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Advancing Infrastructure

Project Summary

Organization:
The Costain Group

Location:
London, England, United Kingdom

Project Objectives:
- Provide detailed design and construction for the redevelopment of London Bridge Station.
- Determine the most efficient, cost-effective method for surveying and documenting existing site conditions of the 180-year-old train station.
- Deliver accurate 3D data to accelerate and enhance decision making for optimal construction planning.

Products Used:
ContextCapture

Fast Facts

- The Thameslink project is a GBP 6.5 billion railway initiative that, upon completion in 2018, will transform UK rail travel, increasing passenger capacity and improving travel time.
- Costain was awarded the GBP 400 million contract for the redevelopment of the 180-year-old station, including construction of the country's largest concourse.

ROI

- Using ContextCapture allowed Costain to generate a 3D textured reality mesh in just a few hours, saving time and costs on this GBP 400 million project, while minimizing the impact of surveys on the rest of the site.
- The redevelopment of London Bridge Station will meet growing transportation needs by increasing passenger and rail capacity at the station by 40 percent.
- Upon completion in 2018, the reconstructed station will connect many regional destinations on either side of London for the first time.

Costain Explores Photogrammetry to Document Site Conditions for GBP 6.5 Billion Project

ContextCapture Delivers Efficient, Cost-effective Solution for Reconstruction of London Bridge Station

Railway Redevelopment Plans

As part of its vision to improve the safety, reliability, and efficiency of railway travel within the city of London and throughout the United Kingdom (UK), Network Rail undertook responsibility for the government-sponsored GBP 6.5 billion Thameslink project. The project was initiated in 2009 with an expected completion in January 2018, when new spacious trains will travel through central London at peak times every two-to-three minutes. The massive railway improvement scheme includes platform lengthening, station renovations, new railway infrastructure, and additional railway vehicles. It involves collaborative efforts among UK train companies, architects, engineering and design firms, and construction organizations, all managed by Network Rail.

At the heart of the Thameslink initiative is the redevelopment of London Bridge Station, the UK's largest and fourth busiest station handling over 56 million passengers each year. Plans for the London Bridge Station involve reconstructing its concourse to unify the station for the first time, allowing passengers access to all platforms in one place, as well establishing new retail stores and station facilities. Upon completion, the new street-level concourse will be the largest in the country, exceeding the size of the pitch at the iconic Wembley Stadium.

To manage the London Bridge Station refurbishment, Network Rail awarded The Costain Group (Costain), one of the UK's leading provider of engineering solutions, a GBP 400 million contract under which Costain is responsible for delivering detailed design and reconstruction plans. "Our focus is to design and deliver a world-class London Bridge Station that enhances the capital's infrastructure and improves the journeys of the hundreds of thousands of passengers who pass through the station every day," commented Andrew Wyllie, chief executive of Costain.

Challenges Reconstructing London Bridge Station

The sheer size of reconstructing London Bridge Station to include 15 new platforms presented numerous demands ranging

Horizontal cut of the rebars showing accurate comparison of photogrammetry to terrestrial laser scanning (TLS): blue circles represent photogrammetry, and red circles represent TLS; maximum deviation is ~6-10 millimeters.

from reconfiguring the station's tracks and installation of new signaling, to demolishing existing platforms and removing the existing roof, all while keeping the station operational. To minimize passenger impact it was decided that the project would be completed in nine phases. To implement its phased construction approach, Costain and the project team needed to obtain reliable data for the nearly 200-year-old site.

Originally constructed between 1836 and 1839, London Bridge Station housed a considerable amount of masonry arches that required surveying to determine the optimal approach for designing and constructing the new concourse. To obtain this information Costain needed cost-efficient survey techniques that could generate an accurate 3D representation of the aging structures to understand the subsurface for reconstruction potential and enable stakeholders to make informed decisions on a tight deadline.

Photogrammetry vs. Laser Scanning

For years laser scanners have been the preferred method of capturing digital data to survey and document site conditions with precise accuracy. Laser scanning provides the ability to capture a point cloud so dense that it's almost a 3D picture. Points in the scan are given 3D coordinates and this virtual geo-referenced representation can be shared among the design team.

Costain has invested in this technology to successfully deliver numerous projects. However, given the age of the structures
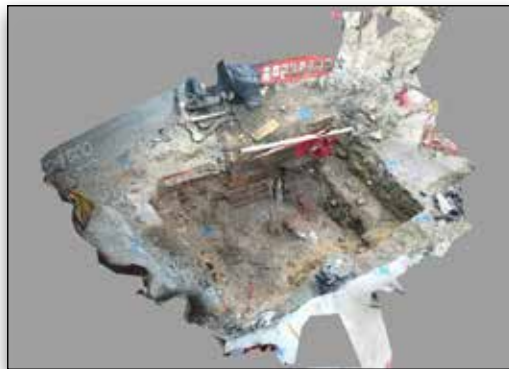
ContextCapture automatically processed images into accurate 3D mesh models documenting existing conditions of London Bridge Station and facilitating decision making for redevelopment.

at London Bridge Station and limitations of laser scanning (a process that would take months to complete), Costain's graduate surveyor, Richard Bath, experimented with photogrammetry to ensure each brick in the existing structures would match perfectly with the new façade.

Using a simple camera to capture the old surface area delivered a denser survey than the scanner and provided color, enabling designers to quickly identify the bricks from the mortar joints. Additionally, photogrammetry was less disruptive to the onsite workers given the speed and size of a small digital camera, or even just a smartphone, to survey the site. The workers were able to move out of the area while Bath recorded a video or snapped a few photos, and within minutes returned to their assigned task.

Using Bentley ContextCapture allowed Costain to process the images into accurate 3D mesh models that facilitated decision making and provided documentation of existing conditions for use not only in the London Bridge Station reconstruction, but also throughout the lifecycle of the infrastructure for maintenance and future projects.

A Simplified Workflow

Another advantage of photogrammetry is that it accelerated workflows. While laser scanning requires highly skilled, well-trained technicians to obtain a virtual 3D representation, photogrammetry requires only a camera to snap a few photos, and using ContextCapture automatically generates the 3D reality model.

Costain followed a basic four-step workflow process: 1) Mark ground control points (GCPs) of the area of interest and ensure they are clearly visible in the photos; 2) take pictures from varying angles and elevations surrounding the area; 3) survey the GCPs (at least three are needed to scale and geo-reference the model); and 4) process photos and GCPs together using ContextCapture to produce the final model in a range of deliverables.

The first two steps can be implemented by anyone with five minutes training on determining the best method to mark GCPs and take the photos to ensure optimal deliverables. The final step uses Bentley's reality-capture software and is completely automated, aside from the limited user time required for uploading the pictures and identifying the GCPs. While the overall processing time varies according to number of photos and GCPs, the entire workflow, from taking the photos, surveying the GCPs, and processing, can be completed in under an hour.

Automatic 3D Reconstruction Delivers Optimal Results

Comparing the accuracy of photogrammetry to that of laser scanning on the project, Bath observed there was a difference of a few millimeters for many uses on site, such as excavations. And, while the accuracy of the final 3D reality mesh predominantly relies on the comprehensiveness of the photos acquired, it is not imperative to invest in an expensive camera. The entire process from initial photography through to the 3D model is automated; and for the London Bridge Station reconstruction project, produced sufficiently accurate results that optimized costs and other project deliverables.

Photogrammetry saved time for data collection and eliminated the bottleneck associated with sharing a scanner among two dozen surveyors. Furthermore, using a camera is much less expensive than the cost of a laser scanner. Photogrammetry and ContextCapture provided a safe, reliable non-contact survey technique that streamlined workflows and improved efficiency. Using Bentley software for the London Bridge Station reconstruction saved time and costs while reducing the chance of misinterpretation, enhancing reliability and decision making on this railway redevelopment initiative that, upon completion in 2018, will transform travel throughout London and the UK, expanding through-station passenger capacity to 90 million people annually.

Said Bath, "ContextCapture is providing Bentley users like Costain a software environment that is progressing the use of reality 3D capture on a construction site. With just a smartphone, the entire workforce has the potential to document visually-rich 3D construction progress with a minimal amount of training. ContextCapture is changing data capture onsite."