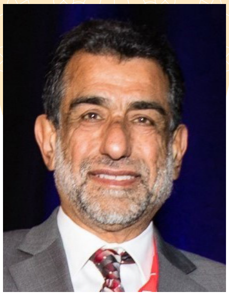

MAPPINGMATTERS

YOUR QUESTIONS ANSWERED

The layman's perspective on technical theory and practical applications of mapping and GIS

BY Qassim A. Abdullah, Ph.D., PLS, CP**

QUESTION:

Question: I came across one of your articles while searching for some answers about breaklines, so I figured I'd contact you for more information. The article I found is from September 2017 and it is about using breaklines for lidar datasets. I'm working with a surveyor and a drone pilot. The pilot flies, the surveyor does the ground control setup, I process the data and the surveyor confirms whether the product is accurate. Recently, the surveyor asked me if I can provide him directly with a TIN (triangulated irregular network). The problem that I am having is with breaklines. I can't find an industry standard or guidelines on when or where breaklines are needed. I'm starting to wonder, aside from using them for obvious things like gutters and roads and the sides of a cliff, if this is as much of an art as a science. Would you be able to point me in the right direction so I can learn more about what features need breaklines and when we should and should not use them?

Nathan Mangsen, Mangsen Mapping

Dr. Abdullah: First of all, it is always good to hear from a former student. As for your question, whether there is a need for breaklines is a controversial issue among users within the geospatial community. Breaklines were originally developed to ensure the accurate modeling of a terrain surface where sparsely compiled mass points (3D points collected by a stereo compiler using photogrammetric mapping principles) may result in the inaccurate representation of abrupt changes in terrain. Before lidar and digital photogrammetry, all topographic maps were created through a manual process using stereo photogrammetry. This process was time-consuming, expensive and did not always result in an

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accurate terrain model, since it depended on the thoroughness of the compilers and the quality of their stereo vision. The introduction of the breaklines concept was a genius approach at the time because we could not afford to model the terrain with a dense enough network of mass points, i.e. collecting a mass point every one meter along the terrain, to accurately depict all details on the ground. Over the last two decades, lidar has alleviated the geospatial mapping community's main concern about the density of mass points and its ability to accurately model the terrain. These days, aerial lidar is collected at densities ranging from 2 points per square meter (USGS QL2) to hundreds of points per square meter, while a terrestrial or mobile lidar system can acquire data with a density of thousands of points per square meter. However, 30 years after the introduction of lidar, some factions of the industry are still hooked on the idea of collecting breaklines to augment dense lidar data. This outdated practice continued even when the data acquired using mobile lidar resulted in a point cloud with a density of thousands of points per square meter. Breaklines are used today in several other geospatial applications, including hydro enforcement, transportation engineering and to avoid some anomalies during the ortho-rectification

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process. The need for breaklines in those applications can be eliminated if software companies would devise solutions based on artificial intelligence (AI), machine learning and deep learning algorithms that utilize the computational power of the processing machine, AI-based algorithms and the richness of lidar data (that lidar includes points cloud,

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lidar intensity images, and the natural color imagery from the RGB cameras). As an industry, we need to exert some pressure on the leading software manufacturers who are providing the industry with 3D modeling and road design packages. Their software is used by all state departments of transportation (DOTs) for road planning and design. Their software requires the user to provide breaklines to represent road centerlines, road edges, roadbeds, curbs and gutters, sidewalks, shoulders, tops of endwalls, tops of slopes, ditch bottoms, etc. For transportation projects, mobile lidar is usually used to create point clouds with a density estimated to be from 2,000 to 6,000 points per square meter. With this kind of dense points cloud, the software should be smart enough to find road crown, slopes, edges, etc. without relying on any manually compiled information. The question for the software developers is what could define the terrain details better than the information provided by 6,000 points (each with accurate X,Y,Z) per square meter and sub-centimeter resolution colored imagery? Currently, many users of these road design software packages acquire mobile lidar data with thousands of points per square meter, create breaklines from it, then decimate the point clouds to a 5-foot grid to be able to ingest it into the software. This practice is wasteful for two reasons: First, mobile lidar data acquired with a density of thousands of points per square meter is being decimated to 5-foot grid; and second, manually extracting breaklines, as mentioned above, is time-consuming and costly.

There is no justifiable reason for using breaklines, especially with dense lidar data. The lack of innovation by some leading software companies is crippling the industry and limiting the utilization and benefits of lidar data. I hope algorithms and AI-based software will soon advance in a way to help us to unleash the power of lidar data and eliminate or minimize unnecessary laborious tasks such as these. The breakline concept was created decades ago to suit that era of mapping technologies. Breaklines should have no place in our mapping practices today since lidar can provide us with the most accurate and most thorough way to model the terrain.

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I hope this answers your question. For further reference, the Florida DOT manual for surveying and mapping provides excellent information about the requirements and guidelines for breaklines.

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