

An Innovative Approach for Bridge Clearance Inspection

TxDOT 2020 Bridge Clearance Program Statewide

TEAM 2025

3/12/25



Bridge Inspection

- Bridge inspection is a continuous process on a two-year cycle in the interest of public safety and protection of the public investment.
- The inspection process yields a bridge's condition, expressed as a classification and a rating.
- A bridge is classified as **Functionally Obsolete** if it is unable to serve current traffic because of several reasons including **inadequate vertical or horizontal clearances**.
- SAM delivered a bridge clearance program for TxDOT that required inspection of clearance values for 4,448 bridges throughout the state of Texas.

Clearance Measurements Diagram



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Commitment to Safety



Commitment to Safety

- Safely complete the following task: inspection of clearance values for 4,448 bridges throughout the state of Texas.
- Review of all project information provides us with the ٠ opportunity to make adjustments in the collection and processing of the datasets to meet the specific needs of the client.
- Every project plan, discussion, process, field activity or project task is first addressed with evaluating risks and safety concerns.
- Remote sensing technologies significantly reduce worker ٠ exposure, which creates a safer environment to the general public.





SAM's Innovative Approach

- **Mobile mapping** Data can be collected remotely, day or night, removing the need for traffic diversion caused by traditional surveying activities.
- Enhanced Accuracy The system provides designers with a more complete picture of the project with highly accurate point density measurements and the ability to locate features that are inaccessible with current technology.
- Cost & Time Savings Mobile LiDAR can gather all required point measurements in one setting, eliminating the need for additional mobilization costs. With data collection speeds up to 1,000,000 points per second, this can mean significant savings for design firms or government agencies managing tight project budgets.



Advancements in technology and data processing are crucial in order to reduce risk, labor costs, and time.



Field Data Acquisition

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SAM's Dual Sensor Mobile Mapping System



Fully supports 3D Visualization and Measurement of Bridges

State-of-the-art dual sensor engineering grade system.

Integrates ultrahigh resolution cameras and LiDAR sensors, as well as GNSS, IMU, and DMI units.

- Facilitates acquisition of precise point cloud and high-quality imagery, as well as merging data from different methodologies into a seamless deliverable.
- Allows for safe collection speeds that do not impede the flow of traffic and in conformance with posted traffic laws.

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Dual Scanner System



SAM's Riegl VMX-2HA mobile mapper is the most customizable design grade system available today.

Key Features

- High precision (less than 0.01') range accuracies, 1 million+ point per second acquisition rate LiDAR sensors.
- Metric cameras for precise imagery alignment with the LiDAR data.
- 360-degree cameras array for full bubble imagery acquisition.
- High accuracy Applanix positioning systems with GNSS, IMU, and DMI units for **design** accuracy survey.
- Constant sensor alignment check via comparison of the separate LiDAR channels on common surfaces during acquisition.

Drive Plan

- SAM used an advanced routing software to take all the project roadways and determine the most efficient routes to collect all the necessary drive lanes and critical features.
- Reduced Travel Time (collect 4,448 bridge decks).
- Lane Nodes were created for Drive Planning which included bridge basic attribution before measurements.





Strategic Collection of Bridges

- Drive Planning allows for strategic collection with optimized turn-by-turn direction to efficiently capture multiple features (bridges) in one acquisition session.
- Pre-planned focus areas are uniquely defined and tracked, making sure all the features are captured, reducing the need for re-driving routes.
- Bridge polygon creation Optimize data for Drive Planning (i.e., capture a long run of highway, then come back and do on/off ramps on the way back).



- Approximately 40 bridge decks/day.
- Approximately 125 bridge approaches/day.
- Day drives were preferred due to collection of imagery.



Real-Time Data Coverage and Quality

- Operators monitor in real-time positioning system metrics, decimated versions of the point clouds, and imagery to ensure a quality acquisition.
- Field data is uploaded to SAM's server immediately after collection using SAM's proprietary field-to-office software for instant coverage check.
- SAM's geospatial team performs a full coverage and quality check of all data acquired prior to marking a route complete, and before making the data available to the feature extraction team and the end customer.









Real-Time Project Tracking

- SAM built a secure dashboard on the ArcGIS Online platform that automatically populates the geodatabase asset inventory progress in real-time, on percent complete, over the course of the project.
- Clients are provided access to view realtime project progress.
- Daily drive miles were utilized to track project progress so that SAM's Project Manager and TxDOT stayed informed.





Data Management Approach

- A data management approach was implemented to allow efficient data segmentation of the 2 TB of data acquired daily.
- Pre-Extraction file setup:
 - LiDAR LAS files were cropped to smaller sections, such as 50 feet in front of and behind each bridge.
 - Entrance slopes were calculated, and bridge LAS files were attached to the database while limiting the LAS file size to only that bridge.
- 10 Districts (e.g., Houston District -120 TB of raw data, 1 TB for deliverables).





Data Extraction Methods

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Bridge Clearances

Full Clearance Analysis

- Minimum Vertical Clearance (Lanes)
- Minimum Vertical Clearance (Shoulders)
- Inventory Vertical Clearance
- Maximum allowable height of a 10' wide object
- Inventory Horizontal Clearance
- Minimum distance between immovable objects
- Routing Horizontal Clearance
- Minimum Clearance between movable barriers
- Lateral Horizontal Shoulder Clearances
- Approach and departure slope analysis
- Bridge Approach photo
- Proper signage confirmation



Project Geodatabase

To achieve data compatibility and assure a quality deliverable, the development of a project geodatabase from TxDOT's existing schema was critical to support consistent deliverable creation including:

- Road names
- Bridge
 - Name/ID
 - Location
 - Sign types
- Fields for the project's attributes
- Any other spatial data that exists that could be relevant to the project.

Bridge ID	142270B00425007		
Operational Status	Open I-str		
Facility Carried	S CONGRESS AVE		
Feature Crossed	LADY BIRD LAKE		
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Custom Software Tools and Workflows



- SAM developed customized routines with COT software to automate and optimize LiDAR extraction tools in a CADD environment.
- Each asset had a specific standardized extraction workflow and quality control measures to ensure consistent extraction.





Customized Macros

- Aid data extraction and classification.
- Extract data measurements from the CADD system to automatically populate the database.
- Populate the database with links to images or small LAS files.
- Create consistent GeoPDF's.





Specific Workflows

- Shapes and points are used to extract asset data in an automated process thus keeping the CADD, imagery and LAS files for each unique structure to allow individual analysis and data extraction into the database.
- SAM also has an extensive library of customized feature extraction tools to aid in extracting data, including integrated imagery and street views to allow for verification of features.







Data Delivery





Deliverables

- SAM acquired mobile LiDAR and imagery for all 4,448 bridges within 6 months and delivered 150,000+ unique features.
- Bi-Product Point clouds and bridge approach and departure imagery delivered in the latest ASPRS formats, and all data referenced to the Esri Roads and Highways Linear Referencing System.
- Bi-products can be used for other DOT purposes.
- Contractual documentation of conditions and measurements in a standard PDF output for inclusion in compliance reports.



Disclaimer: Data contained herein are representative of conditions existing at the time of the data acquisition. Site conditions may have changed since then which may make such data presently inaccurate.

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Data Delivery Options

Onsite Hosted Solution

- Secure Storage and Accessibility
- Indexed Data
- Accessible for Detailed Extraction in Design Software

Cloud Based Monitoring and Reporting Environment

- Secure
- Global View of the Dataset
- Accessible for Large Scale Data Review
- Interactive







Added Value

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Re-Utilizing Mobile Data

- Utilization of design-grade, dual-scan mobile mapping systems for acquisition and innovative data calibration techniques allow users to post control datasets to both survey control and high accuracy remote sensing datasets that may already exist.
- As projects develop, survey control can be established and the previously collected mobile data can be calibrated to it and now 3D modeling of bridges, jersey walls, curbs and mapping can be done for the roadway and all overhead structures with existing data.
- With minimum additional effort, if authorized by the Department, LiDAR point cloud can be collected for the entire highway while driving between bridges, with minimum increased data archiving and processing costs, that can be used in future design or as-built projects.



3D modeling of bridges

Re-utilizing mobile data results in cost savings on future engineering projects around the state.



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Conclusions



Conclusions

- Mobile mapping significantly reduces worker exposure, which creates a safer roadway to the driving public.
- Integration of highly flexible data collection platforms and revolutionary software allowed SAM to develop innovative solutions for TxDOT that included:
 - Efficient routing solutions
 - Custom software tools and extraction workflows
 - Real-time project tracking
 - Cloud based delivery of data
- The accuracy and detail of mobile LiDAR data allows end-users to filter and extract data in an almost infinite number of ways, which allows multiple agencies to use the dataset for multiple applications.



SAM's innovative & customized technical approach reduced risk, labor costs, and time for the inspection of TxDOT's bridges.

Thank You & Questions

