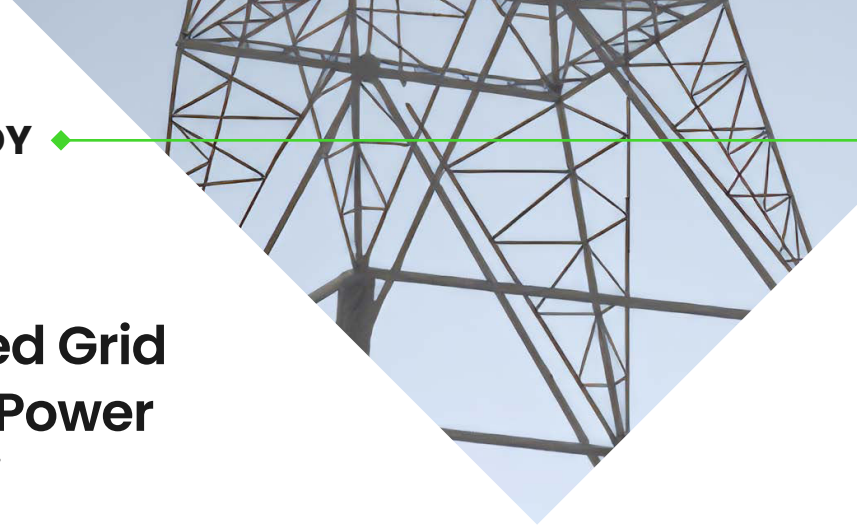
Bentley
Advancing Infrastructure

CASE STUDY



Exo Inc. Stabilizes Damaged Grid Tower Supporting Critical Power Source to Central Missouri

Using Digital Twins Saved Four to Six Weeks Remediating the Structure, Preventing Significant Power Loss During a Global Pandemic

AVOIDING A CATASTROPHIC POWER OUTAGE

Originally constructed with a wood frame and bundled conductor in 1959, the 161-kilovolt Clinton-Stillwell Line in Clinton, Missouri, was modified in 1977 to accommodate the Harry S. Truman Dam and Reservoir. The portion of the line spanning 1.8 miles across the Truman Reservoir floodplain was rebuilt as steel lattice towers ranging from 115 feet to 148 feet in height, constructed on drilled pier foundations ranging from 32 feet to 42 feet in depth. These measurements, however, did not keep the structures above flood-stage water levels, making them vulnerable to damage from floating debris in flood events.

While conducting a routine inspection during the pandemic, Midwestern energy utility Evergy observed that the lattice tower, known as tower 58—which supports the high-voltage Clinton-Stillwell transmission line—sustained damage from flood debris. At the time, a significant construction project was occurring on an adjacent major line serving the area, leaving tower 58 as the only source of power to the region and its crowded hospitals. To avoid tower failure and keep the power line in service, Evergy retained Exo to determine a stabilization solution. "This particular line was serving several area hospitals that were at capacity with COVID-19 patients during the pandemic and loss of power would have been catastrophic to the area," explained Michael Miller, vice president of engineering services at Exo, Inc.

SURVEY AND SITE CONSTRAINTS

"The high-voltage power line supported by this structure was the only available power line to provide electrical service to much of central Missouri during the most tumultuous times of the pandemic," said Miller. The serious ramifications of a potential widespread tower outage, coupled with the location of the asset in the difficult-to-access floodplain with elevated water levels, left Evergy and Exo with limited options to attempt to stabilize the tower. Compounding these challenges was the added constraint that the line remain constantly energized, prohibiting a conventional tower climb to perform an adequate survey.

To overcome these issues and ensure accurate data acquisition and survey results, Exo sought to utilize advanced data capture and processing technology to survey and model the structure and create a digital twin to determine a feasible stabilization plan. "Alternatives to using [a digital twin approach] would have required weeks of survey data after the flood waters receded, and the structure was on the verge of failing, causing a regional-wide power outage, which could have left the region without power for weeks," said Miller.

FACILITATING DATA ACQUISITION, MODELING, AND ANALYSIS

Exo determined that they would access the site by air boat and perform a drone survey, collecting high resolution images. "These images would then be used to create a true digital twin to determine the deflected shape of the structure and to structurally model the tower to assess its condition, and then design and install a stabilization solution so that the line could remain in service," explained Miller. To implement their comprehensive structural inspection and digital twin strategy, Exo leveraged iTwin Capture and Bentley's Power Line Systems (PLS) applications.

Using iTwin Capture, they processed the drone-captured images into a reality mesh of the existing conditions of the contorted tower and adjacent structures. "This was the first time in the industry

PROJECT SUMMARY

ORGANIZATION
Exo Inc.

SOLUTION
Transmission and Distribution

LOCATION
Clinton, Missouri, United States

PROJECT OBJECTIVES
- To stabilize a damaged 161-kilovolt overhead transmission tower.
- To establish a digital twin to avoid a catastrophic power outage.

PROJECT PLAYBOOK
iTwin® Capture, Power Line Systems™

FAST FACTS

- A routine inspection revealed that a critical 161-kilovolt overhead transmission tower had been damaged by flood debris.
- The tower supported the Clinton-Stillwell line, serving several COVID-crowded hospitals in central Missouri.
- Exo was retained to determine a stabilization solution to avoid a catastrophic power outage.

ROI

- With Bentley's iTwin and Power Line Systems applications, they created a digital twin and saved four to six weeks designing a stabilization solution.

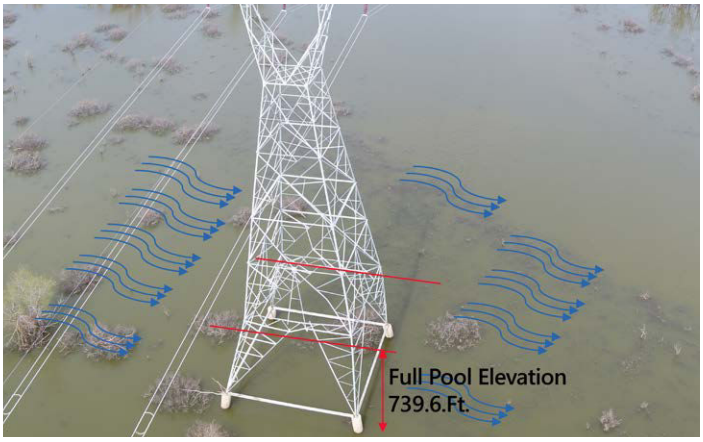
> "Use of the Bentley software and executing a flat boat launched drone-based photogrammetry survey over the flooded area saved at least four to six weeks of time, and possibly saved multiple lives by stabilizing the structure, avoiding a potentially long power outage."
>
> *– Michael Miller, Vice President of Engineering Services, Exo Inc.*

that the concept of photogrammetry with iTwin Capture was used to determine the deflected shape of a structure that has significant damage due to flooding or any other hazard," said Miller. Integrating PLS-TOWER and PLS-CADD, they created a 3D model and performed finite element analysis, applying varying loading conditions, including failure containment loading, to the model to evaluate the structural integrity of the tower. The applications allowed Exo to establish a digital twin and develop recommendations for temporary stabilization of the tower.

DIGITAL TWIN HELPS SAVE LIVES AND SETS INDUSTRY BENCHMARK

"The use of iTwin Capture, PLS-CADD®, and PLS-TOWER™ allowed stabilization engineering to take place," said Miller. Using a drone-based photogrammetry survey and Bentley applications to systematically model the power lines and latticed steel support structures, as well as establish a digital twin, saved at least four to six weeks designing a stabilization solution and completely avoided placing crews in a dangerous situation to obtain the survey information. Working in a digital twin environment enabled Exo to complete the design, detailing and the supply of the construction works within two months and stabilization installation in just three days.

Historically, steel poles and lattice towers were thought to be low-maintenance assets that would perform as designed for 50-plus years with little issue. However, with the world's electric transmission grid structures operating largely beyond their planned design lifetimes and the risk of economic resilience and life safety subject to environmental perils, digital twins of the physical grid are becoming invaluable. This project successfully demonstrates their viability, paving the way for the extended use of future industry digital twins. Based on the digital twin, Exo saved lives, stabilizing the tower and avoiding a potential extended power outage during the pandemic. "The loss of this line would have likely made the national news," concluded Miller.



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