

■ Pointcloud of Kijewo-Petscherska Lavra monastery in Kiev.

Holy Caves in 3D

by Valentyn Kovtun and Yuriy Serebrianny

Kiev Pechersk Lavra in Kiev, Ukraine is a unique monastery complex. In the course of its history it has been visited by over 43 million tourists from all parts of the world. It consists of an above-ground part (a complex of religious buildings) and an underground part (caves). A Leica ScanStation 2 and total stations now help preserve this UNESCO World Heritage Site.

The caves of Kiev Pechersk Lavra form a system of underground corridors subdivided into several parts – the Near Caves, the Far Caves and the Varangian Caves. The caves are first mentioned in the chronicles in the year 1051. Initially occupied by the monks, they were later used to bury deceased monastery settlers. The caves serve as a resting place for imperishable relics of saints.

The idea of creating a 3-dimensional model of Lavra's caves was suggested by Kiev Pechersk Lavra coe-

nobites. "Our aim is to attract public attention to the problem of preserving the Lavra Caves for future generations. Today the caves are in a desperate state and urgently need repair work," says Archbishop Pavel, Father Superior of Kiev Pechersk Lavra.

Laser Scanning Using Leica ScanStation 2

In November and December 2008, laser scanning of St. Anne's Conception Church in the Far Caves of Kiev Pechersk Lavra was performed by Ukrgeodezmark Subsidiary Company in cooperation with the official Leica Geosystems dealer in Ukraine, Doka. The work was carried out within the scope of a cave laser scanning project with the goal of creating a visualization of the cave interior. Work specifications for this scanning project were developed by Ukrgeodezmark Subsidiary Company specialists Sergey Marchuk and Maksim Mikhailov.

Laser scanning with 2 cm resolution was performed using the new Leica ScanStation 2. The work was carried out at night due to high cave attendance





in the daytime. Previously created survey networks in the local coordinate system were used as a geodetic base for scanning. Additional measurements in those parts of the caves that presented difficulties were performed using a Leica TCR1201+ total station. "This is the most advanced equipment in the world today," assured Yuriy Serebrianny, Director of Doka, Ltd.

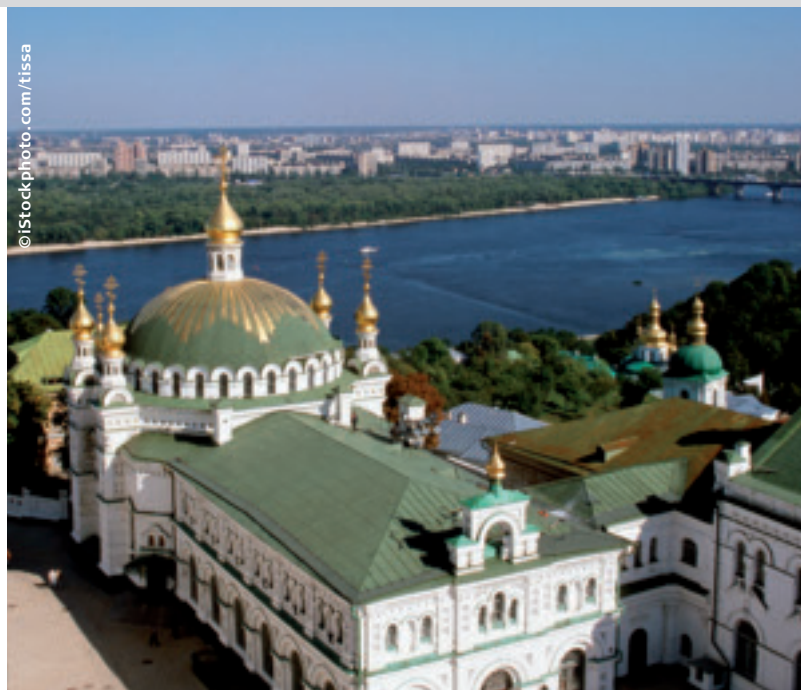


The Leica ScanStation 2 demonstrated high reliability in the work process and the scanning results are yet another testimony to its unparalleled performance. According to the statement made by Ukrgeodezmark's Director Nikolay Belous at the press-conference organized by Kiev Pechersk Lavra priests, the equipment is so accurate that it records the slightest wall irregularities and even murals. "After all the work is done, it will be possible to walk through all of Lavra's caves while sitting on a couch with a cup of tea," said Mr. Belous. However, according to Project Manager Valentyn Kovtun, some of the caves remain unexamined since their entrances are still blocked up.

Labyrinth Modelling

Based on the results of surface scanning and 3D modelling, the next step is a visualization of the entire cave labyrinth using proprietary technology. First, triangulation models of object surfaces are created with a 50x50 mm increment. This increment may be reduced to 25x25 mm for places with complicated surfaces and room interiors. Then the entire object is modelled by combining individual triangulation modules of object surfaces (walls, ceiling, floor etc).

All walls, floors and ceilings of caves and rooms are modelled using primitives of Polyface Mesh type. The scanning results are processed by the Leica Cyclone software suite. Three-dimensional models are created using specialized software by combining triangulation models generated based on scanning data with high-quality photographic material. As a result, a user can view the completed model, freely move around it and get additional information.



Future plans include creation of a three-dimensional Kiev Pechersk Lavra geographic information system (GIS). Availability of such a 3D GIS would allow reproduction of the unique Lavra architecture, including its smallest details, at any time with maximum possible accuracy and speed.

3D Technologies: the Future of Visualization

Today 3D laser scanning is an integral and the most promising part of engineering surveying in the field of architecture, construction and historical and cultural heritage. Use of the latest laser scanning technologies from Leica Geosystems opens up new horizons for humankind in such areas as preservation of valuable historical and cultural objects for our descendants and ensuring general availability of the world's cultural heritage that would help spread culture and knowledge among citizens of all countries. A 3D visualization model would enable many pilgrims who cannot come to ancient Kiev in person to take a virtual "walk" through the holy caves of Kiev Pechersk Lavra and pay their respects to the sacred Christian relics. ■

About the authors:

Valentyn Kovtun, Project Manager at Ukrgeodezmark, is a general surveyor specializing in engineering, surveying and construction.

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Ancient Kiev

Ancient Kiev is over 1,500 years old. People call it "The Heart of Rus" and "The Mother of Rus Cities". Kiev was the historical centre of Slavic culture and the capital of powerful Kievan Rus.

According to legend, brothers Kiy, Shchek and Khoryv and their sister Lybid founded the city on the steep right bank of the River Dnepr in the late 5th – early 6th – century and named it Kyiv in honour of the eldest brother. The first mention of Kyiv in the Old Russian Primary Chronicle dates back to 862 A. D.

The history of the city of Kiev has been turbulent. In the 11th century it was already one of Europe's largest cities with a population of 50,000. Throughout its history the city, strategically located on the banks of the (navigable) Dnieper river, was repeatedly attacked and conquered – by Mongols, Poles, Russians and Nazi Germany to name just a few.

Kiev has been the capital of the Ukraine since the Ukrainian parliament declared its independence from Russia on 24 August 1992, and today it is the country's largest city with a population of nearly three million. With its many churches and monasteries it is of great importance, particularly to orthodox Christians.