Topographic GIS Layer

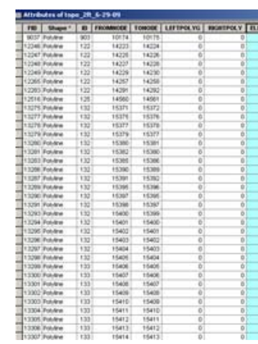
Connecting broken line segments





Editing contour lines in the attribute table





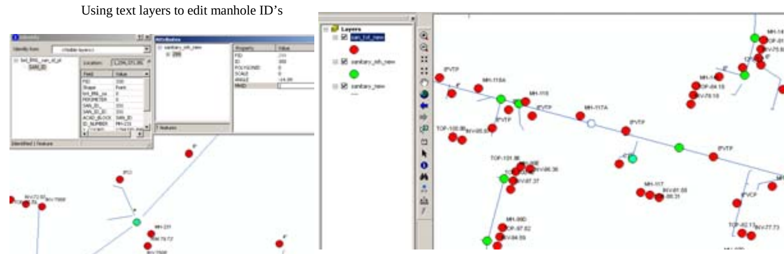
Methodology: The goal was to clean and verify the data of the updated topographic contour lines and sanitary lines imported from the Facility and Operations (F&O) Division into the EIMS geodatabase. Previously a GIS analyst converted the CAD layers to an ESRI® shapefile. During the conversion, the data had to undergo a transformation from the BNL coordinate system to a standard NAD 83 system. This difference in the coordinate systems prevented a direct import from CAD into GIS. Once the shapefile was created, the first step was to locate all the topographic contour lines that had no elevation labels due to the data conversion process. Some of the actual contour lines needed to be edited as well for broken segments. In order to make changes in a shapefile, an editing session was started. On the editing toolbar, the start editing button was clicked. It is important in an edit session to note the task and the target layer that is being edited. This feature will safeguard layers and feature classes that are not to be modified. After editing, all edits were saved and the edit session was ended.

The first tool that was used was a comparison of layers from the original 2ft contour to the new 2ft contour. By layering, these two data sets lines from the original map were compared to lines from the new map. In some instances, the lines were shifted slightly and the elevations were taken from the original line. In other instances, the lines were broken and the elevations were pulled from a segment that should have been connected to the line in question. To find these line errors, the elevation field in the attribute table was sorted in ascending order. This revealed all the zero elevations as a batch. These were selected as a group and locked in with the selection button. When a a row was highlighted with a zero elevation, a right click brought up a menu that included zoom to. This took you to this selection on the map. This visual assessment included tracing the line to its origination point, overlaying another layer or finding broken line segments that would be part of the line. Another piece of information is the adjacent contour line and its elevation. The reverse operation was used as well. Instead of starting with the attribute table and going to the map, the investigation also started with the map and used the editing selector tool to select a feature. When right clicking on this selection, it took you to its individual row on the attribute table and a change was made there.

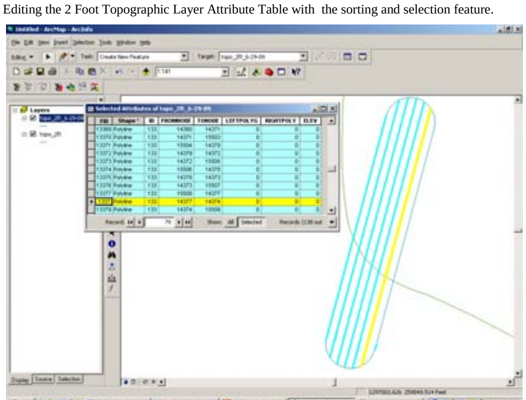
The suggested methodology for editing the broken contours on the topographic layer was to create a topology with a must be covered rule. This topology could have been created with a feature data set. The topology can be created within ArcCatalog®. The steps are: to right click on a feature data set and choose New > Topology. The next prompt will ask you to rank feature classes for reliability from low to high. The next step is to add rules. An example of a rule in this case could be lines must be covered by other lines. This will allow the editor to visualize all the lines that are not matched to the originals. To fix lines, a series of snapping rules can be set. Snapping allows the editor to designate either lines, vertices, or ends that the new line will snap to. The snapping tolerance also allows a certain level of move that will register with the program as a valid correction.

Sanitary layers were also imported from the F&O AutoCAD map. These included sanitary lines, manholes, and structures like septic tanks, grease traps, and sewage pumping stations. Again, an analyst transformed the original AutoCAD layers to allow for the importation into GIS. The sanitary shapefile layer was then edited for missing manhole cover identification numbers. The editing of the sanitary maps utilized the same basic concept of layering. The data on manhole Id's was obtained from the text layer exported from AutoCAD. These labels allowed for the identification of the corresponding manhole. A new field was inserted into the attribute table for all manhole points. When this data was filled into each field, it dynamically updated the associated point feature. By enlarging the points and changing their symbology, the identification became readily apparent. At times, the points needed to be made invisible to reveal the label beneath it. The labels were turned on and off using the layer properties dialog box. The Query builder was used to sort manholes that were missing identification from the ones that were labeled.

Using text layers to edit manhole ID's



Editing the 2 Foot Topographic Layer Attribute Table with the sorting and selection feature.



ArcGIS® 9.2 Desktop Help[2]	Geodatabase	Shapefile
Collections of datasets	A geodatabase is a collection of feature datasets	A shapefile folder is a collection of shapefiles.
Datasets	A feature dataset is a collection of feature classes	A shapefile has one shapefile feature class.
Collections of features	A feature class is a collection of features of the same type.	A shapefile feature class is a collection of shapefile features
Features	Point, multipoint, polyline, polygon, annotation, dimension, multipatch, and network.	Point, multipoint, line, polygon, and multipatch.
Topologies	Geodatabase datasets may contain topologies or a geometric network.	Map topology may be used to integrate and edit shapefile feature classes.

Discussion: GIS addresses the phenomenon of dynamic data management. Data very often changes over time. New technology increases precision in data collection. Updating and validating data is an essential part of scientific research and data management. ArcInfo® offers multiple ways of editing and managing changes in data. Although the scientific procedure appears to be a linear process, it often becomes non-linear when the results are pointing to a new hypothesis. This flexibility in research strategies needs to have the appropriate technology to support it. This can often modify the category of data that needs to be collected and require revisions in fields in the attribute table.

By editing the attribute tables in the shapefiles, there is now a version of the layer that has the elevations and the manhole identification numbers. Using topology in a geodatabase would have yielded faster results with more inherent risk to the original files. The broken lines on the elevation layer were an error that could have been more easily fixed with Topology in a geodatabase. Because elevation contours change with the elevation, it is not easy to determine where the broken lines should be. We would need to rely on the accuracy of the original survey and trace them from there. However, there are physical changes to the natural topography and the built environment. Using the original survey as a guide could cause errors and invalidate the new data that has been gathered. Although BNL does have a geodatabase, topology has not yet been built for many layers. Permission issues also prevent access by non-employees into the geodatabase.

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References: [1]ArcGIS 9.2 Desktop Help, [2] ArcGIS 9.2 Desktop Help