



Use of Laser Scanning Technology to Obtain As-Built Records of Historic Covered Bridges

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Problem Covered bridges are part of the fabric of American history, and several hundred historic covered bridges still exist today. Although much effort is expended to preserve these structures, the high cost of restoration, neglect, vandalism, and arson often take their toll, and many are lost forever. No engineered drawings exist for many such bridges, so rebuilding them in the event of damage or destruction would require a lot of guesswork.

Solution The City of Zumbrota contracted with the University of Minnesota Duluth's Natural Resources Research Institute (UMD NRRI) to complete three-dimensional scanning and data processing of the Zumbrota Covered Bridge, the only remaining historic covered bridge in Minnesota. Constructed in 1869 and relocated several times, the bridge now spans the Zumbro River in a city park. The UMD NRRI had previously partnered with the U.S. Forest Service to conduct similar scanning of historic covered bridges in Wisconsin and Iowa.

Procedure In July 2010, UMD NRRI contractor SightLine, LLC, completed approximately 35 laser scans of the bridge from a variety of angles using a three-dimensional laser scanner. Prior to scanning, paper targets were placed in numerous locations on the bridge for use in linking multiple scans together. All visible surfaces of the bridge were documented in the scans, which were then given to the UMD NRRI for data processing. The information was used to assemble a complete digital representation of the bridge and to generate a 1/100-scale three-dimensional replica.

Results The scan data, images, and figures were provided to the City of Zumbrota for its records. The as-built documentation produced by the project could be used, if needed, to repair or reconstruct the bridge in the future.

Approximate Cost \$10,000

OPERA Funding \$10,000

Implementation In September 2010, the Zumbro River flooded, with floodwaters rising to nearly the same elevation as the bottom of the Zumbrota Covered Bridge. This situation demonstrated the importance of collecting as-built documentation, as additional river cresting could have caused substantial damage to the bridge.

Status Complete

Alternate Uses for 3D Laser Scanning Technology

The laser scanning technology used to document the Zumbrota Covered Bridge has a wide variety of additional applications. The following summary of potential applications was provided by Faro Technologies, Inc., a laser scanner manufacturer.

Architecture and Civil Engineering Applications

- Excavation control: Simple and precise volume and dimension control of excavations.
- Deformations control: Documentation of deformation processes and monitoring of countermeasures.
- Facades inspection: 3D dimensional inspection of building shells and facade components before final assembly.
- Structural analysis and maintenance: Rapid and cost-effective control of the specified load-bearing capacity of supporting structures as well as wear and tear.
- Free-form components inspection: Precise dimensional check of complex components such as free-form shape elements.
- Built environment: Precise geometrical recording of existing properties as the basis for conversions or extensions.
- Construction progress monitoring: Seamless capture and monitoring of construction progress for legal and technical documentation.

Process Industry and Digital Factory Applications

- Conversions and extensions: Precise 3D documentation of the current state of the property as the planning basis for conversions and extensions.
- Offsite production: Possibility of precise-fit off-site assembly, thanks to exact 3D CAD data and dimensional control.
- Asset management: Simplification of facility management, maintenance, and training through comprehensive 3D master data, simulations, and training in virtual reality.
- Site supervision: Improved coordination between different trades and comprehensive documentation and supervision of all work.

Inspection and Reverse Engineering Applications

- Reverse engineering: Copies of products and components for which there are no construction plans and/or CAD data available.
- Interior fixtures and fittings: Precise 3D CAD documentation of complex interiors of ships, cars, or aircrafts as a basis for planning of conversions.
- Manufacturing documentation: Complete 3D documentation of the manufacturing status of complex machine components.
- Quality control: Precise 3D documentation and dimensional inspection of large and complex components such as rotor blades, turbines, ship propellers, etc.

Forensic and Accident Scene Applications

- Rapid and complete 3D recordings of crime and accident scenes or insurance damage: All details of relevance in any subsequent reconstruction of the crime or accident are covered.

Heritage Applications

- Complete and detailed documentation of historical structures or excavation sites: for restoration or scientific analysis purposes, for securing protected buildings, or for virtual presentations of historical sites that must not be accessed by visitors.

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