Mobile Mapping Solutions for Ohio’s Integrated Transportation Network

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About Woolpert

- Established in 1911
- Over 600 Professionals
- 25 Offices
- $12,000,000 invested in new technology in last 5 years
Transportation Practice

GEOSPATIAL
- Aerial Mapping
- Mobile Mapping
- Laser Scanning
- Survey

PLANNING
- Access Studies
- Corridor & Alignment Studies
- Feasibility Studies
- Safety Studies
- Traffic Data Collection
- Traffic Impact Studies

DESIGN
- Roadways
- Bridges
- Utility Relocation
- Right-of-Way Plans
- Drainage/Stormwater
- Traffic Signal
Mobile Mapping System (MMS)

MMS Specification
- Freightliner Cargo Van
- Optech Lynx M1
  - (2) LiDAR Sensors
    - Range - 200 meters
    - 500,000 points per sec each
  - (4) 5MP Cameras
    - 90° FOV = 360° coverage
Optional Collection Vehicles

Hi-Rail

Boat/Watercraft

UTV/ATV
Ohio Integrated Transportation MMS Projects

- DOT (design grade)
- Asset Management (mapping grade)
- Pavement Analysis
- Utility transmission lines and vegetation encroachment
- Design-build
- FAA airport design, layout plans, distress analysis
- Shoreline assessments, urban flood mapping
- Disaster response, forensic mapping
- Condition assessments
- Rail
- Bridge
- Haul routes
- Dams & Levees
Typical MMS Deliverables

- **Point Cloud/LiDAR**
  - Raw
  - Processed to control
  - Classified

- **Georeferenced Imagery**
  - Oblique images
  - Ortho-rectified images
  - GEKO – Google Earth KMZ w/ Obliques

- **Feature Extraction**
  - Plan (2D)
  - 3D breaklines
  - Surface model - TIN/Contours
  - Cross sections

- **Horizontal & vertical clearances**
- **Pavement & surface distresses**

- **Asset Inventories**
  - Signs
  - Light poles
  - Power poles
  - Paint striping
  - Utilities

- **Condition assessments**
  - Curb
  - Pavement
  - Sidewalk
Asset Management

- Pavement Management
  - Material
  - Distresses
  - Rutting
  - Potholes
  - Paint markings
- Curb & Gutter
- Hydrants
- Manholes
- Parking meters
- Signs
- Trees
- Traffic signals
- Utility poles/lines
- Buildings
- Real Estate Info. (apraisals)
- Sidewalks
- ADA Ramps
- Guardrails
Pavement Analysis
Utility Line and Vertical Obstruction

Bridge Vertical Clearance

Utility Vertical Clearance

Other Obstructions
Airports
Railroad
DOT Design Grade
Project 5-mile Corridor

- Existing Road Design - Reduce curves, Widen road
- Safety – Keep personnel off roadway
- Provide a **comprehensive cost effective solution**
- Obtain 3D horizontal and vertical information for infrastructure to be used as needed during design process
- Accurate road surface data – 0.20’ horizontal 0.05’ vertical
- Accurate (60’) infrastructure data – 0.20’ horizontal 0.20’ vertical
- Accurate data for remainder of the project – 1.0’ horizontal, 0.5’ vertical
- 1” = 40’ scale planimetric and topographic mapping with 1’ contours - 0.5’ contours on roadway
- Orthoimagery at 0.25’ pixel resolution
- 3D Point Cloud (60’) corridor
- Mobile mapping Imagery
Approach: Data Fusion

- Develop an approach considering the unique complexity of the project site - blind curves, little or no shoulder, high walls and drop offs, heavy industry, manufacturing facility, sub-station, heavy traffic (semi-trucks), school bus route, bridges, overhead structures, power lines, etc.
- Obtain new 2015 1” = 350’ scale aerial imagery of the entire site
- Obtain new 2015 Mobile mapping data for the 60' roadway corridor 0.20’ horizontal 0.05’ vertical
- Use existing 2014 Statewide 1.5-meter LiDAR adjusted to the project control to be used for DTM
Project Layout
Mapping Corridor
Planimetric and Topographic Mapping Using Statewide LiDAR
Mobile LiDAR
Mobile LiDAR
Mobile LiDAR
Mobile LiDAR
Mobile LiDAR
Mobile LiDAR Imagery
Mobile Oblique Imagery & LiDAR
Data Viewed in Quick Terrain Reader (Free)
BRIDGE MODEL
Mobile Mapping System Data During Design

• Highly accurate road surface – Cross-section and profile anywhere as needed
• 3D point Cloud that can be used in Microstation, AutoCAD, etc.
• Detailed oblique view imagery
• Using the point cloud and/or the imagery provides another tool
• Ex: Bridge clearance, horizontal and vertical obstructions can be measured as needed
Comprehensive Cost Effective Solution

**Mobile Mapping System for 60' Corridor**
- 2 Day targeting and Acquisition
- One collection, multiple uses
- Cross sections and profiles anywhere
- Includes feature extraction of edge of pave
- 3-D point cloud provides infrastructure data
- Fee = $9,000 per line mile

**Existing Aerial LiDAR and New Digital Terrain Model**
- Adjusted Existing 1.5 meter LiDAR from Statewide Program, DTM, Contours, Contour Labels spot Elevations
- Fee = $38,000.00

**Traditional Survey for roadway surface data**
- Two weeks with daily lane closures and safety risk
- Cross sections located at 50' intervals
- Fee = $10,000.00 per line mile

**New Aerial LiDAR and DTM**
- 1.5 meter LiDAR from Statewide Program, DTM, Contours, Contour Labels spot Elevations
- Fee = $68,000.00
What Clients are saying about MMS

• Kentucky Transportation Cabinet
• PennDOT
• MaineDOT
• VDOT
“Woolpert as a Sub-Consultant and brings their expertise in all phases of Mobile LiDAR to the table. They were given three large Mobile LiDAR jobs (their first for PennDOT) in the Fall of 2014. Their efforts on three consecutive Mobile LiDAR projects were superb. All three projects were completed in a timely manner and with exceptional accuracy. PSS was stunned with the quality of the end product which easily exceeded the Department’s expectations.”

David Casciotti,
Photogrammetry Liaison Supervisor, Pennsylvania Department of Transportation
Mobile Mapping for Use in Design
Control of Acquired Data in Design

• Ever wished your surveyor had not skipped over something or taken another shot to help define a driveway or curb ramp?
• How often do you wonder if they really shot the exact point you intended them to?
• Ever wish you had just turned around and taken another picture looking the other direction?
• How long after your survey was completed do you ask these questions?
Control of Acquired Data in Design

- For some firms the field survey is performed by a sub-consultant.
- For others they have these services in house.
- When you as the engineer of record seal the drawings, often times you are taking on the liability of the accuracy of the survey with little ability to validate the survey and the basis of your design.
Control of Acquired Data in Design

- LiDAR produced basemaps and tins give the designer the ability to validate the information they are designing from.
- It allows for the extraction of additional information without a return visit to the field.
- Provides more complete representation of the existing conditions.
Limitations

• Understand the technology and it’s strengths and weakness.
• Know your desired accuracy. This has a big impact on the amount of control needed.
  – Woolpert is systematic with it’s targeting. Every site is different.
  – Woolpert R&D efforts are reducing the number of targets needed.
  – Targets don’t always need to be set at a stand interval.
• LiDAR is based on line of sight. What you see is what you get.
Limitations

• Impediments
  – Heavy vegetation and tall grass
  – Wet pavement
  – Standing water on the pavement or in ditches
  – Stationary obstacles

• Mitigation for Impediments
  – Mowing or supplement with traditional survey
  – Waiting for favorable weather
  – Supplement with Static LiDAR
Limitations

- Impediments
  - Vegetation. The LiDAR will penetrate it but some areas will require additional processing or qa/qc. Where accuracy cannot be reduced, traditional field survey can be used.
Gurneyville Road

- Clinton County Engineer’s Office
- Safety improvement project correcting site distance issues
Petersburg Road and Overman Road

- Highland County Engineer’s Office
- Safety improvement project correcting distance issues
Project Control

Petersburg and Overman Road
• Woolpert set eight control targets

Gurnveyville Road
• Clinton County set thirteen control targets
Accuracy

Petersburg and Overman

• Field checked using traditional survey

• Collected data at 50’ interval along the centerline of the road

• Average difference was 0.033 feet (about 3/8 of an inch)

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Data Fusion – ODOT D11 GUE-513-8.65

Bridge Replacement

• Project will widen the existing structure and increase the vertical clearance on the interstate while salvaging the existing substructure.
• ODOT provided aerial mapping including planimetrics and tin.
• Woolpert performed traditional survey on existing utility features and a static LiDAR scan of the bridge.
• Data was merged to create the basemaps used in design.
Bridge Scan

• Bridge Deck Thickness
  – We knew the original bridge deck had been overlaid, but records were unclear as to the exact thickness of the overlay.
  – Used Static LiDAR under the bridge to collect the bottom of the concrete deck.
  – Compared the bridge deck surface tin to the under bridge LiDAR data to accurately determine the existing deck and overlay thickness.
Bridge Scan
• Accurate Location of Beams
  – The existing bridge has a dog-legged framing plan on a curved alignment. Redrafting of this beam arrangement by hand would have been difficult and time consuming. Survey crews would have been exposed to interstate traffic as they attempted to survey the locations of the existing beams.
  – The use of the LiDAR provided a more complete as built representation of the existing structure.
  – Able to measure existing deflection and camber along the existing beams at any location.
Data Fusion – ODOT D11 GUE-513-8.65

Bridge Scan

• Accurate Location of Beams
Bridge Scan

• Accurate Deck Overhang
  – LiDAR provided an accurate representation of the existing deck overhangs, which varies due to the curved deck and dog-legged beams.
  – The use of the LiDAR provided a more complete as built representation of the existing structure.
Data Fusion – ODOT  
D11 GUE-513-8.65

Bridge Scan

• Accurate Deck Overhang
Data Fusion – ODOT
D11 GUE-513-8.65

Bridge Scan

• Accurate Deck Overhang
Data Fusion – ODOT D11 GUE-513-8.65
Bridge Scan
• Accurate Deck Overhang
Data Fusion – ODOT D11 GUE-513-8.65

Bridge Scan

• Accurate Representation of the Piers
  – The ends of the existing piers are rounded.
  – The project will scab onto the piers and extend them.
  – The LiDAR data provides the designer with a more complete representation of the pier and a way to validate the data used in design. Traditionally the designer would be at the mercy of the field crew’s interpretation of the designers request and how it relates to the structure they are surveying in the field.
Data Fusion – ODOT D11 GUE-513-8.65

Basemap

• Scanned data was merged into the ODOT provided data to create the project basemaps.
Data Fusion – ODOTD11 GUE-513-8.65

Combined Data Isometric View
Data Fusion – ODOT D11 GUE-513-8.65

Combined Data with Stationary Lidar Point Cloud Overlaid
Data Fusion – ODOT D11 GUE-513-8.65
Data Fusion – ODOT D7 MOT-70-3.34

Bridge Rehabilitation

• Widen existing bridge from 2-lanes to 3-lanes and increase vertical clearance on Interstate 70.

• Mobile Mapping LiDAR is being used to collect the existing pavement keeping our surveyors out of the traveled way and reducing impacts to traffic flow.

• Static LiDAR is being used on the underside of the bridge to supplement the Mobile LiDAR.
Data Fusion – ODOT D7 MOT-70-3.34

Bridge Rehabilitation

• Traditional survey is being used to pick up areas beyond the pavement, utilities, and project control.

• Statewide LiDAR and aerial mapping will be used to provide a background and help in determining drainage areas and watersheds.
Data Fusion – ODOT D7 MOT-70-3.34
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MMS Applications and Reuse of the Data
City of Indianapolis

- 400 sq. mi. area
- 3400 centerline miles
- Collected
  - LiDAR
  - Imagery
- Performed sign inventory
Woolpert’s Smart Feature Extraction Tool

Imagery (Visual Information)
- Sign Color
- Sign Text
- Sign Type
- Condition

LiDAR (Spatial Information)
- Positional Coordinates (+/- .5’)
- Size
- Height
- Orientation
Woolpert’s Smart Feature Extraction Tool
Woolpert’s Smart Feature Extraction Tool
City of Indianapolis

• More information on this project can be found in the July 2015 publication of xyHt magazine. Look for the article on “Signs of Change”. www.xyht.com
Reuse of Sign Inventory Data – Bean Creek
Bean Creek, City of Indianapolis

• Previous study identified areas for improvement. Five of those areas were selected and advanced into design.

• The purpose of the project was to install drainage improvements to help eliminate/mitigate flooding in the neighborhood.
Bean Creek, City of Indianapolis

• The project identified sections of pavement for full replacement or rehabilitation.
• Installed infiltration trenches and utilized perforated pipes to better convey, filter, and store storm water.
Bean Creek, City of Indianapolis

• Survey efforts included:
  – Additional control point set to tighten up the accuracy of the previously acquired mobile mapping.
  – Survey existing utilities not marked in the field when the Sign Inventory was performed.
  – Hard shots on buried pipe invert and inside existing structures.

• Survey data and Mobile Mapping data was fused with existing City GIS data to create the project basemaps for design.
Bean Creek, City of Indianapolis

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Bean Creek, City of Indianapolis

• Cost
  – Each project area required only a few days of field work and office processing. Roughly $5k per area.
  – Reprocessing of the LiDAR collected as part of the Sign Inventory cost Roughly $35k
Bean Creek, City of Indianapolis
Bean Creek, City of Indianapolis

• Design Benefits
  – Design team was able to move around inside the point cloud to validate the existing conditions.
  – Provided a great benefit to the designer when determining limits for pavement replacement vs. overlay.
  – Provided a more complete representation of the existing conditions. Existing streets and front yards were very flat and often low points were not easily discernable in the field. Field crews may have passed over them, especially if collecting data at 25’ or 50’ cross section intervals.
Bean Creek, City of Indianapolis

- Construction Results
  - Project was constructed in 2015.
  - Engineer’s estimate was $2.4 M. Bids came in $200k under engineer’s estimate. Actual construction costs came in $80k under contractor’s bid due to unused contingency items.
  - No major construction issues.
Questions/Comments

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