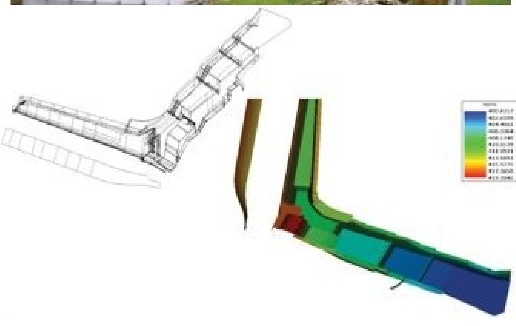
Bavarian Surveyors use a Multi-pronged Approach to Support Critical Infrastructure



The Alzkanal is a key component of Germany's industrial and clean power infrastructure that was due for maintenance and repairs. Detailed inspection and planning is normally needed prior to the work. But in this case, the worksite was a canal filled with fast-flowing water – and it needed to stay that way as much as possible.

The canal operators faced a paradox: How do you develop a strategy to repair and maintain something that you can't see or access? The answer would come from a small group of surveyors and engineers using an array of geospatial technologies.

Planning for the Challenge

Located in southern Bavaria, the Alzkanal carries water from the Alz River to the Danube River in the city of Burghausen on the Austrian border. The 40km canal was commissioned in 1923 to supply water for three hydroelectric power stations. The stations are the primary power source for industrial facilities along its route. In addition to hydropower, the canal's water provides fire protection for the surrounding communities.

Like any large infrastructure, the Alzkanal requires periodic maintenance. Canal operators have performed inspection and maintenance at roughly 20 year intervals, with the last major work taking place in 1998. During maintenance, the canal is cleaned and any cracks or damaged areas are filled and sealed. But the maintenance is costly. In addition to the expense of materials and labour for repairs, the canal must be shut down and drained during the work. During that time, electricity users must purchase power from other, more costly, sources, and municipalities need to find alternative sources for fire protection water. As a result, it is imperative to keep the shutdowns as brief as possible.

The maintenance was scheduled for a 16.8km section of the canal. The shutdown was planned to last eight weeks. The schedule was inflexible due to the cost of the shutdown. Because the canal was kept full, it wasn't possible to perform any pre-shutdown inspections. The uncertainty and strict time constraints put pressure on the contractors tasked with inspection and repair. It was especially intense for the surveying teams, which needed to quickly provide comprehensive information on the condition of the canal and surrounding features and structures.

The canal operators selected SAK Ingenieurgesellschaft GmbH, an engineering and surveying consultancy located in nearby Traunstein, to provide surveying and related services for the canal refurbishment. According to SAK's Christian Fendt, the company was responsible for surveying the canal before and after the renovation. Prior to starting the work, SAK consulted with the owner to determine the scope and requirements for the survey, which would document existing conditions and provide data for structural analyses and construction planning.

The survey needed to provide precise measurements of the channel surface at a point density of 2cm. In addition to surveying the channel, SAK was asked to provide 3D data extending out 100m along both sides of the canal. The work would involve technologies including aerial imaging, photogrammetry, total stations and static and mobile laser scanning. “Preplanning for construction was very limited because the channel is always full of water,” Fendt said. “The owner and contractors needed detailed information to perform the repairs. We had a very tight time frame to survey the channel to produce the required data.”

Coordinated Actions

The surveying began with a combination of GNSS and optical surveys to establish fixed control point for horizontal and vertical positioning. Two weeks before the shutdown, SAK used Trimble R10 GNSS receivers and a Trimble S8 1” total station to set points that would control aerial imaging and ground-based measurements. They installed 156 control points at intervals of roughly 300m on both sides of the canal.

Additional control was created near bridges over the canal.

The canal gates were closed on a Friday afternoon and the water level dropped rapidly. By Monday morning much of the channel was exposed. SAK started work using a Trimble UX5-HP unmanned aerial system (UAS). They completed eight missions over two days and captured nearly 5,100 images covering the entire length of the project.

SAK had designed the aerial work to move quickly. For example, the first mission covered 3.2km in one flight and captured 810 images at a height of 100m above the ground. When the UX5 landed, data was downloaded and immediately taken by motorcycle to the SAK office while the aircraft was cycled to start its next flight.

The data was loaded into Trimble UASMaster software as soon as it reached the SAK office. Technicians extracted tie points and created and stitched together multiple point clouds. Finished orthoimages of the site could be produced in roughly seven hours after the raw data arrived. SAK technicians also produced digital terrain models of the canal at the required 2cm ground density. In areas where the channel wasn’t visible from the air (the channel passes through two tunnels) they used a Trimble TX8 laser scanner to capture detailed data. By Tuesday afternoon, SAK had captured comprehensive data for the entire channel.

When the aerial work was complete, contractors swarmed over the channel to repair cracks and damage to the concrete and asphalt surface. SAK again turned to their TX8 laser scanner. As construction progressed, SAK scanned each completed segment, complementing the scanning with total station measurements to geo-reference the scans and capture parts of the channel that were beneath bridges or still underwater. They used Trimble RealWorks software to combine UAS, scanning and point data to manage and analyse the survey results.

Optimised Results

The scanning data provided precise “before and after” models of the channel and supported analysis of the work. Because the contractors were paid according to the size of cracks and volume of materials, they needed rapid, accurate results.

After the eight week shutdown was completed, SAK surveyed the surrounding above-ground elements (fences, canal stationing and related data). In addition to the static scanner and total station for this work, SAK tested mobile mapping solutions using vehicle and cart-mounted technologies.

Finished deliverables included point clouds, digital terrain models, cross sections and geo-referenced raw scanning data. In reviewing the work, Fendt attributed the project’s success to their ability to blend multiple technologies (UAS, scanning, GNSS and total stations) into a single solution. “Since the project worked well, we would use the same approach again,” he said. “Through good planning and cooperation, small teams can handle huge projects and tight schedules.”

This article was published in Geomatics World September/October 2018