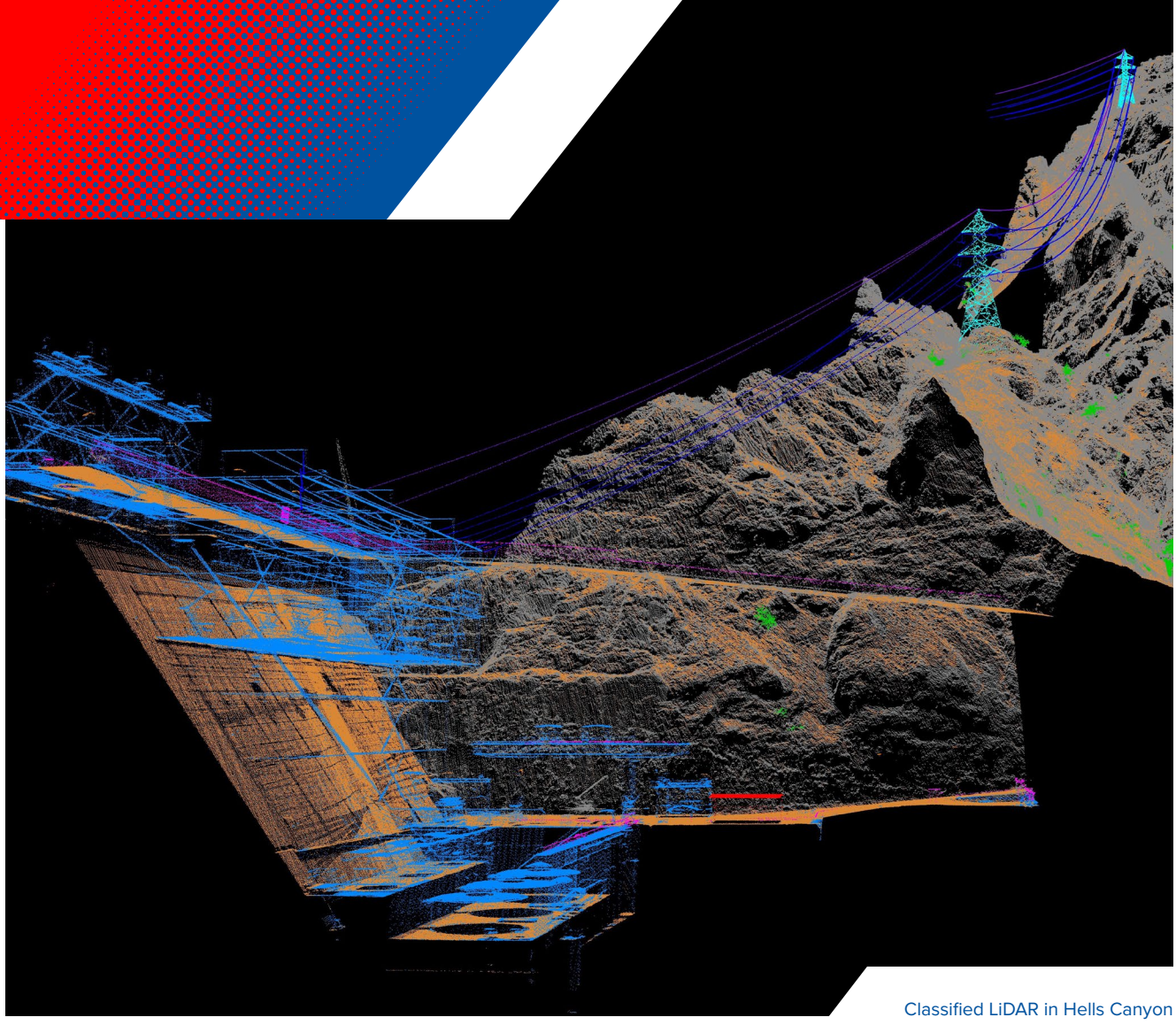
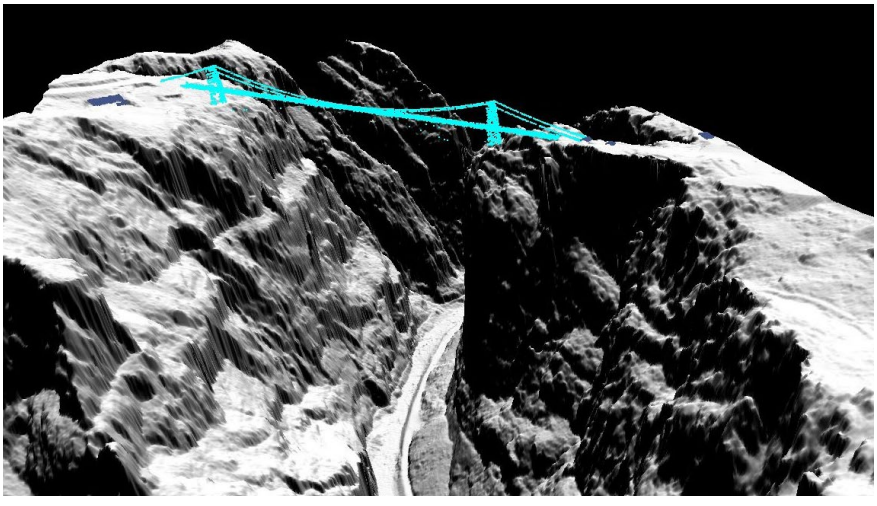


Classified LiDAR in Hells Canyon

Why Do You Have To Be That Way? A look at Aerial LiDAR Again!

The September 2016 issue of *LiDAR Magazine* featured an article titled "YES, WE CAN Provide High-Quality LiDAR for Less than $100 per Square Mile". The general premise of the article was that Atlantic can provide USGS QL2 LiDAR for $100 a square Mile and why? That is AWEsome!! It is difficult to make any correlation to the article in the October 2015 titled "You Can Do That for *How Cheap*? A Look at Aerial LiDAR Now" and a price of $100 a square mile for a given product and there was no mention of the USGS QL2 product in the article. The article in October was not intended to offer any price point as it related to a given product, ironic enough, surely there are many LiDAR provider's that would offer to do LiDAR for $100 a square mile. The premise of the October

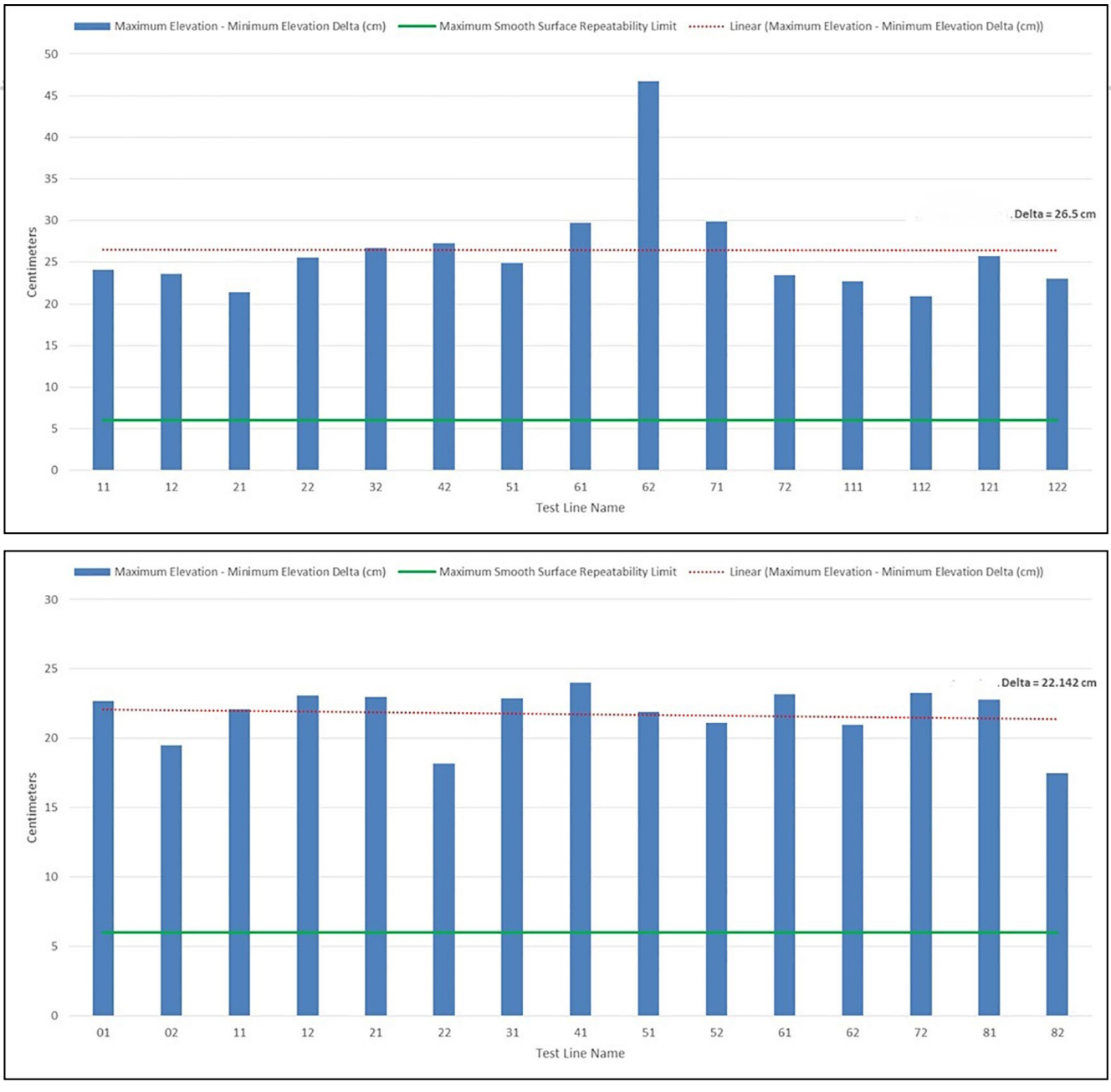
BY JAMIE **YOUNG**



Hill shade with point overlap of the Bridge of Royal Gorge in Colorado from USGS NGP LBS V1.2 QL2 Data

article was to educate on what are the driving factors in the cost of LiDAR and provide questions to someone interested in getting LiDAR. The article was based on all types of LiDAR collection for all types of applications including but not limited to all types of wide area mapping and all types of corridor Mapping. Furthermore, there is no way to speak for other professionals and there are a lot of quality, very experienced, stand up and knowledgeable professionals in the LiDAR mapping profession.

Most any LiDAR provider could offer USGS QL2 Data for $100 a square mile but again the characteristics of the project play a major role in this price point. It is also unclear if someone had a half mile project does it cost $50? Well, Why not? That is a stupid question but the answer is simple. The size of collection and the amortization of cost of executing that project is much different than a very large project. Most companies have a minimum project cost and the cost of doing business also drives the cost of each square mile based on project size. A project in Kansas is going to cost significantly less per square mile than a project in the high mountains of Colorado or the Pacific Northwest because of the weather, terrain and vegetation characteristics of these project locations. The shape of the project area will also play into cost. A square or rectangle is much easier to collect than a complex or disjointed project area. A good resource for this theory would be FEMA because their project areas are usually based on drainage basins which are very complex and require more flight lines regardless of efficiencies provided by innovation or technological advances. If there is a 25% efficiency provided by innovation or using multi-pulse versus single pulse the number of flight lines maybe less for a given project but the number of 25% more efficient flight lines is going to be more for a complex drain basin. Additionally, as a result of the physics of a system capable of doing Single Pulse and Multi-Pulse, there are limitation to using Multi-Pulse in extensive relief thus making it necessary to use the Single Pulse to avoid laser dropouts or Scan Mutations as a result of the range gate and blind zones. A professional



Top: Smooth Surface Repeatability tested for a sensor in Multi-Pulse.
Bottom: Smooth Surface Repeatability tested for a sensor in Single-Pulse

that is not accustom to flying areas of high relief would not know that. The Colorado USGS 2013 flood Project was a prime example of this.

All the manufactures of LiDAR sensors are continually trying to address the issue of terrain and how that affects the operational parameters of LiDAR sensors because LiDAR Manufactures continually compete to provide the best solution for their customers. Currently, for example the Optech Galaxy with Pulsetrack™ provides the ability to collect LiDAR data in areas of varying terrain at a given flight altitude and achieve a consistent point density and it is able to provide up to a 40% efficiency over other sensors having double the repetition rate. This means a 500 Khz Galaxy can be up to 40% more efficient than a 1000 Khz or 1 Mhz system because of its PulseTrak™ technology. The Galaxy has proven to be more efficient but the extent of the efficiency depends on the project characteristics. It could be ascertained that 40% efficient could be achieved

in flat and low relief areas. Moderate relief would be a better example of these efficiencies.

The October 2015 article reviewed the driving factors in collecting LiDAR and there is no way to get away from the environmental make up of a project but to provide innovated technological solutions to the controlled variables of a project. The systems used for collecting LiDAR projects was discussed in both articles and how those systems were operated and the efficiencies that can be achieved by such systems. What was not discussed is if the systems used in a project meets the required specifications for the project. Most notable specification for the USGS NGP LBS V1.2 specification is the requirement of repeatable points as stated on Page 8, Table 2. Relative vertical accuracy for lidar-swath data, Quality Level-0-Quality Level 3.

> "The "interpreted notion" of the October 2015 article appears to be that since there is no innovation and analytics and we are providing out of the box solutions that it is what it is and we need more professionals in the industry to get to $100 a square miles for providing USGS QL2 data."

This table indicates that the smooth surface repeatability for QL2 needs to be less than or equal to 6 centimeters, the swath overlap difference, RMSDz is less than or equal to 8 centimeters and the swath overlap difference, maximum is +/- 16 centimeters. The big concern here is how do you really check this as an end user and do you trust your provider to provide the necessary results of this. It is well documented currently in the LiDAR community that there is a sensor being used that cannot meet the 6 centimeter smooth surface repeatability and 8 centimeter Swath overlap difference, RMSDz that is required by the USGS. So it would be imperative for any end user to ask for concrete evidence and statics of their project that prove that this requirement is being met because it is in the USGS NGP LBS v1.2 Specification and when future version of the specification are released there will be the requirement to provide horizontal accuracy.

The "interpreted notion" of the October 2015 article appears to be that since there is no innovation and analytics and we are providing out of the box solutions that it is what it is and we need more professionals in the industry to get to $100 a square miles for providing USGS QL2 data. This could not be more false. The article was detailing the variables that affect cost and to suggest that all LiDAR providers are not innovative is presumptuous. Atlantic and Mr. Mayfield should be applauded for pushing the envelope with their analytics and innovation but it is not to say that other companies in the industry are doing the same or we are driving to the bottom. The hardest part of working in any profession is trying to figure out ways to make more money as prices are driven down. Providing solution and solving our customers problems with innovation and analytics is natural to most in our profession. One could look at what has happened to the imagery side of the mapping profession and deduce that some folks like to collect imagery and there is a commodity component of that product but there are still disciplines that require specialized imagery. There seems to be an equal amount of this in the LiDAR side. Wide area LiDAR collection is pretty straight forward and as long as the specification is followed it can be very successful and there are a lot of very successful projects done by many LiDAR professionals and some of those jobs are done for $100 a square mile. The key to any profession is creating solutions and solving problems for applications and markets that did not exist a couple of years ago. The automation and innovation that comes from multi-discipline LiDAR companies provides benefits across all applications including the wide area LiDAR collections, which we have all been doing for upwards of 15 years. Another key item that should be mentioned is that the LiDAR manufactures have done an excellent job designing systems that get the required point density for USGS QL2 data at maximum altitudes. So for example the Optech Pegasus at it's maximum altitude gets 2 PPM. Additionally, there are ways to attenuate

the LiDAR sensors so that they can be flown at higher attitudes with special built attenuators from the manufacture. Typically, the scan angle will need to be reduced to accommodate the attenuated signal but the swath on the ground is typically the same or greater providing better accuracies and efficiency not realized before. This was done on the DuPage County, Illinios LIDAR project. The reason for this use on this project was because of the restricted airspace from O'Hare International Airport. The project was designed to fly above Class B airspace or above 10,000 feet AGL and there was a requirement to collect 4 PPM on this project. The project followed the USGS NGP LBS specifications for QL2 Data.

It is intriguing to look at Geiger and Single Photon LiDAR as it relates to per square price. In both articles it was indicated that this technology was disruptive and this is good for the Geiger and Single Photon providers. In context of it being a new and viable technology it would be interesting to look at it like conventional or linear mode LiDAR. In 1998 a 1200 square mile project was awarded for $6.7 million dollars in Southeast Alaska. That was using a 5 Khz sensor. That is not a typo. That is $5583 a square mile versus $100 today for much more dense and evolved product. The Geiger Mode and Single Photon LiDAR is currently improving at a staggering rate and the data generated are impressive. About one year ago a large project was quoted for $110 per mile using Geiger Mode LiDAR. The Technology is new and the processing of the data is much different than that of Linear Mode LiDAR. The calibration is much different especially for Geiger Mode. An AT like solution is being used to calibrate the Geiger Mode LiDAR. The amount of returns and noisy data is significantly more. Linear Mode LiDAR has been around for just over 20 years commercially and the Geiger and Single Photon LiDAR technologies have only been commercially available for 3 to 4 years at most. To make a blank statement about the cost of a competing technology without a full understanding of that technology or the cost structure of that technology is naïve at best. Regardless of the end cost of this technology and the resulting cost based on good competition, this technology is here and it will improve and the cost will go down.

"It is very impressive that our clients can get USGS NGP LBS V1.2 LiDAR Quality Level 2 data for $100 a square mile but it should continually be noted that collection of LiDAR in the Midwest is significantly different than collecting data in the Pacific Northwest and in the Mountains of Colorado."

It is very impressive that our clients can get USGS NGP LBS V1.2 LiDAR Quality Level 2 data for $100 a square mile but it should continually be noted that collection of LiDAR in the Midwest is significantly different than collecting data in the Pacific Northwest and in the Mountains of Colorado. Typically, any LiDAR flown in the Pacific Northwest requires a Quality Level 1 data set or 4 to 8 PPM. This is how most all the data in Oregon, Washington and Idaho is done. The reason for this is because of the extremely dense vegetation that is in that area and extensive terrain relief. Although, extensive innovation and analytics have been used to get the cost of LiDAR data per square mile down there are certain environmental conditions that prevent anymore efficiencies at this time, it is feasible to believe that we could get there but maybe not. There will be further innovations and efficiencies made in the LiDAR profession. LiDAR is a very powerful mapping tool and even after 20 years its use for new applications contiues to grow and although wider area collection is well established, specialize applications do not warrant $100 a square mile at this time.

James Wilder Young (Jamie) CP, CMS-L, GISP is currently a Senior Geomatics Technologist for Merrick & Co. located in Greenwood Village, Colorado. His experience includes all aspects of LiDAR including sensor development, applications development, data acquisition, data processing and project management. He graduated from The University of Colorado.