MAPPS 2016 Geospatial Products and Services Excellence Awards
Awards Entry Form

Please include a copy of this document with the project/product submission

Entry Information

Submission Number: 10315390

Name of Firm: Merrick & Company

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About the Project

Project Name: New Heights To Railroad Safety - NE Illinois PTC System Integrator Project

Category: A. Airborne and Satellite Data Acquisition

Geographic Location of Project: Chicago, IL

Scheduled Date of Completion: 16-May-16

Actual Date of Completion: 16-May-16

Affirmed: I agree that this project follows the completion date criteria

Budgeted Fee: $539,990

Actual Fee: $539,990

Yes: I accept the competition rules.

Yes: I have obtained permission from the client to publicize project's details with respect to its complexity, innovative application of technology or techniques, and value to the geospatial profession and the public.

Yes: I understand that the awards will be announced at the Excellence Awards Reception at the MAPPS Winter Conference in Palm Harbor, Florida. I understand that a representative from my firm should make every effort to attend.

PROJECT DESCRIPTION

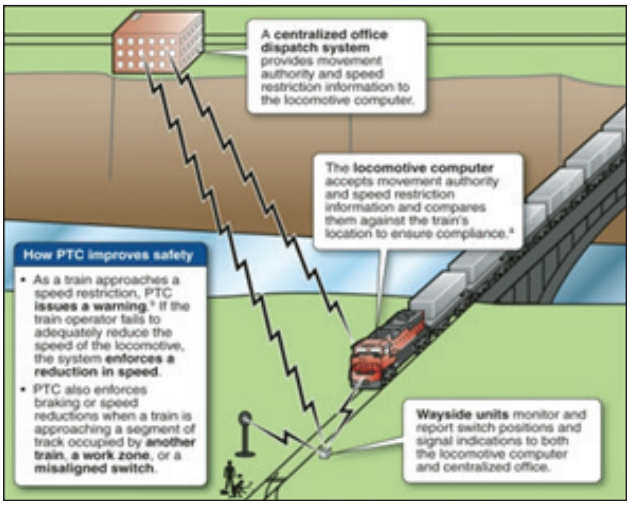
NEW HEIGHTS IN RAILROAD SAFETY (Northeast Illinois Positive Train Control Project)

INTRODUCTION

Railroad safety has always been very important to the National Transportation Safety Board (NTSB), however, due to a variety of human and track reasons, railroad disasters periodically occur causing the tragic loss of lives, injuring passages, and triggering major disruptions to the rail transportation system. Concrete action was taken in 2008 following one of the worse disasters in railroad history when a Metrolink passenger train collided with a Union Pacific freight train in California. The accident resulted in the death of 25 passengers and injuries to more than 135 others on the trains.

This accident prompted the Senate Commerce Committee, and the House Transportation and Infrastructure Committee to use the legislative process to create a bill further addressing railroad safety. As such, the United States Congress made this a national priority, and President George W. Bush signed the Rail Safety Improvement Act into law on October 16, 2008. The law requires the implementation of Positive Train Control (PTC) across most of the major rail lines throughout America. PTC technology is capable of automatically controlling train speeds and movements should a train operator fail to take appropriate action for the conditions at hand. PTC systems required to comply with the new requirements must reliably and functionally prevent: 1) Train-to-train collisions; 2) Overspeed derailments; 3) Incursion into an established work zone; 4) Movement through a main line switch in the improper position; and, 5) Other functions applicable within the requirements as specific conditions warrant.

To date, many of the major operators including Metra of Chicago are actively engaged in a variety of engineering and geospatial activities to make PTC procedures possible to facilitate a wide array of interoperable instrumentation technologies. Metra is responsible for installing PTC on all trains and along the five lines it controls – Metra Electric, Milwaukee North, Milwaukee West, Rock Island and SouthWest Service. Metra states that once PTC is installed and implemented, the Metra system will be in full compliance with the federal mandate and feature the latest, state-of-the-art technology to ensure the safety of our passengers.



The final end client/user of Merrick's data is Metra who oversees all commuter rail operations in the 3,700-square-mile Northeastern Illinois region, with responsibility for day-to-day operations, fare and service levels, capital improvements and planning. Metra is committed to the PTC strategy and plans to invest almost $400 million in its full implementation of a system that integrates GPS, wayside sensors and communications units with Metra's centralized office dispatching system. Together, all of these components, track and trains will convey operating instructions and monitor the crew's compliance. Once fully implemented PTC will have the capability to automatically stop a train if the system detects that a safety violation or equipment failure is about to occur. Complements of Metra, the previous graphic

provides an illustration of the PTC concepts. As one can imagine, precise elevation and railroad asset data are critical for providing the spatial reference for this sophisticated system. This is where the Parsons team and Merrick comes in.

ROLE OF ENTRANT'S FIRM

Merrick & Company (Merrick) was on a team led by Parsons who held a contract with Metra in Chicago. As the primary mapping consultant, Merrick was responsible for the overall technical implementation, aviation coordination, LiDAR and camera sensor integration, surveying, LiDAR acquisition, point cloud post-processing, data fusion, and client geospatial training.

ROLE OF OTHER CONSULTANTS

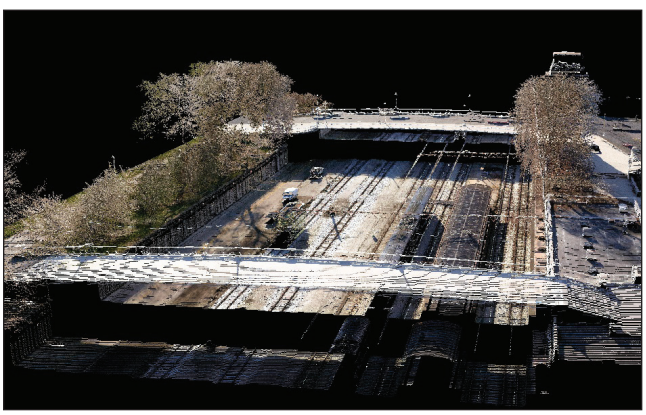
Xorail held a contract with Parsons to provide a variety of PTC related services to Metra. Xorail was Merrick's client which has been focused on the many challenges of PTC implementation and has developed and implemented a strategic plan and team to work with railroads to effectively deliver all of the federally mandated PTC requirements as well as the railroad needs. Xorail is one of the nation's leading railway signal design and construction companies.

In order to collect a higher density of LiDAR data in the railroad right-of-way (ROW) and in areas not visable from the air such as tunnels and under bridges, Merrick hired Maser Consulting, PA (Maser) to provide track-mounted LiDAR. Maser Consulting is a nationwide, privately owned, multi-discipline engineering firm with a unique balance of public and private sector experience.

ENTRANT'S CONTRIBUTION TO THE PROJECT

Original or Innovative Technologies and Techniques

In order to meet the requirements of the congressionally mandated PTC, Merrick created a customized data solution that combined LiDAR collected from both a helicopter and track-mounted truck (Hi-Rail). LiDAR is an advanced geomatics technology that uses rapid pulses of light originating from a sophisticated sensor to precisely measure objects that the beam touches. LiDAR works by emitting beams of light from a sensor at more than 500,000 light pulses per second allowing a dense sampling of X, Y, Z points (called a point cloud) to define everything the light pulse comes in contact with (e.g., buildings, transmission towers, railroad tracks, trees, etc.). After post processing and thematic classification of this point cloud using a specialized remote sensing software called Merrick Advanced Remote Sensing (MARS®), a highly detailed 3D representation of the rail ROW was created. The unique and innovative method to combine the airborne (helicopter) and hi-rail tack-mounted (on a truck) LiDAR allows continuous elevation and feature data to be collected throughout the ROW without any gaps or interruptions. The track-mounted LiDAR sensor is even able to take measurements in tunnels and in areas that may be obscured from the air.



These two LiDAR data sets are integrated because they use the same GPS positions established by Merick. There were 380 miles of LiDAR created from the airborne platform and 12 miles of LiDAR using the track mounted.

Other sensors included on the airborne platform include a set of oblique cameras which were oriented fore and aft, as well as, a nadir color

digital camera. These additional sensors allow the photogrammetrist and engineer to accurately map, display and analyze infrastructure and elevations within the railroad ROW. Mounting all of these sensor on one helicopter allowed many types of data to be collected during a single flying mission, thus saving the client money and time. The image on the previous page illustrates the LiDAR point cloud fused with the color photography.

Track assets and railroad infrastructure within the ROW were mapped using a derived product called a digital ortho. A digital ortho utilizes the aerial photography and LiDAR elevations to produce a color photograph that has camera lens distortion and terrain relief displace removed. The ortho product has a 0.7 inch (2cm) pixel resolution ortho image that allows more accurate asset mapping and feature identification to occur.

Another extremely important part of this project was to complete the airborne and track-mounted data collection without interrupting the normal time-table and maintenance schedules of this highly active railroad system. The Merrick team is very familiar with operating in restricted and busy transportation corridors, however, in order to operate safely and efficiently, additional training and field operations were created specifically for this project. For example, Merrick stopped airborne collection when a train was passing under the helicopter so that LiDAR and photography would not be obscured by the train. Another example included extra communication with track management personnel when the track-mounted LiDAR was operational and going through tunnels.

Future Value to the Geospatial Profession and Public

Enactment of the Surface Transportation Extension Act (H.R.38.19) now requires PTC studies and implementation to be completed for all Class 1 railroad main lines. These are lines with over 5 million gross tons annually over which any poisonous, toxic or hazardous materials are transported; and, on lines over which regularly scheduled passenger intercity or commuter operations are conducted. It is currently estimated this equates to approximately 70,000 miles of railroad track nation-wide that meets this criteria. Therefore, it was paramount that Merrick's project be successful because there are many miles of track needing to be modeled. An unsuccessful project could ruin this use of LiDAR and geospatial technologies for future PTC projects and clients.

As mentioned, the two different LiDAR sensors created a very dense set of elevations call a point cloud. In this project, there were approximatley 25 discrete elevations mapped per square meter. This higher density of LiDAR points allowed assets and infrastructure features to be mapped with more accuracy. The 15cm horizontal and 3cm vertical accuracy of the assets and elevations now offer track grade, slope, and curve calculations to be more precise allowing better train speed control, constraints and restrictions analysis to be conducted by Parsons, Xorail, and Metra.

Merrick's approach created geospatial data that exceeded the positional accuracy of a normal PTC system. Discussions with the client on this topic uncovered that the increased elevation accuracy will only improve the performance of the system by more readily identifying problematic and high risk areas. Because many train accidents occur from operator's not understanding curve or slope information and exceeding safe operating speeds; more accurate and complete elevation data resulting from the combined airborne and track-mounted LiDAR allow models to be created that produce safer train speeds for each problem area.

Social, Economic, and Sustainable

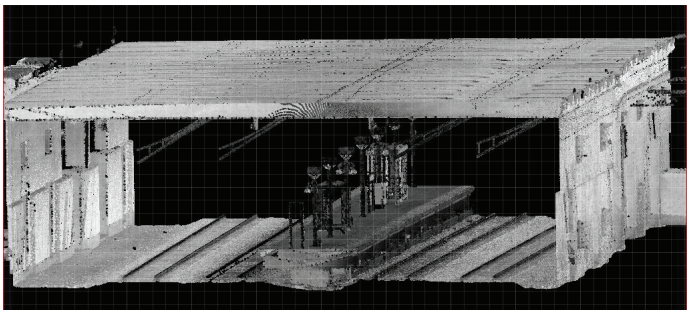
As a result of a tremendous amount of planning, engineering and capital investment, Metra is getting close to full compliance with congressional PTC safety and operational mandates. By the end of 2018, to meet their implementation schedule benchmarks, Metra will have: 1) Installed all PTC equipment,

2) Acquired all necessary radio spectrum, 3) Trained all necessary personnel, and 4) Initiated revenue service PTC demonstration on one line. All of these benchmarks will be facilitated by the robust LiDAR, imagery and asset databases created by Merrick for Parsons and Xorail.

The integration of precise geospatial data enhances track intelligence to avoid collisions and derailments which saves people's lives. This is yet another example of how spatial data when used correctly has a positive and long-term value to society. This is evident by many examples with the PTC project including integrated asset inventory of signals, switches, platforms, crossings and obstructions to allow features within the right-of-way to be included in order to improve work-zone and track safety.

Complexity

Extensive coordination with two busy Chicago airports had to occur to keep the airborne data acquisition on schedule. This was necessary because the project was located near the high traffic airspace of both Chicago's O'Hare International and Midway airports. In fact, when you combine the number of take-offs and landings of both airports, this airspace is close to the busiest in the world.



For this project, high resolution Light Detection and Ranging (LiDAR), color aerial imagery, oblique imagery, high-definition video data was collected using a helicopter platform. Additionally, a common surveying network was created using precise geodetic Global Positioning Systems (GPS) to reference all of the data. Finally, a track-mounted LiDAR technology was used to map tunnels and bridges not visible from the air (see adjacent example). In order for the client to obtain maximum benefit from this project all of the data had to be processed and converted into various formats that were usable be different engineering and modeling software.

Collecting ground survey, airborne and track-mounted mobile LiDAR without disrupting train time-tables and operations was another aspect of the project workflow that required excellent communication and coordinating with Parsons, Xorail and Metra to mitigate this complexity.

Successful Fulfillment of Client/Owner Needs

At the conclusion for this project Merrick completed the project within the pre-defined budget and time-frame. Moreover, Metra now also has Xorail and also has feature-rich elevation and rail asset data that can be used for more than PTC. To leverage this data and obtain a better rate of return on the project this data can be distributed to other internal and external users.

Merrick's technical experts assisted Xorail engineers to better understand every project aspect. This included Merrick providing detailed explanations, reports, and training sessions in order for Xorail to increase their knowledge of the complicated technical processes required to provide superior data and cost effective solutions that exceeds the requirements of PTC.

During the project close-out meeting, the Xorail client stated, "Merrick is the provider of choice for future PTC projects". This statement clearly demonstrates that Merrick exceeded the client's expectations and exhibited extremely and high level of satisfaction.

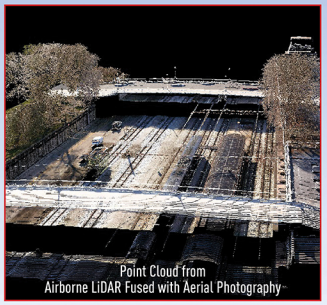
NEW HEIGHTS IN RAILROAD SAFETY

Northeast Illinois Positive Train Control System Integrator Project (Chicago, Illinois)

Client & Location: ***Xorail/Parsons (Chicago, Illinois)*** | **Entering Firm:** ***Merrick & Company (Greenwood Village, Colorado)*** | ***Category B: Photogrammetry/Elevation Data Generation***

Point Cloud of Tunnel from Hi-Rail LiDAR

Screenshot from HD Video taken from Merrick Helicopter



Point Cloud from Airborne LiDAR Fused with Aerial Photography

Train Disasters like this can be Eliminated with PTC

ORIGINAL & INNOVATIVE

- Combined LiDAR from a helicopter and hi-rail truck
- Survey controlled both LiDAR datasets
- Color oblique and nadir photography were also integrated
- Track assets within the ROW were mapped using 2cm pixel resolution orthoimagery
- Customized field operations created safer and efficient procedures

FUTURE VALUE, PROFESSIONAL & PUBLIC

- Surface Transportation Extension Act requires Positive Train Control (PTC) for Class 1 railroads
- LiDAR grade and curve calculations allow better speed control, constraints and restriction compliance
- Exceeding typical PTC survey accuracies added value
- Data identifies high-risk and problematic areas

SOCIAL, ECONOMIC & SUSTAINABLE

- Client now complies with congressional PTC safety and operational mandates
- Geospatial track and ROW knowledge helps to avoid future collisions and derailments which could save people's lives
- Integrated inventory of track assets including signals, switches, platforms, crossings and obstructions improves rail work-zone safety
- Other efficiencies and continuity are now possible because of geospatial track and asset intelligence

COMPLEXITY

- Extensive coordination with busy Chicago airports kept airborne data acquisition on schedule
- Data fusion of color photography, airborne and mobile LiDAR into specific PTC formats
- Collecting survey, airborne and mobile LiDAR without disrupting train time-tables and operations

EXCEEDING CLIENT'S NEEDS

- Metra now maximizes the feature-rich data set for more than PTC requirements by distributing to other internal and external users
- Merrick's technical experts assisted client's engineers to understand every aspect of the project
- Client stated, "Merrick is the provider of choice for future PTC projects"

MAPPS Management Association for Private Photogrammetric Surveyors

PARSONS

Xorail A Wabtec Company

MERRICK & COMPANY