MOBILE MAPPING REDEFINES PAVEMENT MARKING INVENTORY IN OHIO

MOBILE MAPPING, THE ANSWER TO PAVEMENT MARKING INVENTORY STUDY CHALLENGES. A PAVEMENT MARKING INVENTORY STUDY IS A CHALLENGE TO PERFORM PROPERLY, EFFECTIVELY AND QUICKLY. IT INVOLVES A MULTITUDE OF OBSTACLES RANGING FROM IN-FIELD SAFETY ISSUES WITH TRAFFIC TO ACCURATELY TRACING THE CONTOUR OF LONG STRIPED LINES AND PRODUCING ACCURATE DISTANCE CALCULATIONS TO GEOREFERENCING ALL OF THE PAVEMENT MARKINGS.

The MasterMind mobile mapping vehicle displaying the 360° camera, multiple LiDAR units, GPS antennas, the distance measuring instrument (DMI) and the solar panel.

Pavement Marking Inventory studies are very beneficial once completed. With highly accurate lineal footage marking totals, bead and paint quantities can be easily calculated for entire roadways or even just sections. With identifying the markings materials, proper replacement can be easily planned and achieved. Proper yearly striping plans can be assembled based on inspection ratings. Striping projects can be more accurately assembled and bid. Proper t-marking can be more easily applied when striping repaved roadways. Overall, with the cost analysis benefits, government agencies can save a considerable amount of money and time and improve their budgets.

Richland County Ohio

It began with the Richland County Ohio Engineer's office. They set out to inventory and inspect all their roadway pavement markings.

Pavement Marking Examples:
• Centerline (No-Passing, Safe Passing)
• Edgeline (White and/or Yellow Edgelines)
• Auxiliary (Turn Arrows, Stop Bars, Crosswalk lines, Transverse lines, Railroad crossings)

The Richland County Engineer, Adam Gove, P.E., P.S., stated, "When evaluating the condition of our County Roads, it became clear that our pavement marking inventory was out of date. We did not have an effective way of tracking which roads had pavement markings, when they were last repainted, and what type of material was used when last applied…"

Pavement marking inventory studies are riddled with challenges, and everyday government agencies are demanding greater accuracy and more ways to visualize their asset data. For the Richland County project and all safety studies, safety is the number one priority. In addition to safely performing the study, all pavement markings needed to be geo-referenced, the contour of long edgelines and centerlines would need to be strictly traced and 347.7 miles of roadway pavement markings would need to be inventoried and inspected.

We at MasterMind, LLC were thrilled to be awarded the project and redefine how a pavement marking study would be performed. We would use mobile mapping to overcome the challenges. To dive into the field work, we utilized our custom designed mobile mapping system which was supplementary powered by solar energy and mounted on-top of a Fiat 500. We choose the Fiat vehicle because of its smaller size, which helped increase visibility of the roadway within the spherical imagery. At MasterMind, when we perform a safety study, safety really is the first concern. After all, whether it's a pavement marking inventory study or any other safety study, the result is to make our roadways safer. With mobile mapping, first and foremost, we would increase the safety of the pavement marking inventory study. We were able to map the Richland County roadways at normal highway speeds and not impede traffic flow. The pavement marking inventory study was performed without traffic backups or traffic stops which increased safety exponentially.

Our MasterMind mobile mapping vehicle is composed of multiple Velodyne LiDAR units, a 360° LadyBug 5+ spherical camera, and an Applanix POS LV GPS/IMU unit with a distance measuring indicator (DMI). Our MasterMind mobile mapping vehicle LiDAR mapped Richland County roadways at 600,000 points per second and video mapped at 10 frames per second (FPS) in 8k resolution imagery. This allowed us to offer a full 360° video from the beginning to end of each roadway, along with still frame imagery.

The Richland County Engineer, Adam Gove, P.E., P.S., continued to state, "… Thanks to a grant from the County Engineers Association of Ohio, we were able to contract with MasterMind to complete an inventory and rating of all markings on County Roads in Richland County. The advanced technology utilized by MasterMind has provided us the necessary data and tools to update and track our pavement marking inventory in an efficient and effective manner."

The "Pipeline"

The next challenge was to post-process our in-field data for accuracy before the inventory could even begin. At MasterMind, we refer to the data post-processing on all in-field generated mobile mapping data, as the "pipeline." The pipeline steps include:

1)   Applanix PosPac software performs multiple calculations and adjustments of the in-field GPS/IMU data to greatly increase accuracy for all imagery and LiDAR point cloud data.
2)   The in-field video imagery is updated with the PosPac adjustment file.
3)   Individual image frames are extracted with a movie maker software to be used as spherical imagery.
4)   A specific version of VeloView software created and customized by Kitware, Inc. specifically for us at MasterMind, creates the final RGB coloured .LAS point cloud.
5)   Finally, the spherical imagery frames and RGB coloured .LAS point cloud are ready to be used, but putting them together was our next challenge. Also, the overall Richland project challenges didn't end there. A full inventory of the pavement markings was now to be performed, lineal footage of pavement marking lines would need to be properly identified, the contour of the long lines would need to be traced and the project delivered.

Orbit GT to the rescue

It was an easy choice for us at MasterMind to choose Orbit GT software as our go to mobile mapping software for the Richland County project. Orbit 3DM Content Manager offered ease of integration for our MasterMind custom

mobile mapping system. The Orbit 3DM Feature Extraction Pro software offered an extensive amount of asset inventory capabilities. Impressively, Orbit GT also offered a powerful yet simple delivery platform with the 3D Mapping Cloud.

First, we used the Orbit 3DM Content Manager software to import all the spherical imagery and LiDAR point cloud data. 3DM Content Manager solved our challenge for managing and preparing all 115 Richland County roads. Each road was imported into the "Catalog" section of 3DM Content Manager as a separate dataset known as a "Run." Preparation for so many roads included steps such as: Lidar to imagery alignment, nomenclature identification, metadata insertion, ghost removal and uploading into the 3D Mapping Cloud. These preparations were all more easily and centrally achieved for us using the 3DM Content Manager Catalog. We've performed thousands of miles of safety studies with multiple methods at MasterMind. We needed a new easy to use and advanced software to perform the pavement marking asset inventory. Orbit GT's 3DM Feature Extraction Pro software was our answer. We heavily utilized this software for its asset inventory features. Inside of

the software, you create "Themes" which are used to create asset items such as centerline and auxiliary inventory data. We then used 3DM Feature Extraction Pro's manual and semi-automatic extraction tools to inventory the pavement markings. Thanks to LiDAR and the 3DM Feature Extraction Pro's semi-automated tool, road markings such as centerline and edgeline markings were easily extracted. The main bonus was that the contour of the lines were inventoried perfectly with altitude included. This also allowed us to provide Richland County with extremely accurate lineal footage measurements. The 3D Mapping Cloud was even more desirable by allowing the mobile mapping data to viewed on any computer (laptop, desktop, or tablet). Accurate measurements can be made in the 3D Mapping Cloud on all mobile mapped roadways. The Richland County Chief Deputy Engineer, Kevin Payne, P.E., P.S., stated, "The 360 video has proven to be valuable not only for the markings, but to see all of our County assets without leaving the office, thus saving time and money. The quality and ease of use of the video mapping will provide benefits for years to come. Although other street view mapping is publicly available

through the Google platform, not all of our roads are on it and it would not be directly linked to our asset data like the MasterMind MasterSuite software. After selecting a database inventory item in MasterMind, with the click of a button you can be directed to a 360 street view of the roadway to actually see the item from the video."

In conclusion, our MasterMind mobile mapping vehicle performed the Richland County pavement marking inventory study quickly and accurately with no accidents nor resident complaints. We delivered the final asset data to Richland County in our MasterSuite asset data management software. We found that Richland County Ohio has 1,299,171.5 feet (246.055 miles) of centerline, 1,086,997.2 feet (205.871 miles) of edgeline, 45,220.5 feet (8.565 miles) of auxiliary line and 173 auxiliary symbol markings (ONLY, SCHOOL, RxR, Turn Arrows, etc). We're currently developing connection to the Orbit GT 3D Mapping Cloud from within our MasterSuite asset management software. This feat is accomplished thanks to Orbit GT's excellent software development kit (SDK).

Overall, using general pricing, the estimated cost of only materials (paint
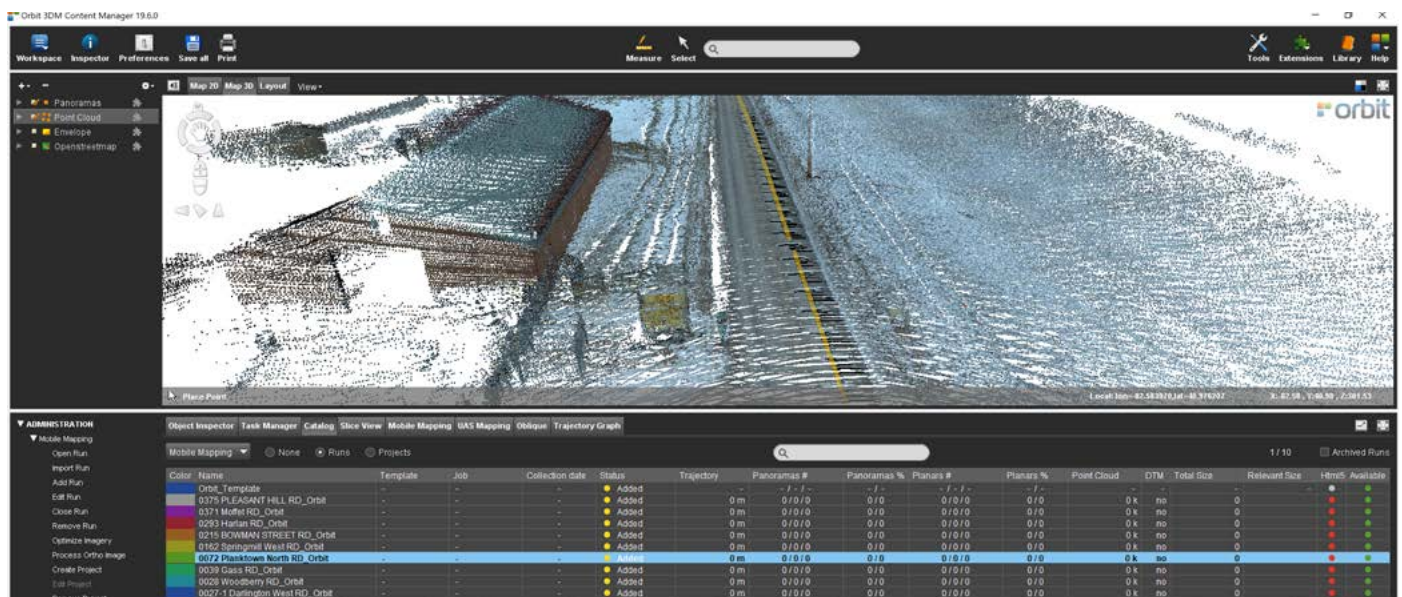
Orbit 3DM Content Manager displaying a LiDAR point cloud of a Richland County roadway with one of Ohio's most common occurrences, snow.

and thermoplastic) to restripe all the Richland County pavement markings, would cost around $440,570.95.

At MasterMind, our clients are mainly composed of U.S. County governments and almost all of them use ESRI ArcMap software. We are very excited to now offer them the 3DM Plugin for ArcMap which allows Orbit's 3D Mapping Cloud data to be connected and used in multiple ways within their ArcMap software.

At MasterMind, we saw so much potential for the U.S. County governments to utilize the 3D Mapping Cloud along with the 3DM Plugin for ArcMap, that as of May 28th, 2019, MasterMind teamed with Orbit GT to become an official reseller for Orbit GT software. We look forward to continually spreading the word and praise of Orbit GT's mobile mapping software, along with mobile mapping in general. Mobile mapping truly redefined how we perform a safety study, such as pavement marking inventory. To learn more, please visit our website at www.onlinemastermind.com.

ABOUT THE AUTHOR

Nicholas Hickman is the President and co-founder of MasterMind, LLC. Nick designed and built the MasterMind mobile mapping system. He also led coordination with companies from around the world to develop software which prepares the data for delivery through multiple post-processing stages.

Nick grew up working on safety study projects and attending tradeshows with his mother and father. He has been working with government agencies for over 18 years. The founding of MasterMind, LLC continues a 4th generation of family businesses and Nick looks forward to continuing that tradition with his family.

ABOUT MASTERMIND, LLC

MasterMind, LLC is a traffic safety software & services company encompassing: 360° Mobile Mapping with LiDAR," No-Passing Zone, Pavement Marking Inventory, Horizontal Curve "Ball Bank, Sign Inventory, Sign Compliance, Guardrail Inventory, Right-of-Way/Roadside Hazard Inventory, Speed Zone and Traffic Count Studies.

MasterMind was founded in 2013 by Nick & Amber Hickman. MasterMind's central office is located in Delaware, Ohio. MasterMind dove into the world of mobile mapping from its founding and created its own field based mobile mapping system.

MasterMind has performed mobile mapping and traffic safety studies on over 25 thousand miles of roadway. MasterMind also has hundreds of software clients all around the United States ranging from the great state of Ohio to Florida, New York and California. www.onlinemastermind.com
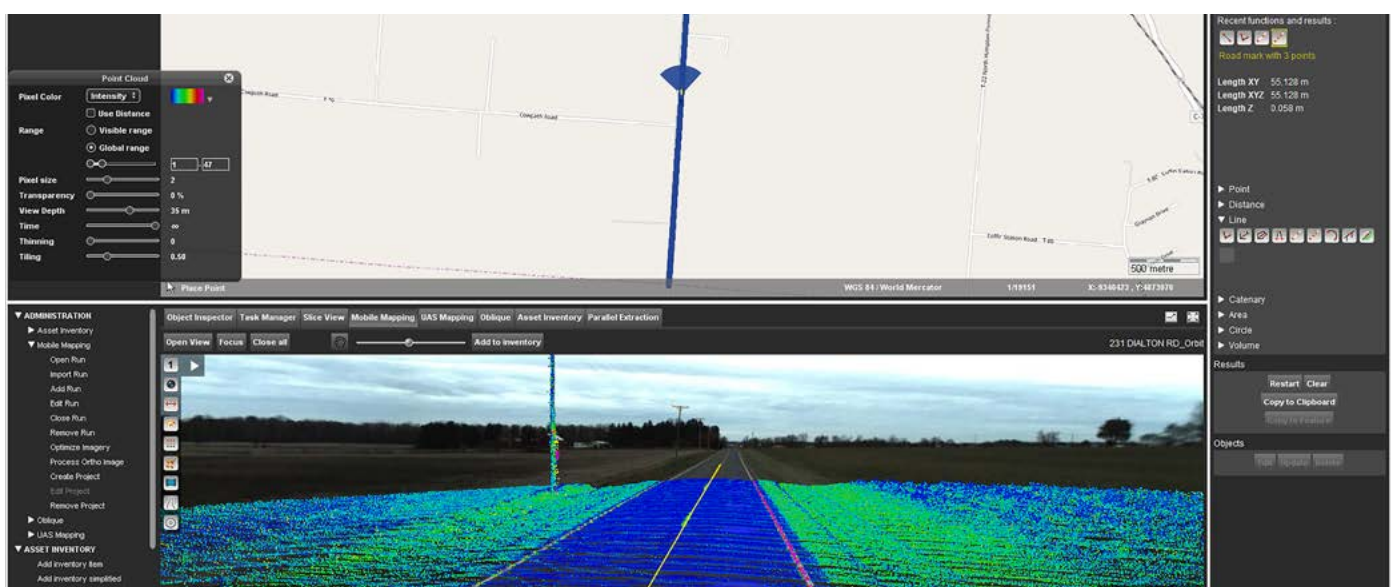
3DM Feature Extraction Pro software with the road marking 3-point semi-automated feature being utilized to extract the centerline pavement marking.