Ok, I have USGS 3DEP lidar data... now what can I do with it?

Many parts of the United States are receiving new lidar data for the first time through the USGS 3DEP (3D Elevation Program). For many end users in the GIS community, their excitement shifts quickly from excitement to contemplation. Understanding the benefits and limitations of lidar is essential to getting the most value from the information. At Atlantic, we have developed several algorithmic approaches to efficiently create additional data products from new lidar at a very reasonable cost. This blog entry will cover our approach to creating building rooflines from lidar data.

Atlantic can certainly produce building footprints from lidar that has at least 2 pulses per square meter. While the building roofline derivative will not be as accurate (or perhaps, as pretty) as traditional, photogrammetrically-compiled building footprints, it may serve many clients very well and can be produced for significantly less cost. Please understand that the lidar data is very accurate and capable of producing a more accurate polygon but doing so would require much more manual labor, thus increasing the cost. What we've heard from our clients across the United States is they need derivative products like building rooflines produced at a reasonable cost to ensure they maximize their return on investment of the lidar.

Atlantic has developed building rooflines from lidar for a number of clients. We have been tasked to use a completely automated approach and we have been tasked to use an automated approach but with some manual cleanup where necessary. In either case, we use a combination of COTS (Commercial-Off-The-Shelf) software and internally-developed algorithms.

We generally start with the LAS dataset itself. The extraction of building rooflines is far better if the buildings are classified in the LAS structure. Using an internally developed algorithm in TerraScan, we utilize a combination of height and echo (return 1 of 1 or last return) to differentiate buildings from proximate vegetation that could be of a similar height as the building itself. All additional classifications are relative to the ground classification (Class 2 of the LAS). The screenshot below shows the buildings classified (white) compared with ground (orange). All other classes are hidden in this example.

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After the building classification is complete, Atlantic uses algorithms in GeoCue's LP360 for extracting the building roofline geometry. This process enforces 90 degree and diagonal angles to automate a general shape of a building, creating polygons for building footprints. Let's look at some examples of areas that are problematic using this algorithmic approach.

The image below illustrates the first-pass building roofline extraction overlaid on a DSM (Digital Surface Model) of the lidar in LP360. As you can see, some residual trees that were not algorithmically classified are creating an issue for a few buildings in the middle of the image, especially the largest building. In most cases, the tree is slightly taller than the building so the tree overhangs the roof line, creating a missed point in the exact corner of the buildings of the LAS.

For many applications outside of taxation, these buildings would be sufficient. However, if the buildings needed had to be more precise at the corners and to include the full building, manual editing would be required. It could involve some combination of additional manual classification of the point cloud or manual editing of the resultant polygon roofline features. As always, additional manual time increases the cost of developing the product so it is important to really understand what can be lived with for your application and what cannot.

Atlantic has been performing this service since 2013. The improvement in lidar point cloud density has a corollary improvement on the ability to properly classify buildings and extract building rooflines. In 2014, Atlantic won the MAPPS Geospatial Products and Services Excellence Award for utilizing lidar in the public domain to extract 3D buildings for a group of government agencies in Northwestern TN. A copy of our poster from that award is shown below.

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Helping Weakley County, Tennessee's Tactical GIS Team Maximize their LiDAR ROI

Location: Eight Counties in Northwest Tennessee
Firm: Atlantic, Huntsville, Alabama
Client: Weakley County, TN E911

Weakley County E911 established a specific data need for planimetric building outlines. Without a recent orthophoto basemap, they asked Atlantic to develop an innovative approach to extract the required data from LiDAR data that were provided to them from a 5,500 mi2 USDA-NRCS project in Western Tennessee.

Atlantic's willingness to take on this customized scope while facing a limited budget and an extremely sensitive timeframe required flexibility and a 'can do' mindset. Atlantic developed new scripting tools that were, by necessity, low on manual effort to ultimately develop this dataset. The resultant building footprints from Atlantic's innovative process have the detail, sharpness and appearance of photogrammetrically-derived features. Atlantic's process helped Weakley County 911 maximize their ROI from this new LiDAR dataset.

Atlantic aligned with the County 911's GIS Specialist to assist and propose options of deliverables that would ultimately enhance the Intelligence Packages requested by Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). 2,822 LiDAR tiles were developed across Weakley County and parts of 7 other counties. Atlantic developed 25,245 buildings that proved critical to Weakley County 911 and the ATF. The 3-D buildings were used in a series of coordinated raids by law enforcement resulting in 45 indictments.

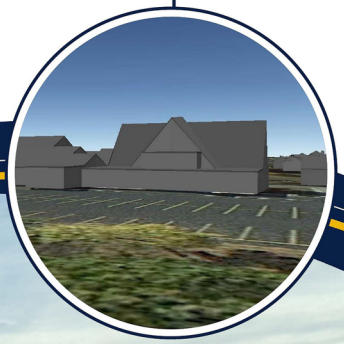
The USGS 3DEP program will deliver high resolution LiDAR data to thousands of new users across the United States. It is imperative for the geospatial community to modify our tools and techniques to help clients maximize their ROI from a LiDAR basemap.

Atlantic determined that properly classifying individual LiDAR points as buildings, prior to the vector extraction process to create the building outlines, was a key component to ensuring the quality of the data.

Resultant building outlines overlaid on the LiDAR intensity. The building outlines have the detail and smoothness of photogrammetrically-derived features.

Atlantic extruded the 3-D buildings using a combination of the final footprints and LiDAR point cloud. The 3-D buildings were delivered as a Google Earth mash-up for easy use by law enforcement officials.

Individual 3-D building detail overlaid on Google Earth. This type of perspective was key to situational awareness for the law enforcement teams prior to their coordinated raids.



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