Indoor Mobile Mapping Takes Off at LAX

A unique approach to interior data collection and management pays dividends for airport operators.

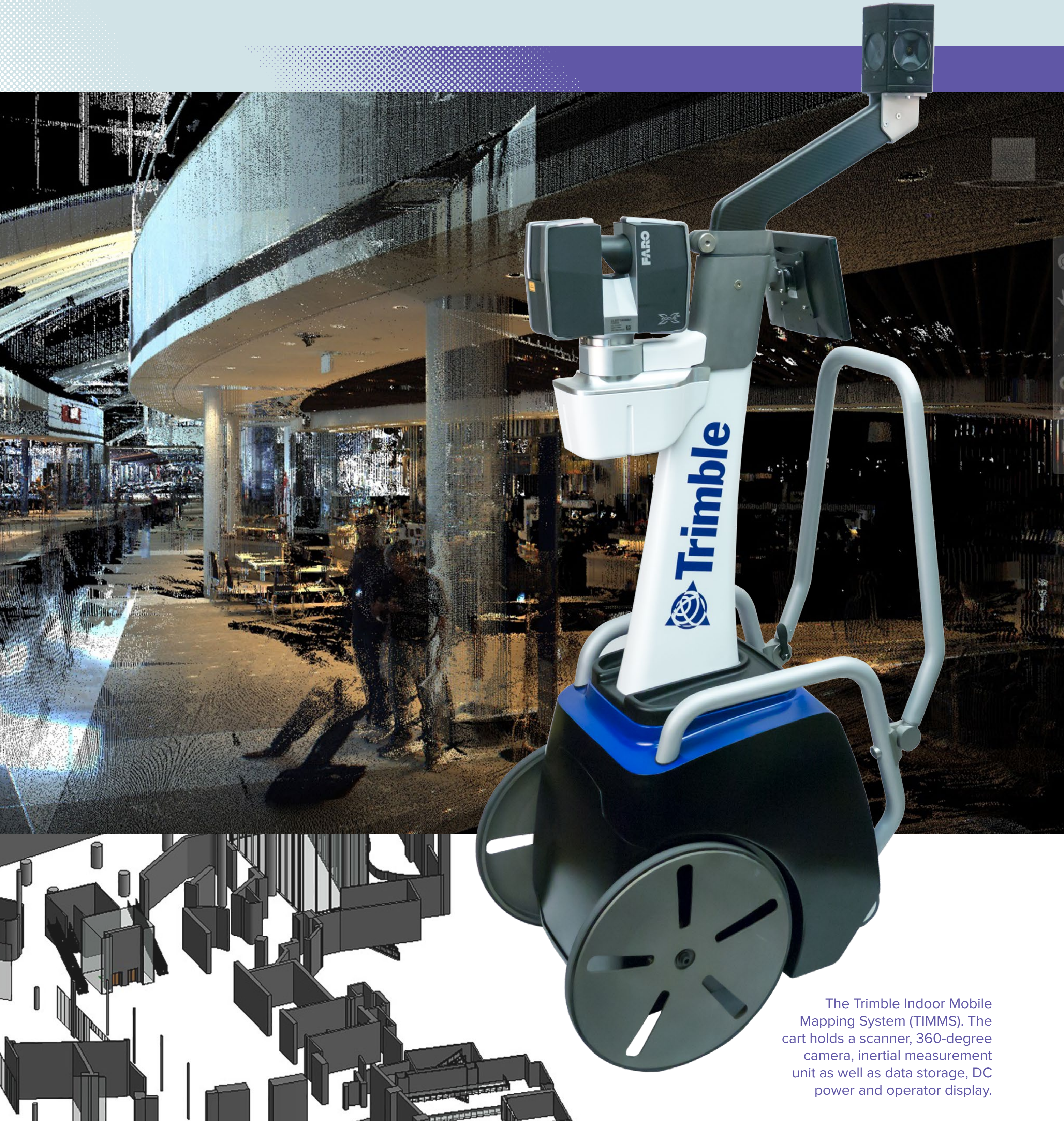
Airports are key components of the global transportation infrastructure. They are complex, expensive investments that require tight management. In order to achieve efficient operations and optimized return on investment, it's essential to have accurate, up-to-date information on the broad range of assets and facilities. The sheer volume and variety of assets introduces challenges for airport operators tasked with managing the complicated operations.

Many airports use geospatial technologies as part of the process to understand and manage airport assets. By combining on-site data collection with GIS, CAD and sophisticated data management, specialized solutions providers can deliver accurate, high-quality information on airport assets. At Los Angeles International Airport (LAX), integrated solutions for indoor mobile mapping are providing significant savings in time and cost to capture and process detailed geospatial information.

Point cloud and images captured at LAX. The data includes passengers and luggage that will be removed during processing.

After modeling, features in a terminal are rendered as 3D objects.

BY JOHN STENMARK



The Trimble Indoor Mobile Mapping System (TIMMS). The cart holds a scanner, 360-degree camera, inertial measurement unit as well as data storage, DC power and operator display.

Terminal 3 and the Tom Bradley International Terminal at LAX. Conventional scanning surveys of the buildings would require several weeks of field work.

Big Data at a Big Airport

Operated by Los Angeles World Airports (LAWA), LAX is the sixth busiest airport in the world. Its nine terminals and four runways will serve an estimated 74 million passengers in 2016. The airport is a hub for international passenger traffic and its massive cargo facilities handle roughly 2 million tons of freight and mail annually.

As part of their management processes, LAWA periodically surveys the terminals at LAX to check for changes and ensure as-built data is up to date. Two terminals—the Tom Bradley International (TBIT) and Terminal 3—have undergone numerous renovations. As a result, the buildings required more in-depth and rigorous surveys. LAWA identified a total of 1.75 million sq. ft. (40.1 ac or 16.2 ha) of interior space that needed new surveys.

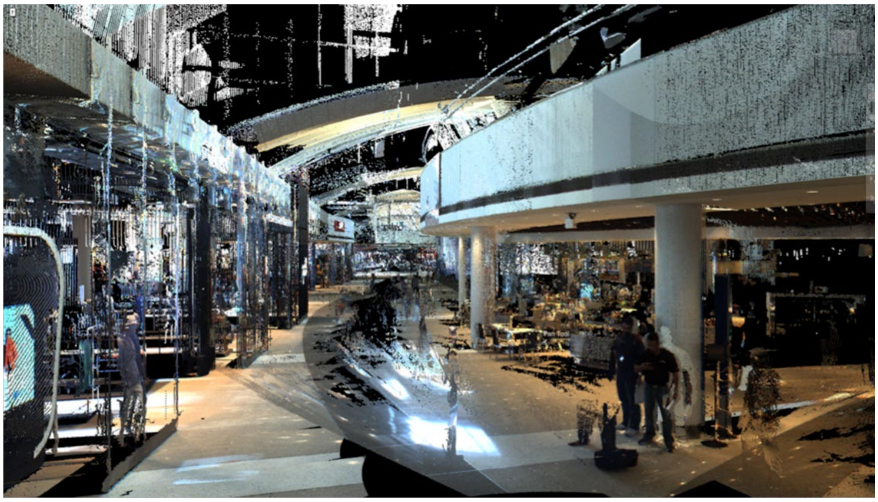
The work at LAX encompassed field surveying and data processing to produce georeferenced GIS data, 2D floor plans and 3D models for all of Terminal 3 and three floors in TBIT. LAWA turned to x-Spatial, LLC, a Los Angeles-based company that provides software solutions for airport infrastructure management. In addition to managing the data collection work, x-Spatial provides tools for management and integration of spatial and enterprise information.

Multi-purpose Spatial Data

According to x-Spatial president Ed Maghboul, collecting and managing spatial data at airports is especially challenging. "Just about everything in the airport needs to be tracked," he said. "We look at pavement and pavement structure down to a very granular level of 20 by 25-foot concrete tiles for runways and taxiways. We also look at the terminals, number of square feet in a terminal, what kind of assets, what are the rooms, what kind of equipment are in those rooms and then linking the equipment with the airport's maintenance management system."

Maghboul explained that spatial data provides information in three primary areas. First, it's used to locate and identify physical assets. The data can be used for as-built and asset management including underground utilities, architectural planning, space optimization and security. For many buildings, spatial data may exist only as construction plans that don't include data on years of change and remodeling. The incomplete or inaccurate information can result in expensive surprises when airports need to modify or expand existing facilities.

A second application comes from management of space leased by freight companies, airlines and concessionaires.



TIMMS data display with 1-cm data density. Lower densities ease data management while providing required levels of detail and precision.

Aerial view of LAX. The airport handled nearly 615,000 takeoffs and landings in 2013.

In addition to providing tools for managing tenant agreements and payments, x-Spatial uses spatial data to define and map leased spaces in rental agreements.

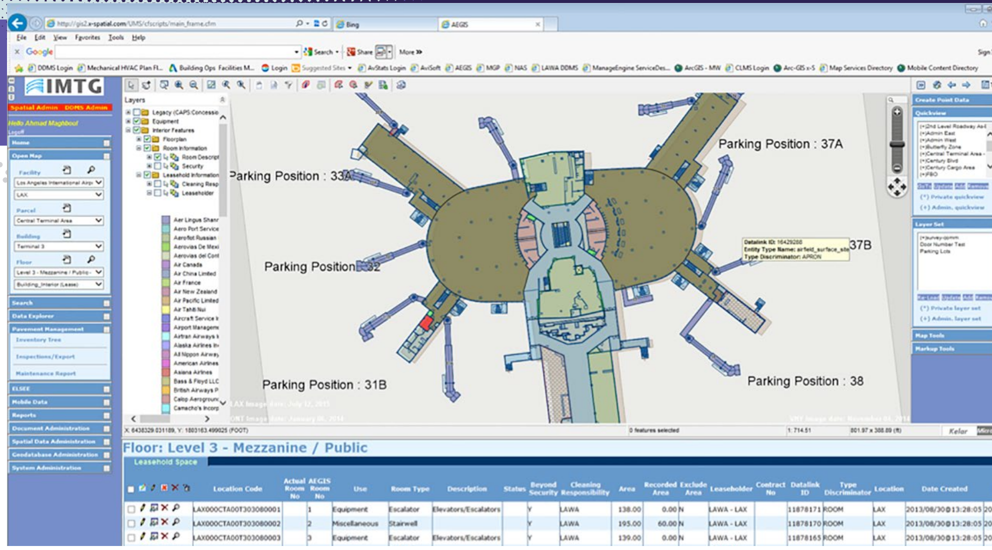
In a third application, first responders and emergency managers can use accurate spatial data to plan and execute emergency procedures. Maghboul points to a 2016 incident at Terminal 3 in which dozens of people were inadvertently evacuated from the terminal onto the tarmac. Security procedures then required the entire concourse area to be shut down and emptied. Roughly 2,000 people needed to be rescreened resulting in delays to dozens of outgoing flights. "Some of the planning could have been better," Maghboul said. "That is where we come in—enabling geospatial data to be shared in a common, standardized environment and then providing web interfaces that enable the enterprise to leverage their information."

In addition to the scope of the work at LAX, x-Spatial was under a tight time frame to complete the survey and deliverables. To meet the schedule, they needed to complete the work quickly. Normally, they would use static 3D scanning with conventional tripod-mounted scanners. But Maghboul estimated that the static approach would require up to six weeks of field work and a similar time for processing and modeling. In addition, the scanning would need to be done at night when activity was light. But at LAX, and especially the international terminal, it's busy all the time. Static scanning was not the answer.

To gather field data with the needed speed and accuracy, x-Spatial turned to the Trimble® Indoor Mobile Mapping System (TIMMS). Based on the concepts of vehicle-mounted mobile mapping (but without the need for GPS), TIMMS integrates a 3D scanner, 360-degree camera and inertial measurement unit (IMU), user display and control electronics; the components are mounted on a small cart. The system is powered using hot-swappable batteries. As an operator pushes the cart at walking speed, the system captures 3D points and images. Data from the IMU supplies positioning information. To provide a georeferenced framework, x-Spatial contracted outside surveyors using a Trimble 5601 total station to establish a network of 3D control points inside the terminals. The points were tied to high-accuracy WGS84 survey marks outside the terminals established by Trimble R8 GNSS receivers. A team of specialists from Applanix operated the TIMMS equipment.

Planning the surveys required coordination with multiple teams to ensure efficient and comprehensive coverage. To provide access and security, LAWA personnel accompanied the TIMMS crew during the work. Certain locations, including Federal Inspection Services (FIS) areas controlled by U.S. Customs and Immigration, required special permission and could be scanned only when no passengers were present.

High-density data captured by TIMMS at LAX. Points and images were automatically connected to the geographic control network.



Information from TIMMS provided spatial basis for GIS maps at LAX. Spatial information linked to other databases supports asset management and maintenance operations.

Other parts of the terminals came with more interesting constraints, Maghboul recalled. "In some passenger lounges, the managers were concerned about noise and disturbing their customers," he said. "We showed that the carts were quiet and wouldn't scratch the floors."

An On-time Arrival

With the planning and control in place, the scanning team moved in. For each scanning run they initialized the TIMMS cart using the indoor control points and then pushed the cart along preplanned routes through the terminals. A display on the TIMMS cart provided information on the status and performance of the system. At the end of each run, the operator checked into a control point to provide a check for the IMU data.

The work progressed smoothly. In just 32 hours of operation, mostly during normal working hours, the TIMMS cart captured comprehensive 3D scans and spherical imagery on the two terminals.

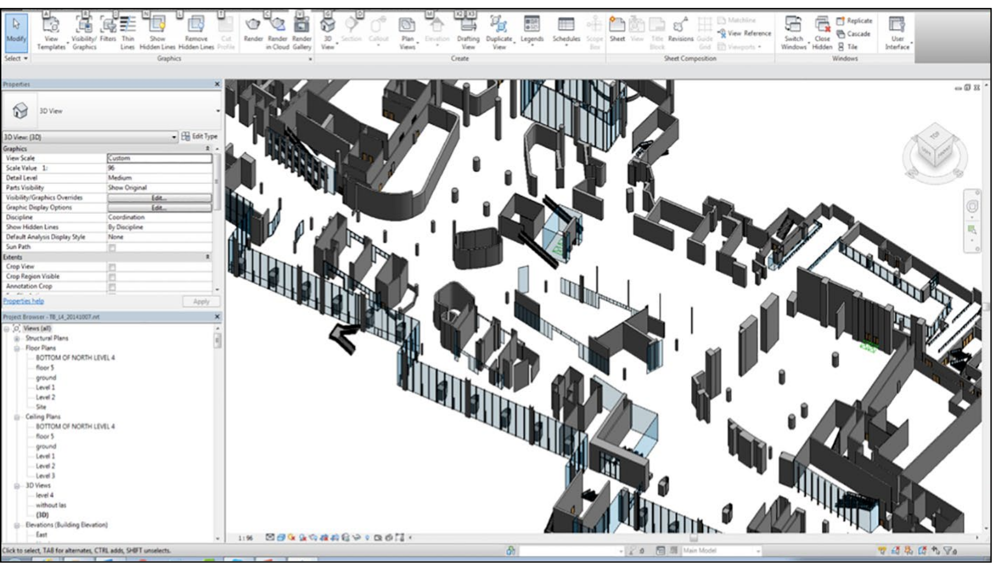
The time savings continued when the field data moved to the office.

Technicians used the TIMMS Post Processing Suite to create 3D point clouds and panoramic images from the raw data. Because TIMMS connects scanning directly to data from the IMU, points and images could be georeferenced as they were captured. When compared to static scanning and the need to register hundreds of separate scans, the TIMMS approach significantly reduced post processing for the raw data.

The finished output included high-density point clouds as well as clouds at 1- and 5-cm density. The positioning accuracy for the work was 1 to 2 cm.

After the initial processing, the Applanix technicians moved the TIMMS data (in LAS format) into Autodesk software, where they created deliverables including 3D models and 2D floor plans. x-Spatial then pushed the information into the geospatial database used by LAX and made it available to airport management teams.

Maghboul said the TIMMS provided a flexible, unobtrusive method to capture a massive amount of data on a congested, complicated site. He suggested that airports establish a network of permanent control marks to facilitate scanning and rescanning over several years. The approach makes it easier to manage and updates part of the spatial database as renovations and upgrades occur. "It's certainly a worthwhile endeavor," Maghboul said. "But you need to do careful planning and coordinate with a lot of people." ■


A 3D model developed from TIMMS data. Images from TIMMS help to streamline the modeling process.

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