Title: Defining Centerline Standards for County Government Applications

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Abstract:

One of the challenging aspects of providing detailed geographic data sets is connecting the desires of the client with a defined standard that will meet project needs. In the case of centerline collection, there is unfortunately no defined photogrammetric standard that can adequately meet the needs of all users. Issues such as feature generalization and methods of attribute assignment heighten the complexity of this particular feature type and require a very close definition of end user needs. This paper discusses the successful collaboration of a data provider and user to define a standard for centerline collection.

Paper Body:

One of the challenging aspects of providing detailed geographic data sets lies in connecting the desires of a client with a defined standard that will meet project needs. In the case of centerline collection, there is unfortunately no photogrammetric or GIS standard that meets the needs of all end users. Centerlines tend to be somewhat ambiguous features whose definition and geometric representation can vary between projects and applications. The feature's name ("centerline") underlies one of the most common misconceptions of this entity: that the feature simply represents the mid point between the yellow lines of a road. While this is true in some instances, centerline collection can be deceptively complex and is often complicated by the topology of real-world road networks and the variety of applications that use this entity. In traditional photogrammetric collection road centerlines mark an actual surface feature that is not always coincident with the mid point of the road. In typical GIS applications, the feature is not always a well-defined geographic entity but instead represents an abstract and schematic representation of transportation routes. The collection of such graph models is a subjective matter. The varying definitions and applications of centerlines require an understanding of end user needs to fit the feature's representation to each application.

In our work with county governments, we encounter requests for centerline data within a variety of applications encompassing the needs of engineers, city planners and a range of other governmental departments. The needs of each client define not only the mode of collection but also the standards that are applied to the product itself. In general, we have found that most centerline products requested by county governments can be categorized into three basic groups:

1) Photogrammetrically compiled 3D surface features
2) GIS oriented centerlines optimized for routing applications
3) A cartographic product for use in GIS or CAD based applications

Each category has its own unique strengths and weaknesses that provide a basis for determining suitability for end users applications. Aligning a particular product category with its intended application has been essential for defining and applying a standard approach to centerline collection within county government applications. The following briefly explores this categorization and how it was applied in a recent mapping project in Harford County, MD.

Photogrammetrically collected centerline data

Centerlines compiled photogrammetrically are three-dimensional representations of a well-defined point on the road's surface. The features are collected stereoscopically at the highpoint or crown of the road, allowing a precise definition of the maximum elevation along any segment of a transportation route. This category is a true DTM feature and is required for all elevation modeling at 50 scale and below. The feature is optimized for engineering applications and, when used in conjunction with DTM data marking the road casings, can be used to extract volumetric or slope information. The

applications of this data set range from determinations of cut and fill operations to a variety of related planning and maintenance tasks. The standards applied to this feature type are defined by the map accuracy standards (NMAS or ASPRS etc.) and the scale of collection requested in the project scope. These standards are well defined within the industry providing a basis for collection and positional accuracy requirements.

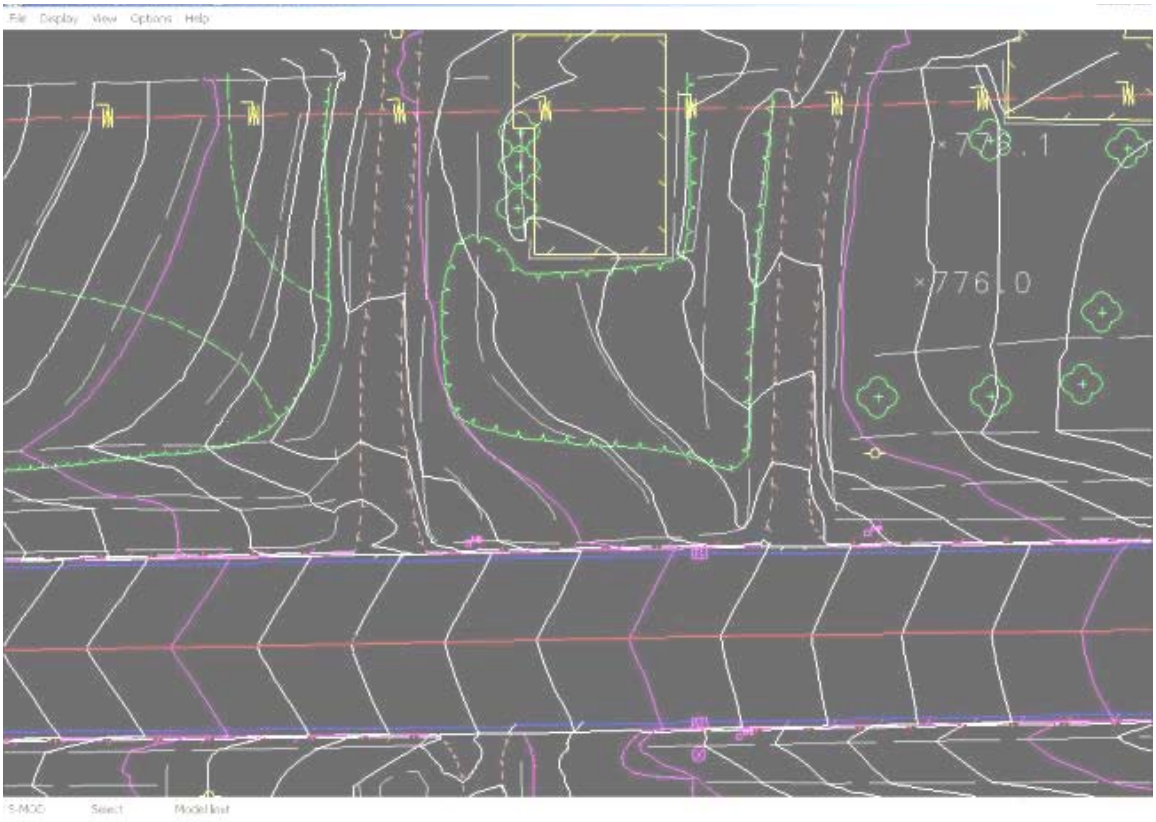

Fig. 1. Stereoscopically collected centerline with contours showing the break in slope from the crown of the road.

While photogrammetrically compiled centerlines present an accurate picture of the road's surface geometry, this category is not optimized for all applications. The crown of the road defines the feature, which is not always located at the true mid point of the road casings. In some cases, the linework may meander in X and Y as it follows the position of the road's crown. Similarly, the vertices of the line are placed to model not

only the X and Y location of the crown but also elevation change. This gives the line a very densified character. The density of collection and geometric properties of the line are not based on a cartographic or routing perspective but instead presents the surface geometry as it exists in the real world. The task of compiling these features is labor intensive which by default increases the costs of this data set. Alternative methods of centerline collection can often be identified for routing and cartographic applications where a more schematic representation of the transportation route is preferable.

Centerlines optimized for routing applications.

Routing applications do not require the same coordinate precision as the stereoscopically collected centerlines described above. For most applications, a schematic and much generalized representation of a transportation route is preferable. This category of centerline collection presents a connected graph that models the center point of road networks. The lines are often collected in two dimensions and may be automatically extracted from road casing when these are available. The linework is optimized for routing applications requiring a different set of topological considerations than their 3D counterpart. For routing applications, connectivity, directionality and node placement take precedence over surface modeling requirements. Nodes mark the intersection of different transportation segments and must be correctly connected to model the overall transportation system. The schematic character of this line type is easier to maintain and attribute than the other categories described in this paper.

Despite the relatively generalized character of this data type, there remain a number of issues that complicate collection. The topology of real world transportation

networks is complex. Turn lanes, islands, and variations in road types, lane configurations and entrance and exit points can be modeled in a variety of ways depending on the needs of the end user.

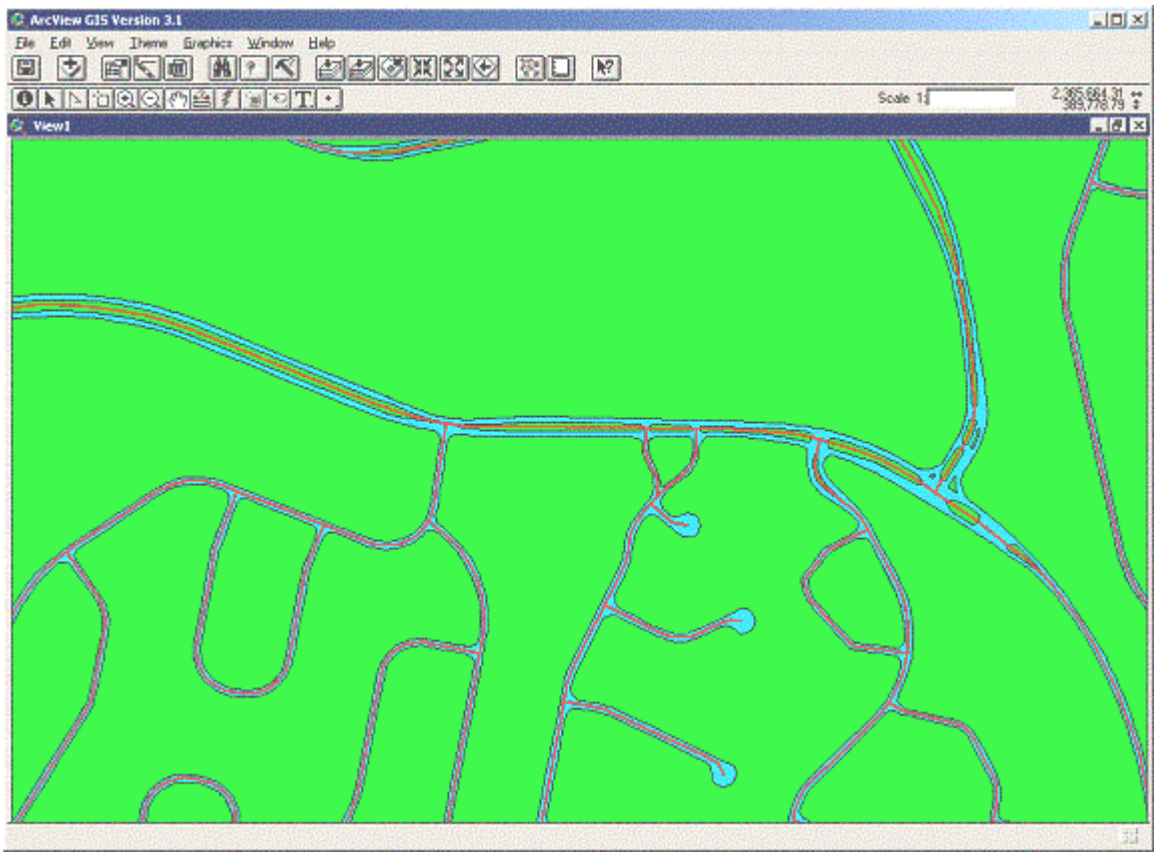

Fig. 2. Centerlines compiled for routing application.

While many aspects can be standardized, a project's success relies on a firm understanding of how complex road networks will be modeled and generalized to fit a particular application. For this reason, standards for defining centerline collection (within routing as well as cartographic applications) must be defined on a case-by-case basis prior to project startup.

Centerlines optimized for cartographic display

The third category of centerline products is concerned primarily with the compilation of linework that is optimized for cartographic display rather than for surface or routing applications. As noted above, photogrammetrically compiled linework may not model the true mid point of a road. The linework, instead, follows the crown, which can meander in X and Y depending on the characteristics of the surface itself. Likewise, centerlines optimized for routing applications tend to be very schematic. While the linework models the approximate center of a road, it typically disregards islands, turn lanes and changes in lane configurations in favor of a simplified graph model of the network. In some cases there is a desire to capture the center point of all drivable surfaces to create a cartographic representation of roads for map production. Such products provide a well-defined centerline for display and are useful references in Internet applications or hardcopy cartographic products. In these applications, islands and other transportation elements are taken into consideration and are treated according to the standards and definitions set forth in the project design. As with routing centerlines, the standards for collecting these features rely on an understanding of the application and end user needs. The compilation of the linework is a subjective process and standards for collecting cartographic product must be handled on a project-by-project basis to adequately meet end user expectations.

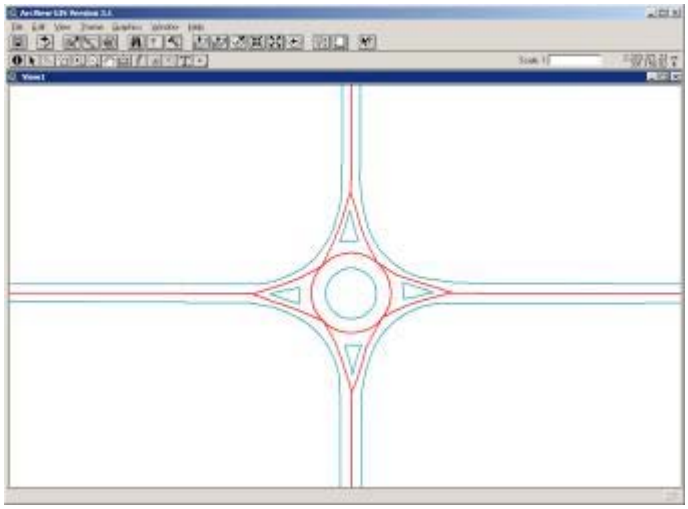

Fig. 3. Centerlines collected around islands for a cartographic application.

While centerlines collected for cartographic display attempt to model all drivable surfaces (within project scope), the characteristics of this category carry certain disadvantages. The complexity of the features does not lend itself to routing applications. Likewise, the increased number of line segments that are used to model routes at islands and interchanges can be time consuming to attribute and difficult to maintain, particularly if the application grows beyond the scope of its intended cartographic use. While the density of line collection is adequate for viewing at a large scale the linework may become busy when smaller scale products are generated from the original data set. This category like the two described above is optimized for a particular use. The specialized character of this dataset may not be the best solution for a county GIS program that is actively developing and expanding its range of services.

Development of a centerline standard for Harford County, MD

In 2000, Surdex Corporation began work on a project to provide base map information for Harford County MD. Among the features requested by the county's GIS department was a base layer of centerline data to aid in EMT, 911 and addressing projects that were currently in development. At the outset of the project, a preliminary assessment of the county's centerline needs and requirements was undertaken. The county's centerline needs were set against the three categories of centerlines described above. The county was primarily interested in a dataset to aid in their EMT and 911 endeavors, which are not well suited to photogrammetrically collected centerlines. Similarly, centerlines specifically designed for cartographic map production were overly complex and insufficient for their present and future applications. A centerline dataset optimized for routing applications was designated as the best fit for the county's GIS project.

After a category for the county's needs was identified, the next step involved modeling the collection and deliverable standards for the final dataset based on their data specifications and project requirements. This process involved understanding not only the present state of their program but also the future application of the new data within their GIS. The topological design of the dataset followed our standard route based collection methodology and used a simplified network of intersecting segments to schematically model the transportation network. There were, however, some modifications to our collection specifications that were requested by the county. A pre-existing database was to be incorporated into the new centerline layer. The county needed the option of connecting their existing data to specific X,Y node locations along the network. The intent was to develop an accurate system of pinpointing specific

residences along the linear network using nodes compiled over ortho-rectified photography.

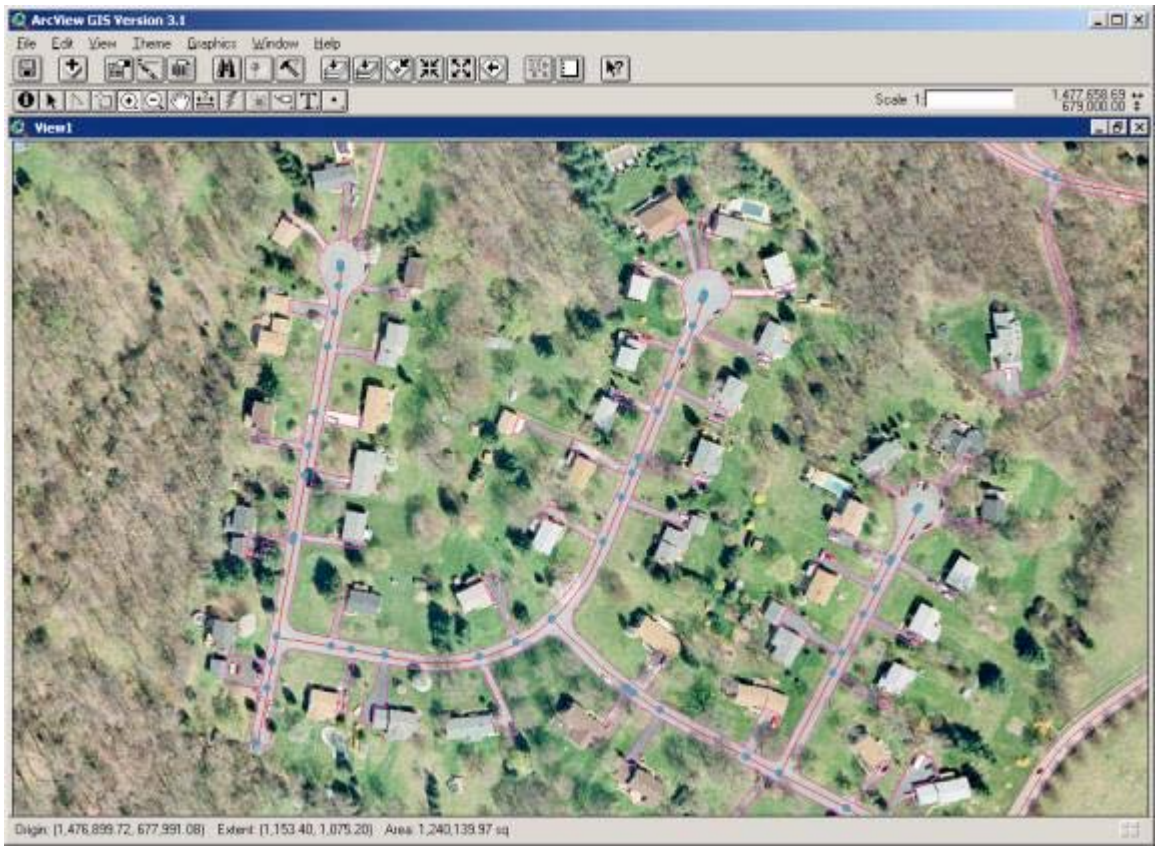

Fig. 4. Centerlines collected for Harford County dataset showing nodes along network.

While this method did not represent the only solution to their problem it was a method that met the needs and requirements of the GIS department.

Conclusion.

As is often the case with custom datasets, Harford County's centerlines were a hybrid that melded the standards defined by the provider with the unique needs of the client. Although the collection of the entities followed the general parameters and guidelines that are standardized within Surdex's compilation and GIS departments, the

end product was optimized to meet the requirements of a custom county government application. The final product set the county's design requirements within a basic template for route based centerline datasets, giving the product the ability to grow and incorporate new routing information as the application and county's needs develop. The collaboration between the data provider and end user was an absolute necessity in defining a centerline standard for Harford County. In the absence of a universal standard for centerline collection, such collaborations offer an avenue for developing data standards that will meet county government requirements now and in the future.

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