

Laser scanning: a powerful tool for school projects

■ *High-tech process could transform how existing building conditions are documented for school remodeling and renovation projects.*

Technological advances can be both inspiring and challenging, however good ideas can be quickly adopted once logistical hurdles are overcome.

Smartphones are a good

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has been around for a while but increased storage capacity, portability and processing speed have allowed for mainstream applications in the architecture, engineering and construction industry.

The ability to accomplish virtual “as-building” — documenting an existing building’s structures and systems — by rapidly capturing millions of three-dimensional data points and then using this information in a building-information modeling application will usher an industry shift in how we go about this process. For large public projects such as renovations or rehabilitations

of existing K-12 and higher-ed buildings (which require accurate documentation of existing facilities) laser-scanning technology resolves many of the inherent problems of old-fashioned tape measure as-building.

Scanning process

Laser scanning is a process where a tripod-mounted laser sends out a beam of light. When a reflective surface is hit, the point in space is recorded as a distance, bearing and azimuth. This process is repeated with the bearing angle and azimuth incrementally changed to create a “point cloud.”

Most laser-scanning devices can provide a full 360-degree scan with full coverage, except for a small cone occupied by the tripod below the device. Accuracy and point density can be within an eighth of an inch out to about 75 feet, and the actual time for scanning can be as little as five minutes. The data is downloaded to software that converts the raw data into a point-cloud file of X, Y and Z coordinates, and a panoramic digital image is usually also provided along with the scan.

At the site, several instrument setups in adjacent locations are required to provide full coverage of the inside or outside of a building. The



A tripod-mounted laser sends out a light beam to record the coordinates of the surrounding surfaces.

Images courtesy of PCS Structural Solutions

laser scans work on the principle of line of sight and cannot see behind pipes, columns, walls and so on.

Several common points (usually reflective targets) are set up to allow the separate point cloud files to be indexed to one another. Software is used in a process called registration to create a single point cloud with the data files merged together to form a true 3-D representation. The scanning is typically done by a one- or two-person

crew, and the registration process is accomplished by office support staff utilizing proprietary software.

The latest versions of 3-D BIM software such as Revit allow for the point clouds to be linked into the model, and the data points are used to model locations of the building components. While a representation of the three-dimensional data can be visually observed, a critical step in the process is transforming the raw data into

a usable model that can then be used for design, detailing and construction.

Unfortunately, the point cloud does not have “intelligence” beyond X, Y, Z geometry and it must be linked in as a background for the creation of a 3-D parametric model. The point cloud can be used to create new geometry or to verify the accurate configuration of a previously built model.

A time saver

In the past, using a tape measure, along with sketches and notes, was the only way to confirm as-built conditions. When existing drawings are not available or don't accurately reflect the way the building was constructed, an extended visit to the site was often required.

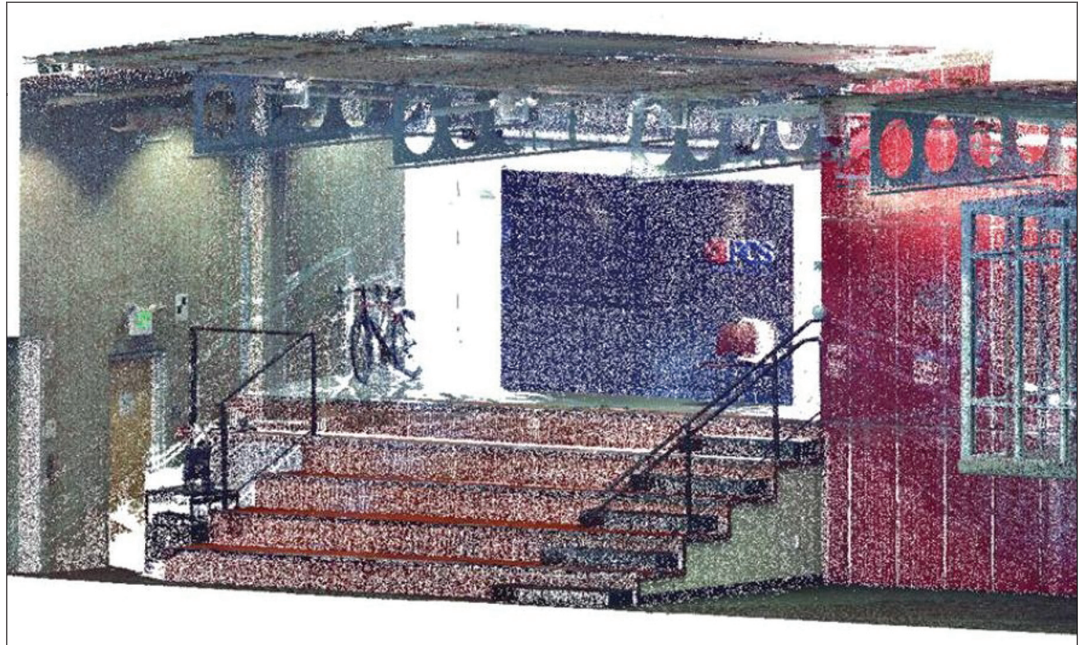
Getting accurate dimensional data with these techniques can be difficult, dangerous and prone to error. Not obtaining a critical dimension can necessitate several return visits. Accurate three-dimensional data that reflects the actual field conditions can reduce errors and associated change orders.

Existing facilities are prime applications for laser scanning to allow an accurate 3-D model of the existing conditions to be obtained.

New structural and mechanical work can be integrated with existing systems with a high degree of confidence in existing geometry and functionality of new components. Another benefit is the ability to visualize existing conditions and new work.

The model can be a powerful visualization tool for owners to “walk through” a remodeled area to react to familiar existing conditions. This allows the owner to offer input on programming and processes that would be difficult to assess from the review of multiple sheets of 2-D plans and elevations.

Similarly, both designers and contractors are able to gather to view the 3-D model for coordination of existing and new systems. Each discipline can utilize the model as a basis for the design, ensuring everyone has the same starting point for



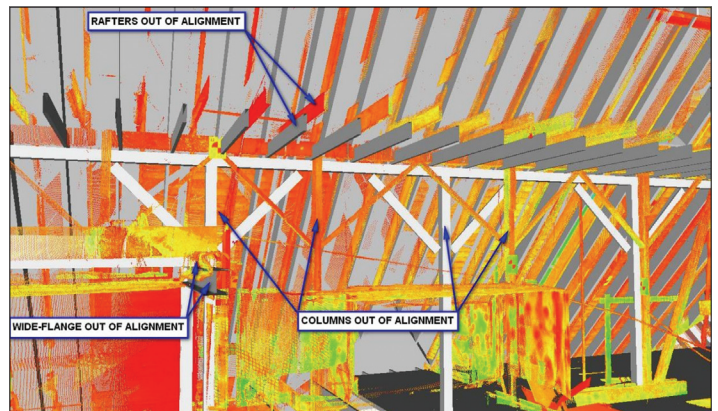
Laser scanning can easily capture complex shapes. When multiple scans are merged, most “shadows” are filled in to the complete the 3-D image, like with the bicycle above the stairs.

an understanding of the existing conditions.

The laser scan can also be brought into an existing 3-D model to verify the precision of the model and check for interferences and “unknown” conditions that were not reflected on the existing 2-D documentation. The progress and accuracy of construction can be verified by scanning a work area on the site and comparing it to the model. With the proper forethought, utility and mechanical, electrical and plumbing conditions can be documented by laser scanning prior to covering for a record of the “buried” components.

Many uses

Historic renovation can be enhanced by the ability to scan both the interior and facade to capture the configuration and condition of critical elements. The precision of the scans will allow replication of deteriorated or missing building components without needing to cast molds or meticulously detail existing configurations at the site. The accompanying panoramic photographic images can be used for presentations and also provide a great way to virtually revisit the site if



This laser scan of a project at University of Washington's Denny Hall identified the differences between the 3-D model built from the “as-built” documents from 1890 and the actual building conditions.

In collaboration with BNBuilders and THA Architecture, courtesy of PCS Structural Solutions

questions arise regarding the actual site conditions.

Not unlike 3-D BIM, laser scanning has been utilized by the airline, automotive and other industries for many years for prototyping and precision documentation of existing conditions. The architecture, engineering and construction industry is now applying this technology to improve workflow and construction processes. Laser scanning has the potential to fundamentally transform how existing conditions are documented and coordinated with new construction.

The speed and ease with which scanning can now be accomplished lends itself to scanning in-progress work to confirm schedule adherences as well as capturing 3-D and photographic images of roughed-in conditions prior to the installation of finishes.

In the near future, point clouds will be as commonplace as any other design/construction process, and it will soon be said, “We just can't imagine doing it any other way.”

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